

**SECTION 22 05 11**  
**COMMON WORK RESULTS FOR PLUMBING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section shall apply to all sections of Division 22.
- B. Definitions:
  - 1. Exposed: Piping and equipment exposed to view in finished rooms.
  - 2. Exterior: Piping and equipment exposed to weather be it temperature, humidity, precipitation, wind or solar radiation.
- C. Abbreviations/Acronyms:
  - 1. ABS: Acrylonitrile Butadiene Styrene
  - 2. AC: Alternating Current
  - 3. ACR: Air Conditioning and Refrigeration
  - 4. A/E: Architect/Engineer
  - 5. AFF: Above Finish Floor
  - 6. AFG: Above Finish Grade
  - 7. AI: Analog Input
  - 8. AISI: American Iron and Steel Institute
  - 9. AO: Analog Output
  - 10. ASHRAE: American Society of Heating Refrigeration, Air Conditioning Engineers
  - 11. ASJ: All Service Jacket
  - 12. ASME: American Society of Mechanical Engineers
  - 13. ASPE: American Society of Plumbing Engineers
  - 14. AWG: American Wire Gauge
  - 15. BACnet: Building Automation and Control Network
  - 16. BAg: Silver-Copper-Zinc Brazing Alloy
  - 17. BAS: Building Automation System
  - 18. BCuP: Silver-Copper-Phosphorus Brazing Alloy

- 19. bhp: Brake Horsepower
- 20. Btu: British Thermal Unit
- 21. Btu/h: British Thermal Unit per Hour
- 22. BSG: Borosilicate Glass Pipe
- 23. C: Celsius
- 24. CA: Compressed Air
- 25. CD: Compact Disk
- 26. CDA: Copper Development Association
- 27. CGA: Compressed Gas Association
- 28. CFM: Cubic Feet per Minute
- 29. CI: Cast Iron
- 30. CLR: Color
- 31. CO: Contracting Officer
- 32. COR: Contracting Officer's Representative
- 33. CPVC: Chlorinated Polyvinyl Chloride
- 34. CR: Chloroprene
- 35. CRS: Corrosion Resistant Steel
- 36. CWP: Cold Working Pressure
- 37. CxA: Commissioning Agent
- 38. dB: Decibels
- 39. db(A): Decibels (A weighted)
- 40. DCW: Domestic Cold Water
- 41. DDC: Direct Digital Control
- 42. DFU: Drainage Fixture Units
- 43. DHW: Domestic Hot Water
- 44. DHWR: Domestic Hot Water Return
- 45. DHWS: Domestic Hot Water Supply
- 46. DI: Digital Input
- 47. DI: Deionized Water

- 48. DISS: Diameter Index Safety System
- 49. DN: Diameter Nominal
- 50. DO: Digital Output
- 51. DOE: Department of Energy
- 52. DVD: Digital Video Disc
- 53. DWG: Drawing
- 54. DWH: Domestic Water Heater
- 55. DWS: Domestic Water Supply
- 56. DWV: Drainage, Waste and Vent
- 57. ECC: Engineering Control Center
- 58. EL: Elevation
- 59. EMCS: Energy Monitoring and Control System
- 60. EPA: Environmental Protection Agency
- 61. EPACT: Energy Policy Act
- 62. EPDM: Ethylene Propylene Diene Monomer
- 63. EPT: Ethylene Propylene Terpolymer
- 64. ETO: Ethylene Oxide
- 65. F: Fahrenheit
- 66. FAR: Federal Acquisition Regulations
- 67. FD: Floor Drain
- 68. FDC: Fire Department (Hose) Connection
- 69. FED: Federal
- 70. FG: Fiberglass
- 71. FNPT: Female National Pipe Thread
- 72. FOR: Fuel Oil Return
- 73. FOS: Fuel Oil Supply
- 74. FOV: Fuel Oil Vent
- 75. FPM: Fluoroelastomer Polymer
- 76. FSK: Foil-Scrim-Kraft Facing

- 77. FSS: VA Construction & Facilities Management, Facility Standards Service
- 78. FU: Fixture Units
- 79. GAL: Gallon
- 80. GCO: Grade Cleanouts
- 81. GPD: Gallons per Day
- 82. GPH: Gallons per Hour
- 83. GPM: Gallons per Minute
- 84. HDPE: High Density Polyethylene
- 85. HEFP: Healthcare Environment and Facilities Program (replacement for OCAMES)
- 86. HEX: Heat Exchanger
- 87. Hg: Mercury
- 88. HOA: Hands-Off-Automatic
- 89. HP: Horsepower
- 90. HVE: High Volume Evacuation
- 91. Hz: Hertz
- 92. ID: Inside Diameter
- 93. IE: Invert Elevation
- 94. INV: Invert
- 95. IPC: International Plumbing Code
- 96. IPS: Iron Pipe Size
- 97. IW: Indirect Waste
- 98. IWH: Instantaneous Water Heater
- 99. Kg: Kilogram
- 100. kPa: Kilopascal
- 101. KW: Kilowatt
- 102. KWH: Kilowatt Hour
- 103. lb: Pound
- 104. lbs/hr: Pounds per Hour
- 105. LNG: Liquid Natural Gas



- 106. L/min: Liters per Minute
- 107. LOX: Liquid Oxygen
- 108. L/s: Liters per Second
- 109. m: Meter
- 110. MA: Medical Air
- 111. MAWP: Maximum Allowable Working Pressure
- 112. MAX: Maximum
- 113. MBH: 1000 Btu per Hour
- 114. MED: Medical
- 115. MER: Mechanical Equipment Room
- 116. MFG: Manufacturer
- 117. mg: Milligram
- 118. mg/L: Milligrams per Liter
- 119. ml: Milliliter
- 120. mm: Millimeter
- 121. MIN: Minimum
- 122. MV: Medical Vacuum
- 123. N2: Nitrogen
- 124. N2O: Nitrogen Oxide
- 125. NC: Normally Closed
- 126. NF: Oil Free Dry (Nitrogen)
- 127. NG: Natural Gas
- 128. NIC: Not in Contract
- 129. NO: Normally Open
- 130. NOM: Nominal
- 131. NPTF: National Pipe Thread Female
- 132. NPS: Nominal Pipe Size
- 133. NPT: Nominal Pipe Thread
- 134. NTS: Not to Scale

- 135. O2: Oxygen
- 136. OC: On Center
- 137. OD: Outside Diameter
- 138. OSD: Open Sight Drain
- 139. OS&Y: Outside Stem and Yoke
- 140. PA: Pascal
- 141. PBPU: Prefabricated Bedside Patient Units
- 142. PD: Pressure Drop or Difference
- 143. PDI: Plumbing and Drainage Institute
- 144. PH: Power of Hydrogen
- 145. PID: Proportional-Integral-Differential
- 146. PLC: Programmable Logic Controllers
- 147. PP: Polypropylene
- 148. ppb: Parts per Billion
- 149. ppm: Parts per Million
- 150. PSI: Pounds per Square Inch
- 151. PSIA: Pounds per Square Inch Atmosphere
- 152. PSIG: Pounds per Square Inch Gauge
- 153. PTFE: Polytetrafluoroethylene
- 154. PVC: Polyvinyl Chloride
- 155. PVDF: Polyvinylidene Fluoride
- 156. RAD: Radians
- 157. RO: Reverse Osmosis
- 158. RPM: Revolutions Per Minute
- 159. RTD: Resistance Temperature Detectors
- 160. RTRP: Reinforced Thermosetting Resin Pipe
- 161. SAN: Sanitary Sewer
- 162. SCFM: Standard Cubic Feet per Minute
- 163. SDI: Silt Density Index

- 164. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
- 165. SPEC: Specification
- 166. SPS: Sterile Processing Services
- 167. SQFT/SF: Square Feet
- 168. SS: Stainless Steel
- 169. STD: Standard
- 170. SUS: Saybolt Universal Second
- 171. SWP: Steam Working Pressure
- 172. TD: Temperature Difference
- 173. TDH: Total Dynamic Head
- 174. TEFC: Totally Enclosed Fan-Cooled
- 175. TEMP: Temperature
- 176. TFE: Tetrafluoroethylene
- 177. THERM: 100,000 Btu
- 178. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 179. THWN: Thermoplastic Heat & Water Resistant Nylon Coated Wire
- 180. TIL: Technical Information Library <http://www.cfm.va.gov/til/indes.asp>
- 181. T/P: Temperature and Pressure
- 182. TYP: Typical
- 183. USDA: U.S. Department of Agriculture
- 184. V: Vent
- 185. V: Volt
- 186. VA: Veterans Administration
- 187. VA CFM: VA Construction & Facilities Management
- 188. VA CFM CSS: VA Construction & Facilities Management, Consulting Support Service
- 189. VAC: Vacuum
- 190. VAC: Voltage in Alternating Current
- 191. VAMC: Veterans Administration Medical Center
- 192. VHA OCAMES: This has been replaced by HEFP.

- 193. VSD: Variable Speed Drive
- 194. VTR: Vent through Roof
- 195. W: Waste
- 196. WAGD: Waste Anesthesia Gas Disposal
- 197. WC: Water Closet
- 198. WG: Water Gauge
- 199. WOG: Water, Oil, Gas
- 200. WPD: Water Pressure Drop
- 201. WSFU: Water Supply Fixture Units

## **1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- G. Section 05 31 00, STEEL DECKING: Building Components for Attachment of Hangers.
- H. Section 05 50 00, METAL FABRICATIONS.
- I. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- J. Section 07 84 00, FIRESTOPPING.
- K. Section 09 51 00, ACOUSTICAL CEILINGS.
- L. Section 07 92 00, JOINT SEALANTS.
- M. Section 09 91 00, PAINTING.
- N. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- O. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- P. Section 22 07 11, PLUMBING INSULATION.
- Q. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- R. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- S. Section 31 20 00, EARTH MOVING: Excavation and Backfill.

### 1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Society of Mechanical Engineers (ASME):
  - B31.1-2013 ..... Power Piping
  - ASME Boiler and Pressure Vessel Code -
  - BPVC Section IX-2019 ..... Welding, Brazing, and Fusing Qualifications
- C. American Society for Testing and Materials (ASTM):
  - A36/A36M-2019 ..... Standard Specification for Carbon Structural Steel
  - A575-96(2013)e1 ..... Standard Specification for Steel Bars, Carbon, Merchant  
Quality, M-Grades
  - E84-2013a ..... Standard Test Method for Surface Burning Characteristics  
of Building Materials
  - E119-2012a ..... Standard Test Methods for Fire Tests of Building  
Construction and Materials
- D. International Code Council, (ICC):
  - IBC-2018 ..... International Building Code
  - IPC-2018 ..... International Plumbing Code
- E. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
  - SP-58-2018 ..... Pipe Hangers and Supports - Materials, Design,  
Manufacture, Selection, Application and Installation
- F. Military Specifications (MIL):
  - P-21035B ..... Paint High Zinc Dust Content, Galvanizing Repair (Metric)
- G. National Electrical Manufacturers Association (NEMA):
  - MG 1-2016 ..... Motors and Generators

H. National Fire Protection Association (NFPA):

51B-2019 ..... Standard for Fire Prevention During Welding, Cutting and  
Other Hot Work

54-2018 ..... National Fuel Gas Code

70-2020 ..... National Electrical Code (NEC)

99-2018 ..... Healthcare Facilities Code

I. NSF International (NSF):

5-2019 ..... Water Heaters, Hot Water Supply Boilers, and Heat  
Recovery Equipment

14-2019 ..... Plastic Piping System Components and Related Materials

61-2019 ..... Drinking Water System Components – Health Effects

372-2016 ..... Drinking Water System Components – Lead Content

J. Department of Veterans Affairs (VA):

PG-18-102014(R18) ..... Plumbing Design Manual

PG-18-13-2017(R18)..... Barrier Free Design Guide

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 11, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements, and all equipment that requires regular maintenance, calibration, etc are accessible from the floor or permanent work platform. It is the Contractor's responsibility to ensure all submittals meet the VA specifications and requirements and it is assumed by the VA that all submittals do meet the VA specifications unless the Contractor has requested a variance in writing and approved by COR prior to the submittal. If at any time during the project it is found that any item does not meet the VA specifications and there was no variance

approval the Contractor shall correct at no additional cost or time to the Government even if a submittal was approved.

- D. If equipment is submitted which differs in arrangement from that shown, provide documentation proving equivalent performance, design standards and drawings that show the rearrangement of all associated systems. Additionally, any impacts on ancillary equipment or services such as foundations, piping, and electrical shall be the Contractor's responsibility to design, supply, and install at no additional cost or time to the Government. VA approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, Contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- F. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.
- G. Manufacturer's Literature and Data including: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
  - 1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
  - 2. Equipment and materials identification.
  - 3. Firestopping materials.
  - 4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  - 5. Wall, floor, and ceiling plates.
- H. Coordination/Shop Drawings:

1. Submit complete consolidated and coordinated shop drawings for all new systems.
2. The coordination/shop drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to 1 foot).  
Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed coordination/shop drawings of all piping and duct systems. The drawings should include all lockout/tagout points for all energy/hazard sources for each piece of equipment. Coordinate lockout/tagout procedures and practices with local VA requirements.
3. Do not install equipment foundations, equipment or piping until coordination/shop drawings have been approved.
4. In addition, for plumbing systems, provide details of the following:
  - a. Mechanical equipment rooms.
  - b. Hangers, inserts, supports, and bracing.
  - c. Pipe sleeves.
  - d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- I. Rigging Plan: Provide documentation of the capacity and weight of the rigging and equipment intended to be used. The plan shall include the path of travel of the load, the staging area and intended access, and qualifications of the operator and signal person.
- J. Plumbing Maintenance Data and Operating Instructions:
  1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  2. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
    - a. Include complete list indicating all components of the systems.
    - b. Include complete diagrams of the internal wiring for each item of equipment.



- c. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- 3. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- K. Provide copies of approved plumbing equipment submittals to the TAB and Commissioning Subcontractor.
- L. Completed System Readiness Checklist provided by the CxA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.
- M. Submit training plans, trainer qualifications and instructor qualifications in accordance with the requirements of Section 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.

## **1.5 QUALITY ASSURANCE**

- A. Mechanical, electrical, and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional plumbing.
- B. Products Criteria:
  - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture, supply and servicing of the specified products for at least 5 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least 5 years.

2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within 4 hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, compressors, water heaters, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Contracting Officers Representative (COR).
5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be of the same manufacturer and model number, or if different models are required they shall be of the same manufacturer and identical to the greatest extent possible (i.e., same model series).
6. Assembled Units: Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark

- cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
8. Asbestos products or equipment or materials containing asbestos is prohibited.
  9. Bio-Based Materials: For products designated by the USDA's bio-based Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- C. Welding: Before any welding is performed, Contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME BPVC, Section IX, "Welding and Brazing Qualifications". Provide proof of current certification to CO.
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder and welding operator has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  4. All welds shall be stamped according to the provisions of the AWS or ASME as required herein and by the association code.
- D. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- E. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the COR for resolution. Printed copies or electronic

- files of manufacturer's installation instructions shall be provided to the COR at least 10 working days prior to commencing installation of any item.
2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include but are not limited to: all types of valves, filters and strainers, transmitters, and control devices. Prior to commencing installation work, refer conflicts between this requirement and contract documents to COR for resolution. Failure of the Contractor to resolve or call attention to any discrepancies or deficiencies to the COR will result in the Contractor correcting at no additional cost or time to the Government.
  3. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved by VA.
  4. Installer Qualifications: Installer shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity. Provide tradesmen skilled in the appropriate trade.
  5. Workmanship/craftsmanship will be of the highest quality and standards. The VA reserves the right to reject any work based on poor quality of workmanship this work shall be removed and done again at no additional cost or time to the Government.
- F. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with current telephone numbers and e-mail addresses.
- G. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- H. Plumbing Systems: IPC, International Plumbing Code. Unless otherwise required herein, perform plumbing work in accordance with the latest version of the IPC. For IPC codes referenced in the contract documents, advisory provisions shall be considered

mandatory, the word "should" shall be interpreted as "shall". Reference to the "code official" or "owner" shall be interpreted to mean the COR.

I. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC). All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

**1.6 DELIVERY, STORAGE AND HANDLING**

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage or theft.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the COR. Such replacement shall be at no additional cost or additional time to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.

4. Protect plastic piping and tanks from ultraviolet light (sunlight) while in pre-construction. Plastic piping and tanks shall not be installed exposed to sunlight without metal jacketing to block ultraviolet rays.

### **1.7 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing Contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing Contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
  1. As-built drawings are to be provided, with a copy of them on AutoCAD version provided on CD or DVD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and

numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.

- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics\_), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS FOR VARIOUS SERVICES**

- A. Non-pressure PVC pipe shall contain a minimum of 25 percent recycled content. Steel pipe shall contain a minimum of 25 percent recycled content.
- B. Plastic pipe, fittings and solvent cement shall meet NSF 14 and shall bear the NSF seal "NSF-PW". Polypropylene pipe and fittings shall comply with NSF 14 and NSF 61. Solder or flux containing lead shall not be used with copper pipe.
- C. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption and shall be certified in accordance with NSF 61 or NSF 372.
- D. In-line devices such as water meters, building valves, check valves, stops, valves, fittings, tanks and backflow preventers shall comply with NSF 61 and NSF 372.
- E. End point devices such as drinking fountains, lavatory faucets, kitchen and bar faucets, ice makers supply stops, and end-point control valves used to dispense drinking water must meet requirements of NSF 61 and NSF 372.

### **2.2 FACTORY-ASSEMBLED PRODUCTS**

- A. Standardization of components shall be maximized to reduce spare part requirements.

- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
  - 1. All components of an assembled unit need not be products of same manufacturer.
  - 2. Constituent parts that are alike shall be products of a single manufacturer.
  - 3. Components shall be compatible with each other and with the total assembly for intended service.
  - 4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly at no additional cost or time to the Government.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, shall be the same make and model.

### **2.3 COMPATIBILITY OF RELATED EQUIPMENT**

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

### **2.4 SAFETY GUARDS**

- A. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gauge sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 8 mm (1/4 inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- B. All Equipment shall have moving parts protected from personal injury.



## **2.5 LIFTING ATTACHMENTS**

- A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

## **2.6 ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING**

- A. All material and equipment furnished and installation methods used shall conform to the requirements of Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT; Section 26 29 11, MOTOR CONTROLLERS; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. All electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.
- B. Special Requirements:
  - 1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 at no additional cost or time to the Government.
  - 2. Assemblies of motors, starters, and controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
  - 3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
    - a. Wiring material located where temperatures can exceed 71° C (160° F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers and water heaters.
    - b. Other wiring at boilers and water heaters, and to control panels, shall be NFPA 70 designation THWN.

- c. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.
- 4. Motor sizes shall be selected so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
- 5. Motors utilized with variable frequency drives shall be rated "inverter-ready" per NEMA Standard, MG1.
- C. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency or Premium Efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient" and the requirements generally exceed those of the Energy Policy Act (EPACT), revised 2005. Motors not specified as "high efficiency or premium efficient" shall comply with EPACT.
- D. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal pumps may be split phase or permanent split capacitor (PSC).
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. A time delay (20 seconds minimum) relay shall be provided for switching from high to low speed.
- F. Rating: Rating shall be continuous duty at 100 percent capacity in an ambient temperature of 40° C (104° F); minimum horsepower as shown on drawings; maximum horsepower in normal operation shall not exceed nameplate rating without service factor.
- G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

## **2.7 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR CONTROLLERS for specifications.
- B. The combination of controller and motor shall be provided by the respective pump manufacturer and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps, shall be product of a single manufacturer.
- C. Motors shall be premium efficient type, "inverter duty", and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.

## **2.8 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown in the drawings, or shown in the maintenance manuals. Refer to Section 09 51 00 for access identification markers and Section 09 91 00 for identity marking and painting of systems to be accomplished by Mechanical Contractors Refer to Section 09 51 00 for access identification markers and Section 09 91 00 for identity markings and painting of systems to be accomplished by Mechanical Contractors.

## **2.9 FIRESTOPPING**

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping. Refer to Section 22 07 11, PLUMBING INSULATION, for pipe insulation.

## **2.10 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint.

## **2.11 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC)

and Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Submittals based on the International Building Code (IBC) and Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS requirements, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in the state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the COR in all cases. See the above specifications for lateral force design requirements.

- B. Type Numbers Specified: For materials, design, manufacture, selection, application, and installation refer to MSS SP-58. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
  - 1. Concrete insert: Type 18, MSS SP-58.
  - 2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
  - 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- D. For Attachment to Steel Construction: MSS SP-58.
  - 1. Welded attachment: Type 22.
  - 2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- E. Attachment to Metal Pan or Deck: As required for materials specified in Section 05 31 00, STEEL DECKING.
- F. For Attachment to Wood Construction: Wood screws or lag bolts.
- G. Hanger Rods: Hot-rolled steel, ASTM A36/A36M or ASTM A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 40 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

- H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 43 mm by 43 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gauge), designed to accept special spring held, hardened steel nuts.
1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
  2. Guide individual pipes on the horizontal member of every other trapeze hanger with 8 mm (1/4 inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 15 mm (1/2 inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.
- I. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 11, PLUMBING INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.
1. General Types (MSS SP-58):
    - a. Standard clevis hanger: Type 1; provide locknut.
    - b. Riser clamps: Type 8.
    - c. Wall brackets: Types 31, 32 or 33.
    - d. Roller supports: Type 41, 43, 44 and 46.
    - e. Saddle support: Type 36, 37 or 38.
    - f. Turnbuckle: Types 13 or 15.
    - g. U-bolt clamp: Type 24.
    - h. Copper Tube:
      - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, copper-coated, plastic coated or taped with isolation tape to prevent electrolysis.
      - 2) For vertical runs use epoxy painted, copper-coated or plastic coated riser clamps.

- 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
- 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
  - i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending 1 inch beyond steel support or clamp.
  - j. Spring hangers are required on all plumbing system pumps one horsepower and greater.
- 2. Plumbing Piping (Other Than General Types):
  - a. Horizontal piping: Type 1, 5, 7, 9, and 10.
  - b. Chrome plated piping: Chrome plated supports.
  - c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
  - d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gauge) minimum.
- J. Pre-insulated Calcium Silicate Shields:
  - 1. Provide 360-degree water resistant high density 965 kPa (140 psig) compressive strength calcium silicate shields encased in galvanized metal.
  - 2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  - 3. Shield thickness shall match the pipe insulation.
  - 4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting cold water shall have insulation that extends a minimum of 25 mm (1 inch) past the sheet metal.
    - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS SP-58. To support the load, the shields shall have one or more of the following features: structural inserts 4138 kPa (600 psig)

compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36/A36M) wear plates welded to the bottom sheet metal jacket.

5. Shields may be used on steel clevis hanger type supports, trapeze hangers, roller supports or flat surfaces.

K. Seismic Restraint of Piping: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

## **2.12 PIPE PENETRATIONS**

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all firestopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
  1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- D. Penetrations are prohibited through beams or ribs, but may be installed in concrete beam flanges, with structural engineer prior approval. Any deviation from these requirements must receive prior approval of COR.
- E. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- F. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.

- G. Galvanized steel or an alternate black iron pipe with asphalt coating sleeves shall be for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel sleeve shall be provided for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, sleeves shall be connected with a floor plate.
- H. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall be connected with a floor plate.
- I. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with firestopping material and sealant to prevent the spread of fire, smoke, water and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
- K. Pipe passing through roof shall be installed through a 4.9 kg per square meter copper flashing with an integral skirt or flange. Skirt or flange shall extend not less than 200 mm (8 inches) from the pipe and set in a solid coating of bituminous cement. Extend flashing a minimum of 250 mm (10 inches) up the pipe. Pipe passing through a waterproofing membrane shall be provided with a clamping flange. The annular space between the sleeve and pipe shall be sealed watertight.

## **2.13 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the COR, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- D. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and



properly identified as to use for each different application. Bio-based materials shall be utilized when possible.

## **2.14 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025 inch) for up to 75 mm (3 inch) pipe, 0.89 mm (0.035 inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

## **2.15 ASBESTOS**

- A. Materials containing asbestos are prohibited.

## **PART 3 - EXECUTION**

### **3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
- B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance, testing and operation of all devices including, but not limited to: all equipment items, valves, backflow preventers, filters, strainers, transmitters, sensors,

meters and control devices. All gauges and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown in the drawings shall not be changed nor reduced.

- D. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Cutting Holes:
  - 1. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
  - 2. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
  - 3. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by COR where working area space is limited.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other services are not shown but must be provided.
- H. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced at no additional cost or time to the Government.
  - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings,

equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

- I. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psig) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, shall be used for all pad or floor mounted equipment.
- J. Gauges, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gauges shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- K. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, alarms, instruments and computer workstations. Comply with NFPA 70.
- L. Domestic cold and hot water systems interface with the HVAC control system for the temperature, pressure and flow monitoring requirements to mitigate legionella. See the HVAC control points list and Section 23 09 23, DIRECT DIGITAL CONTROL SYSTEM FOR HVAC and Section 23 09 24, WATER QUALITY MONITORING.
- M. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers' putty.
- N. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above data equipment, and electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Drain valve shall be provided in low point of casement pipe.
- O. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be

removed and reinstalled or remedial action performed as directed at no additional cost or additional time to the Government.

2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

### **3.2 TEMPORARY PIPING AND EQUIPMENT**

- A. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of paragraph 3.1 shall apply.
- B. Temporary facilities and piping shall be completely removed back to the nearest active distribution branch or main pipe line and any openings in structures sealed. Dead legs are prohibited in potable water systems. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

### **3.3 RIGGING**

- A. Openings in building structures shall be planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.
- C. All openings in the building shall be closed when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.

- E. Contractor shall check all clearances, weight limitations and shall provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to COR for evaluation prior to actual work.

### **3.4 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the COR.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work shall be provided.
- D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC) and these specifications.
- E. Overhead Supports:
  - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
  - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
  - 3. Tubing and capillary systems shall be supported in channel troughs.
- F. Floor Supports:
  - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems

- shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
  3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.
  4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.5 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of 1 liter (1 quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be delivered to COR in unopened containers that are properly identified as to application.
- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

### **3.6 PLUMBING SYSTEMS DEMOLITION**

- A. Rigging access, other than indicated in the drawings, shall be provided after approval for structural integrity by the COR. Such access shall be provided at no additional cost or

time to the Government. Where work is in an operating plant, approved protection from dust and debris shall be provided at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.

- B. In an operating plant, cleanliness and safety shall be maintained. The plant shall be kept in an operating condition. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Work shall be confined to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Dust and debris shall not be permitted to accumulate in the area to the detriment of plant operation. All flame cutting shall be performed to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. All work shall be performed in accordance with recognized fire protection standards including NFPA 51B. Inspections will be made by personnel of the VAMC, and the Contractor shall follow all directives of the COR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property per Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All valves including gate, globe, ball, butterfly and check, all pressure gauges and thermometers with wells shall remain Government property and shall be removed and delivered to COR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications.

Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate. Coordinate with the COR and Infection Control.

### **3.7 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
  - 1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
  - 2. The following Material and Equipment shall NOT be painted:
    - a. Motors, controllers, control switches, and safety switches.
    - b. Control and interlock devices.
    - c. Regulators.
    - d. Pressure reducing valves.
    - e. Control valves and thermostatic elements.
    - f. Lubrication devices and grease fittings.
    - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
    - h. Valve stems and rotating shafts.
    - i. Pressure gauges and thermometers.
    - j. Glass.
    - k. Name plates.
  - 3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint type and color obtained from manufacturer or computer matched.
  - 4. Pumps, motors, steel and cast-iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump manufacturer.



5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats per Section 09 91 00, Painting.
6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this. Lead based paints shall not be used.

### **3.8 IDENTIFICATION SIGNS**

- A. Laminated plastic signs, with engraved lettering not less than 7 mm (3/16 inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, and performance data shall be placed on factory-built equipment.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

### **3.9 STARTUP AND TEMPORARY OPERATION**

- A. Startup of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.
- B. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Contracting Officer's Representative and CxA. Provide a minimum of three weeks prior notice.

### **3.10 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, all required tests shall be performed as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the COR.

- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or systems occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings during the first actual seasonal use of the respective systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.
- D. Perform tests as required for commissioning provisions in accordance with Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

### **3.11 OPERATION AND MAINTENANCE MANUALS**

- A. All new and temporary equipment and all elements of each assembly shall be included.
- B. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- C. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- D. Lubrication instructions, type and quantity of lubricant shall be included.
- E. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- F. Set points of all interlock devices shall be listed.
- G. Trouble-shooting guide for the control system troubleshooting shall be inserted into the Operations and Maintenance Manual.
- H. The control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- I. Emergency procedures for shutdown and startup of equipment and systems.

### **3.12 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system

### **3.13 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 05 12**  
**GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the general motor requirements for plumbing equipment and applies to all sections of Division 22.
- B. A complete listing of common acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and VHA standard will govern.
- B. American Bearing Manufacturers Association (ABMA):  
ABMA 9–2015 ..... Load Ratings and Fatigue Life for Ball Bearings
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):  
112-2017 ..... IEEE Standard Test Procedure for Polyphase Induction Motors and Generators  
841-2018 ..... IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors--Up to and Including 370 kW (500 HP)

D. International Code Council (ICC):

IPC-2018 ..... International Plumbing Code

E. National Electrical Manufacturers Association (NEMA):

MG 1-2016 ..... Motors and Generators

MG 2-2014 ..... Safety Standard for Construction and Guide for Selection,  
Installation and Use of Electric Motors and Generators

250-2018 ..... Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Fire Protection Association (NFPA):

70-2020 ..... National Electrical Code (NEC)

#### 1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with  
Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED  
UNDER SECTION 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING  
EQUIPMENT", with applicable paragraph identification.

C. Submit motor submittals with drive equipment.

D. Shop Drawings:

1. Provide documentation to demonstrate compliance with contract documents.

2. Motor nameplate information shall be submitted including electrical ratings,  
efficiency, bearing data, power factor, frame size, dimensions, mounting details,  
materials, horsepower, voltage, phase, speed (RPM), enclosure, starting  
characteristics, torque characteristics, code letter, full load and locked rotor current,  
service factor, and lubrication method.

3. Motor parameters required for the determination of the Reed Critical Frequency of  
vertical hollow shaft motors shall be submitted.

E. Manufacturer's Literature and Data including: Full item description and optional  
features and accessories. Include dimensions, weights, materials, applications, standard  
compliance, model numbers, size, and capacity.

- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Certification: Two weeks prior to final inspection, unless otherwise noted, the following certification shall be submitted to the Contracting Officer's Representative (COR).
  - 1. Certification shall be submitted stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.
- H. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- I. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

## **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's bio-based Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopREFERRED.gov>.
- B. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

## **1.6 AS-BUILT DOCUMENTATION**

- A. Comply with requirements in Paragraph "AS-BUILT DOCUMENTATION" of Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

## **PART 2 - PRODUCTS**

### **2.1 MOTORS**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, MOTOR CONTROLLERS; and Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- B. For alternating current, fractional and integral horsepower motors, NEMA MG 1 and NEMA MG 2 shall apply.
- C. For severe duty totally enclosed motors, IEEE 841 shall apply. For severe duty totally enclosed motors, IEEE 841 shall apply.
- D. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
  - 1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- F. Voltage ratings shall be as follows:
  - 1. Single phase:
    - a. Motors connected to 120-volt systems: 115 volts.
    - b. Motors connected to 208-volt systems: 200 volts.
    - c. Motors connected to 240-volt or 480-volt systems: 230/460 volts, dual connection.
  - 2. Three phase:
    - a. Motors connected to 208-volt systems: 200 volts.
    - b. Motors, less than 74.6 kW (100 HP), connected to 240-volt or 480-volt systems: 230/460 volts, dual connection.

- c. Motors, 74.6 kW (100 HP) or greater, connected to 240-volt systems: 230 volts.
  - d. Motors, 74.6 kW (100 HP) or greater, connected to 480-volt systems: 460 volts.
  - e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA MG 1 for connection to the nominal system voltage shown in the drawings.
- G. Number of phases shall be as follows:
- 1. Motors, less than 373 W (1/2 HP): Single phase.
  - 2. Motors, 373 W (1/2 HP) and greater: 3 phase.
  - 3. Exceptions:
    - a. Hermetically sealed motors.
    - b. Motors for equipment assemblies, less than 746 W (1 HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- H. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.
- I. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting, acceleration and running torque without exceeding nameplate ratings or considering service factor.
- J. Motor Enclosures:
- 1. Shall be the NEMA types as specified and/or shown in the Contract Documents.
  - 2. Where the types of motor enclosures are not shown in the drawings, they shall be the NEMA types per NEMA 250, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
    - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
    - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.



- c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
  - 3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- K. Electrical Design Requirements:
- 1. Motors shall be continuous duty.
  - 2. The insulation system shall be rated minimum of Class B, 130 degrees C (266 degrees F).
  - 3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80 degrees C (144 degrees F).
  - 4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
  - 5. Motors shall be suitable for full voltage starting, unless otherwise noted. Coordinate motor features with applicable motor controllers.
  - 6. Motors for variable frequency drive applications shall adhere to NEMA MG 1, Part 30, Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable Voltage or Adjustable Frequency Controls, or both, or NEMA MG 1, Part 31, Definite Purpose Inverter Fed Polyphase Motors.
- L. Mechanical Design Requirements:
- 1. Bearings shall be rated for a minimum fatigue life of 26,280 hours for belt-driven loads and 100,000 hours for direct-drive loads based on L10 (Basic Rating Life) at full load direct coupled, except vertical high thrust motors which require a 40,000 hour rating. A minimum fatigue life of 40,000 hours is required for VFD drives.
  - 2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30 percent of normal down thrust.
  - 3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.

4. Grease fittings, if provided, shall be Alemite type or equivalent.
5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
6. Vibration shall not exceed 3.8 mm (0.15 inch) per second, unfiltered peak.
7. Noise level shall meet the requirements of the application.
8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
9. All external fasteners shall be corrosion resistant.
10. Condensation heaters, when specified, shall keep motor windings at least 5 degrees C (9 degrees F) above ambient temperature.
11. Winding thermostats, when specified shall be normally closed, connected in series.
12. Grounding provisions shall be in the main terminal box.

M. Special Requirements:

1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional cost or time to the Government.
2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
  - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
  - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
  - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.

4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
  5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- N. Additional requirements for specific motors, as indicated in other sections, shall also apply.
- O. NEMA Premium Efficiency Electric Motors, Motor Efficiencies: All permanently wired polyphase motors of 746 W (1 HP) or greater shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 W (1 HP) or greater with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Efficiencies Open Drip-Proof				Minimum Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%

14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

- P. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM. Power factor correction capacitors shall be provided unless the motor meets the 0.9 requirement without it or if the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.
- Q. Energy Efficiency of Small Motors (Motor Efficiencies): All motors under 746 W (1 hp) shall meet the requirements of the DOE Small Motor Regulation.

Polyphase Open Motors Average full load efficiency				Capacitor-start capacitor-run and capacitor-start induction run open motors Average full load efficiency			
Rating kW (hp)	6 poles	4 poles	2 poles	Rating kW (hp)	6 poles	4 poles	2 poles
0.18 (0.25)	67.5	69.5	65.6	0.18 (0.25)	62.2	68.5	66.6
0.25 (0.33)	71.4	73.4	69.5	0.25 (0.33)	66.6	72.4	70.5
0.37 (0.5)	75.3	78.2	73.4	0.37 (0.5)	76.2	76.2	72.4
0.55 (0.75)	81.7	81.1	76.8	0.55 (0.75)	80.2	81.8	76.2

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown in the drawings and/or as required by other sections of these specifications.
- B. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

#### **3.2 FIELD TESTS**

- A. All tests shall be witnessed by the CxA or by the COR.
- B. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before startup. All shall test free from grounds.
- C. Perform Load test in accordance with IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.
- D. Insulation Resistance: Not less than 1/2 meg-ohm between stator conductors and frame, to be determined at the time of final inspection.
- E. All test data shall be compiled into a report form for each motor and provided to the contracting officer or their representative.

#### **3.3 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.

#### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- B. Components provided under this section of the specification shall be tested as part of a larger system.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 05 19**  
**METERS AND GAUGES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for water meters and gauges primarily used for troubleshooting the system and to indicate system performance.
- B. A complete listing of common acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS. Requirements for commissioning, systems readiness checklist, and training.
- G. Section 25 10 10, ADVANCED UTILITY METERING SYSTEM.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Society of Mechanical Engineers (ASME):
  - B40.100-2013 ..... Pressure Gauges and Gauge Attachments
  - B40.200-2008 ..... Thermometers, Direct Reading and Remote Reading
- C. American Water Works Association (AWWA):
  - C700-2015 ..... Cold Water Meters, Displacement Type, Bronze Main Case
  - C701-2015 ..... Cold Water Meters-Turbine Type, for Customer Service
  - C702-20115 ..... Cold Water Meters – Compound Type

C707-2010 (R2016)..... Encoder-Type Remote-Registration Systems for Cold-  
Water Meters

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

C2-2017 ..... National Electrical Safety Code (NESC)

E. International Code Council (ICC):

IPC-2018 ..... International Plumbing Code

F. National Fire Protection Association (NFPA):

70-2020 ..... National Electrical Code (NEC)

G. NSF International (NSF):

61-2019 ..... Drinking Water System Components – Health Effects

372-2016 ..... Drinking Water System Components – Lead Content

#### **1.4 SUBMITTALS**

A. Submittals, including number of required copies, shall be submitted in accordance with  
Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED  
UNDER SECTION 22 05 19, METERS AND GAUGES FOR PLUMBING PIPING”, with  
applicable paragraph identification.

C. Manufacturer's Literature and Data including: Full item description and optional  
features and accessories. Include dimensions, weights, materials, applications, standard  
compliance, model numbers, size, and capacity.

1. Water Meter.

2. Pressure Gauges.

3. Thermometers.

4. Product certificates for each type of meter and gauge.

D. Complete operating and maintenance manual shall including wiring diagrams, technical  
data sheets, information for ordering replaceable parts, and troubleshooting guide:

1. Include complete list indicating all components of the system.

2. Include complete diagrams of the internal wiring for each item of equipment.



- 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### **1.5 AS-BUILT DOCUMENTATION**

- A. Comply with requirements in Paragraph "AS-BUILT DOCUMENTATION" of Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING PRODUCTS

## **PART 2 - PRODUCTS**

### **2.1 PRESSURE GAUGES FOR WATER AND SEWAGE USAGE**

- A. ASME B40.100 all metal case 115 mm (4-1/2 inches) diameter, bottom connected throughout, graduated as required for service, and identity labeled. Range shall be 0 to 1380 kPa (0 to 200 psig) gauge.
- B. The pressure element assembly shall be bourdon tube. The mechanical movement shall be lined to pressure element and connected to pointer.
- C. The dial shall be non-reflective aluminum with permanently etched scale markings graduated in kPa and psig.
- D. The pointer shall be dark colored metal.
- E. The window shall be glass.
- F. The ring shall be brass or stainless steel.
- G. The accuracy shall be grade A, plus or minus 1 percent of middle half of scale range.
- H. The pressure gauge for water domestic use shall conform to NSF 61 and NSF 372.

### **2.2 THERMOMETERS**

- A. Thermometers shall be straight stem, metal case, red liquid-filled thermometer, approximately 175 mm (7 inches) high, 4 degrees C to 100 degrees C (40 degrees F to 212 degrees F). Thermometers shall comply with ASME B40.200.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Direct mounted pressure gauges shall be installed in piping tees with pressure gauge located on pipe at the most readable position.
- B. Valves and snubbers shall be installed in piping for each pressure gauge.
- C. Test plugs shall be installed on the inlet and outlet pipes of all heat exchangers or water heaters serving more than one plumbing fixture.
- D. Pressure gauges shall be installed where indicated in the drawings and at the following locations:
  - 1. Building water service entrance into building.
  - 2. Inlet and outlet of each pressure reducing valve.
  - 3. Suction and discharge of each domestic water pump or re-circulating hot water return pump.
- E. Thermometers shall be installed on the water heater inlet and outlet piping, thermostatic mixing valve outlet piping, and the hot water circulation pump inlet piping.
- F. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

#### **3.2 FIELD QUALITY CONTROL**

- A. The meter assembly shall be visually inspected and operationally tested. The correct multiplier placement on the face of the meter shall be verified.

#### **3.3 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

- C. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 05 23**  
**GENERAL-DUTY VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.
- B. A complete listing of common acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Society of Mechanical Engineers (ASME):
  - A112.14.1-2003 ..... Backwater Valves
- C. American Society of Sanitary Engineering (ASSE):
  - 1001-2017 ..... Performance Requirements for Atmospheric Type Vacuum Breakers
  - 1003-2009 ..... Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems
  - 1011-2017 ..... Performance Requirements for Hose Connection Vacuum Breakers

- 1013-2011 ..... Performance Requirements for Reduced Pressure Principle  
Backflow Preventers and Reduced Pressure Principle Fire  
Protection Backflow Preventers
- 1015-2011 ..... Performance Requirements for Double Check Backflow  
Prevention Assemblies and Double Check Fire Protection  
Backflow Prevention Assemblies
- 1017-2009 ..... Performance Requirements for Temperature Actuated  
Mixing Valves for Hot Water Distribution Systems
- 1020-2004 ..... Performance Requirements for Pressure Vacuum Breaker  
Assembly
- 1035-2008 ..... Performance Requirements for Laboratory Faucet  
Backflow Preventers
- 1069-2005 ..... Performance Requirements for Automatic Temperature  
Control Mixing Valves
- 1070-2015 ..... Performance Requirements for Water Temperature  
Limiting Devices
- 1071-2012 ..... Performance Requirements for Temperature Actuated  
Mixing Valves for Plumbed Emergency Equipment
- D. American Society for Testing and Materials (ASTM):
- A126-2004(R2019) ..... Standard Specification for Gray Iron Castings for Valves,  
Flanges, and Pipe Fittings
- A276/A276M-2017 ..... Standard Specification for Stainless Steel Bars and Shapes
- A536-1984(R2019e) ..... Standard Specification for Ductile Iron Castings
- B62-2017 ..... Standard Specification for Composition Bronze or Ounce  
Metal Castings
- B584-2014 ..... Standard Specification for Copper Alloy Sand Castings for  
General Applications
- E. International Code Council (ICC):
- IPC-2018 ..... International Plumbing Code

- F. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
- SP-25-2018 ..... Standard Marking Systems for Valves, Fittings, Flanges and Unions
  - SP-67-2017 ..... Butterfly Valves
  - SP-70-2011 ..... Gray Iron Gate Valves, Flanged and Threaded Ends
  - SP-71-2018 ..... Gray Iron Swing Check Valves, Flanged and Threaded Ends
  - SP-80-2019 ..... Bronze Gate, Globe, Angle, and Check Valves
  - SP-85-2011 ..... Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
  - SP-110-2010 ..... Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- G. National Environmental Balancing Bureau (NEBB):
- 8th Edition 2015 ..... Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- H. NSF International (NSF):
- 61-2019 ..... Drinking Water System Components – Health Effects
  - 372-2016 ..... Drinking Water System Components – Lead Content
- I. University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USC FCCCHR):
- 10th Edition ..... Manual of Cross-Connection Control

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING”, with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

1. Ball Valves.
  2. Gate Valves.
  3. Butterfly Valves.
  4. Balancing Valves.
  5. Check Valves.
  6. Backflow Preventers.
  7. Thermostatic Mixing Valves.
- D. Test and Balance reports for balancing valves.
- E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts and troubleshooting guide:
1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
  4. Piping diagrams of thermostatic mixing valves to be installed.
- F. Completed System Readiness Checklist provided by the CxA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Valves shall be prepared for shipping as follows:
1. Protect internal parts against rust and corrosion.
  2. Protect threads, flange faces, grooves, and weld ends.
  3. Set angle, gate, and globe valves closed to prevent rattling.
  4. Set ball and plug valves open to minimize exposure of functional surfaces.
  5. Set butterfly valves closed or slightly open.
  6. Block check valves in either closed or open position.

- B. Valves shall be prepared for storage as follows:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature.
- C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

## **1.6 AS BUILT DOCUMENTATION**

- A. Comply with requirements in Paragraph "AS-BUILT DOCUMENTATION" of Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

## **PART 2 - PRODUCTS**

### **2.1 VALVES, GENERAL**

- A. Asbestos packing and gaskets are prohibited.
- B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing greater than 15 percent zinc shall not be permitted.
- C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.
- D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 m (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.
- E. All valves used to supply potable water shall meet the requirements of NSF 61 and NSF 372.
- F. Bio-Based Materials: For products designated by the USDA's bio-based Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- G. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.



## **2.2 SHUT-OFF VALVES**

### **A. Cold, Hot and Re-circulating Hot Water:**

1. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4138 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be non-lead solder.
2. Less than 100 mm DN100 (4 inches): Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A536, ductile iron.

## **2.3 MANUAL BALANCING VALVES**

- ### **A. Hot Water Re-circulating, 75 mm or DN75 (3 inches) and smaller manual balancing valve**
- shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read out ports shall be fitted with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (1/4 inch NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to set point without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.

## **2.4 CHECK VALVES**

- ### **A. 75 mm or DN75 (3 inches) and smaller shall be Class 125, bronze swing check valves**
- with non-metallic disc suitable for type of service. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B62, solder joints, and PTFE or TFE disc.

## **2.5 BACKFLOW PREVENTERS**

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCC).
- B. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y positive-seal resilient gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be the thermoplastic type suited for water service. The stem shall be stainless steel conforming to ASTM A276/A276M. The seat disc shall be the elastomer type suited for water service. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet. Reduced pressure backflow preventers shall be installed in the following applications.
1. Deionizers.
  2. Sterilizers.
  3. Dialysis, Deionized or Reverse Osmosis Water Systems.
  4. Water make up to heating systems, cooling tower, chilled water system, generators, and similar equipment consuming water.
  5. Water service entrance from loop system.
  6. Dental equipment.
  7. Power washer.
  8. Medical equipment.
  9. Process equipment.
  10. Autopsy, on each hot and cold water outlet at each table or sink.
  11. Reclaimed water systems.

- C. The pipe applied or integral atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be cast bronze. The seat disc shall be the elastomer type suited for water service. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable. Atmospheric vacuum breakers shall be installed in the following applications.
1. Hose bibs and sinks with threaded outlets.
  2. Disposers.
  3. Showers (telephone/handheld type).
  4. Hydrotherapy units.
  5. All kitchen equipment, if not protected by air gap.
  6. Ventilating hoods with wash down system.
  7. Film processor.
  8. Detergent system.
  9. Fume hoods.
  10. Glassware washers.
  11. Service sinks (integral with faucet only).
  12. Laundry tubs (integral with faucet only).
  13. Sitz baths.
- D. The hose connection vacuum breaker shall be ASSE listed 1011. The main body shall be cast brass with stainless steel working parts. The diaphragm and disc shall be the elastomer type suited for water service. The device shall permit the attachment of portable hoses to hose thread outlets. Hose connection vacuum breakers shall be installed in the following locations requiring non-continuous pressure:
1. Hose bibbs and wall hydrants.
- E. The double check backflow prevention assembly shall be ASSE listed 1015 and supply with full port, OS&Y, positive-seal, resilient gate valves. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade. The seat ring and

check valve shall be the thermoplastic type suited for water service. The stem shall be stainless steel conforming to ASTM A276/A276M. The seat disc shall be the elastomer type suited for water service. The first and second check valve shall be accessible for maintenance without removing the device from the line. Double check valves shall be installed in the following location requiring continuous pressure subject to backpressure and backsiphonage conditions.

1. Lawn Irrigation.
2. Food Processing Equipment.
3. Laundry equipment.

## **2.6 THERMOSTATIC MIXING VALVES**

A. Thermostatic Mixing Valves shall comply with the following general performance requirements:

1. Shall meet ASSE requirements for water temperature control.
2. The body shall be cast bronze or brass with corrosion resistant internal parts preventing scale and biofilm build-up. Provide chrome-plated finish in exposed areas.
3. No special tool shall be required for temperature adjustment, maintenance, replacing parts and disinfecting operations.
4. Valve shall be able to be placed in various positions without making temperature adjustment or reading difficult.
5. Valve finish shall be chrome plated in exposed areas.
6. Valve shall allow easy temperature adjustments to allow hot water circulation. Internal parts shall be able to withstand disinfecting operations of chemical and thermal treatment of water temperatures up to 82°C (180°F) for 30 minutes or 50 mg/L (50 ppm) chlorine residual concentration for 24 hours.
7. Parts shall be easily removed or replaced without dismantling the valves, for easy scale removal and disinfecting of parts.
8. Valve shall have a manual adjustable temperature control with locking mechanism to prevent tampering by end user. Outlet temperature shall be visible to ensure

outlet temperature does not exceed specified limits, particularly after thermal eradication procedures.

9. Provide mixing valves with integral check valves with screens and stop valves.

B. Master Thermostatic Water Mixing Valves:

1. Application: Tempered water distribution from hot water source.
2. Standard: ASSE 1017.
3. Pressure Rating: 861 kPa (125 psig).
4. Type: Exposed-mounting or Cabinet-type, as indicated, thermostatically controlled water mixing valve.
5. Connections: Flanged or threaded union inlets and outlet.
6. Valve Finish: Chrome plated.
7. Cabinet: Factory-fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.
8. Thermometers shall be provided to indicate mixed water temperature.
9. Provide a high temperature alarm device to detect mixing valve failure.

C. Hi-Lo Water-Mixing-Valve Assemblies:

1. Application: Tempered water distribution from hot water source covering a wide range of flow.
2. Description: Factory-fabricated, cabinet-type or exposed-mounting, thermostatically controlled, water-mixing-valve assembly in two-valve parallel arrangement including pressure regulators, pressure gauges and thermometer.
3. Large-Flow Parallel: Master thermostatic water mixing valve and downstream pressure regulator with pressure gauges on inlet and outlet.
4. Small-Flow Parallel: Master thermostatic water mixing valve.
5. Master Thermostatic Mixing Valves: Comply with ASSE 1017.
6. Water Regulator(s): Comply with ASSE 1003. Include pressure gauge on inlet and outlet.
7. Component Pressure Ratings: 861 kPa (125 psig) minimum, unless otherwise indicated.

8. Cabinet: Factory-fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.
  9. Connections: Soldered or threaded union inlets and outlet.
  10. Thermometers shall be provided to indicate mixed water temperature.
  11. Provide a high temperature alarm device to detect mixing valve failure.
- D. Automatic Water Temperature Control Mixing Valves:
1. Application: Gang plumbing fixtures point-of-use when no other mixing at fixtures occurs.
  2. Standard: ASSE 1069.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Thermostatically controlled water mixing valve set at 43 degrees C (110 degrees F).
  5. Connections: Threaded union or soldered inlets and outlet.
  6. Thermometers shall be provided to indicate mixed water temperature.
  7. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.5 gpm maximum.
  8. Provide a high temperature alarm device to detect mixing valve failure.
- E. Water Temperature Limiting Devices:
1. Application: Single plumbing fixture point-of-use such as sinks or lavatories.
  2. Standard: ASSE 1070.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Thermostatically controlled water mixing valve set at 43 degrees C (110 degrees F).
  5. Connections: Threaded union, compression or soldered inlets and outlet.
  6. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.2 gpm maximum.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- C. Threads on valve and mating pipe shall be examined for form and cleanliness.
- D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### **3.2 INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- C. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- D. Valves shall be installed in a position to allow full stem movement.
- E. Check valves shall be installed for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level and on top of valve.
- F. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that shall be sources of contamination. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment or system.
  - 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least

- two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are prohibited for this application.
- G. Install pressure gauges on outlet of backflow preventers.
  - H. Do not install bypass piping around backflow preventers.
  - I. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets.
    - 1. Install thermometers if specified.
    - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
  - J. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
  - K. Install thermostatic balancing valves with inlet strainer and inlet and outlet isolation valves.

### **3.3 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Calibrated balancing valves.
  - 2. Master, thermostatic, water mixing valves.
  - 3. Manifold, thermostatic, water-mixing-valve assemblies.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

### **3.4 ADJUSTING**

- A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Valves shall be replaced if persistent leaking occurs.
- B. Set field-adjustable flow set points of balancing valves and record data. Ensure recorded data represents actual measured or observed conditions. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock



memory stops. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.
- D. Testing and adjusting of balancing valves shall be performed by an independent NEBB Accredited Test and Balance Contractor. A final settings and flow report shall be submitted to the VA Contracting Officer's Representative (COR).

### **3.5 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.

### **3.6 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.7 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

-- E N D --

**SECTION 22 07 11**  
**PLUMBING INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for the following:
  - 1. Plumbing piping and equipment.
- B. Definitions:
  - 1. ASJ: All Service Jacket, Kraft paper, white finish facing or jacket.
  - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
  - 3. All insulation systems installed within supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces, interiors of air conditioned or heating ducts, and mechanical equipment rooms shall be noncombustible or shall be listed and labeled as having a flame spread indexes of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723. Note: ICC IMC, Section 602.2.1.
  - 4. Cold: Equipment or piping handling media at design temperature of 15 degrees C (60 degrees F) or below.
  - 5. Concealed: Piping above ceilings and in chases, and pipe spaces.
  - 6. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather. Shafts, chases, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
  - 7. FSK: Foil-scrim-Kraft facing.
  - 8. Hot: Plumbing equipment or piping handling media above 40 degrees C (104 degrees F).
  - 9. Density: kg/m<sup>3</sup> - kilograms per cubic meter (Pcf - pounds per cubic foot).

10. Thermal conductance: Heat flow rate through materials.
  - a. Flat surface: Watts per square meter (BTU per hour per square foot).
  - b. Pipe or Cylinder: Watts per linear meter (BTU per hour per linear foot) for a given outside diameter.
11. Thermal Conductivity (k): Watts per meter, per degree K (BTU - inch thickness, per hour, per square foot, per degree F temperature difference).
12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders/vapor barriers shall have a maximum published permeance of .02 perms.
13. HWR: Hot water recirculating.
14. CW: Cold water.
15. SW: Soft water.
16. HW: Hot water.
17. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## **1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Insulation material and insulation production method.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General mechanical requirements and items, which are common to more than one section of Division 22.
- G. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING: Hot and cold water piping.
- H. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.
- I. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### 1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced.

The publications are referenced in the text by basic designation only.

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

B209-2014 ..... Standard Specification for Aluminum and Aluminum-Alloy  
Sheet and Plate

C411-2011 ..... Standard Test Method for Hot-Surface Performance of  
High-Temperature Thermal Insulation

C449-2007 (R2013)..... Standard Specification for Mineral Fiber Hydraulic-Setting  
Thermal Insulating and Finishing Cement

C450-2008 (R2014)..... Standard Practice for Fabrication of Thermal Insulating  
Fitting Covers for NPS Piping, and Vessel Lagging

Adjunct to C450..... Compilation of Tables that Provide Recommended  
Dimensions for Prefab and Field Thermal Insulating Covers,  
etc.

C533-2013 ..... Standard Specification for Calcium Silicate Block and Pipe  
Thermal Insulation

C534/C534M-2014 ..... Standard Specification for Preformed Flexible Elastomeric  
Cellular Thermal Insulation in Sheet and Tubular Form

C547-2015 ..... Standard Specification for Mineral Fiber Pipe Insulation

C552-2014 ..... Standard Specification for Cellular Glass Thermal Insulation

C553-2013 ..... Standard Specification for Mineral Fiber Blanket Thermal  
Insulation for Commercial and Industrial Applications

C591-2013 ..... Standard Specification for Unfaced Preformed Rigid  
Cellular Polyisocyanurate Thermal Insulation

C680-2014 ..... Standard Practice for Estimate of the Heat Gain or Loss  
and the Surface Temperatures of Insulated Flat,  
Cylindrical, and Spherical Systems by Use of Computer  
Programs

- C612-2014 ..... Standard Specification for Mineral Fiber Block and Board  
Thermal Insulation
- C1126-2014 ..... Standard Specification for Faced or Unfaced Rigid Cellular  
Phenolic Thermal Insulation
- C1136-2012 ..... Standard Specification for Flexible, Low Permeance Vapor  
Retarders for Thermal Insulation
- C1710-2011 ..... Standard Guide for Installation of Flexible Closed Cell  
Preformed Insulation in Tube and Sheet Form
- D1668/D1668M-1997a (2014)e1 ..... Standard Specification for Glass Fabrics (Woven  
and Treated) for Roofing and Waterproofing
- E84-2015a ..... Standard Test Method for Surface Burning Characteristics  
of Building Materials
- E2231-2015 ..... Standard Practice for Specimen Preparation and Mounting  
of Pipe and Duct Insulation to Assess Surface Burning  
Characteristics
- C. Federal Specifications (Fed. Spec.):
- L-P-535E-1979 ..... Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride)  
and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- D. International Code Council, (ICC):
- IMC-2012..... International Mechanical Code
- E. Military Specifications (Mil. Spec.):
- MIL-A-3316C (2)-1990 ..... Adhesives, Fire-Resistant, Thermal Insulation
- MIL-A-24179A (2)-1987 ..... Adhesive, Flexible Unicellular-Plastic Thermal Insulation
- MIL-PRF-19565C (1)-1988 ..... Coating Compounds, Thermal Insulation, Fire-and Water-  
Resistant, Vapor-Barrier
- MIL-C-20079H-1987 ..... Cloth, Glass; Tape, Textile Glass; and Thread, Glass and  
Wire-Reinforced Glass

- F. National Fire Protection Association (NFPA):  
90A-2015 ..... Standard for the Installation of Air-Conditioning and  
Ventilating Systems
- G. Underwriters Laboratories, Inc (UL):  
723-2008 (R2013) ..... Standard for Test for Surface Burning Characteristics of  
Building Materials  
1887-2004 (R2013) ..... Standard for Fire Test of Plastic Sprinkler Pipe for Visible  
Flame and Smoke Characteristics
- H. 3E Plus® version 4.1 Insulation Thickness Computer Program: Available from NAIMA  
with free download; <https://insulationinstitute.org/tools-resources/>

#### **1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with  
Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED  
UNDER SECTION 22 07 11, PLUMBING INSULATION", with applicable paragraph  
identification.
- C. Manufacturer's Literature and Data including: Full item description and optional  
features and accessories. Include dimensions, weights, materials, applications, standard  
compliance, model numbers, size, and capacity.
- D. Shop Drawings:
  - 1. All information, clearly presented, shall be included to determine compliance with  
drawings and specifications and ASTM Designation, Federal and Military  
specifications.
    - a. Insulation materials: Specify each type used and state surface burning  
characteristics.
    - b. Insulation facings and jackets: Each type used and state surface burning  
characteristics.
    - c. Insulation accessory materials: Each type used.

- d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation shall follow the guidelines in accordance with ASTM C1710.
  - e. Make reference to applicable specification paragraph numbers for coordination.
  - f. All insulation fittings (exception flexible unicellular insulation) shall be fabricated in accordance with ASTM C450 and the referenced Adjunct to ASTM C450.
- E. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### 1.5 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

- B. Criteria:

1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.11.2.6, parts of which are quoted as follows:

**4.3.3.1** Pipe and duct insulation and coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels and duct silencers used in duct systems shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E84 and appropriate mounting practice, e.g. ASTM E2231.

**4.3.3.3** Coverings and linings for air ducts, pipes, plenums and panels including all pipe and duct insulation materials shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service. In no case shall the test temperature be below 121 degrees C (250 degrees F).

**4.3.11.2.6.3** Nonferrous fire sprinkler piping shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1887, Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

4.3.11.2.6.8 Smoke detectors shall not be required to meet the provisions of Section 4.3.

2. Test methods: ASTM E84, UL 723, and ASTM E2231.
  3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
  4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

## **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model



number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **1.7 STORAGE AND HANDLING OF MATERIAL**

- A. Store materials in clean and dry environment, pipe insulation jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

## **PART 2 - PRODUCTS**

### **2.1 MINERAL FIBER OR FIBER GLASS**

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m<sup>3</sup> (nominal 3 pcf), k = 0.037 (.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F).
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density 32 kg/m<sup>3</sup> (nominal 2 pcf), k = 0.04 (0.27) at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F).
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (446

degrees F) with an all service vapor retarder jacket (ASJ) and with polyvinyl chloride (PVC) premolded fitting covering.

## **2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C534/C534M,  $k = 0.039$  (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (199 degrees F). Under high humidity exposures for condensation control an external vapor retarder/barrier jacket is required. Consult ASTM C1710.

## **2.8 INSULATION FACINGS AND JACKETS**

- A. Vapor Retarder, higher strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on pipe insulation jackets. Facings and jackets shall be ASJ or PVDC Vapor Retarder jacketing.
- B. ASJ shall be white finish (kraft paper) bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture is 50 units, suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: FSK or PVDC type for concealed ductwork and equipment.
- D. Except for flexible elastomeric cellular thermal insulation (not for high humidity exposures), field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping as well as on interior piping exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) in high humidity locations conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg

(30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

- E. Except for cellular glass thermal insulation, when all longitudinal and circumferential joints are vapor sealed with a vapor barrier mastic or caulking, vapor barrier jackets may not be provided. For aesthetic and physical abuse applications, exterior jacketing is recommended. Otherwise field applied vapor barrier jackets shall be provided, in addition to the applicable specified facings and jackets, on all exterior piping as well as on interior piping exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) in high humidity locations conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- F. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2070 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be PVC conforming to Fed Spec L-P-535E, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape. Staples, tacks, or any other attachment that penetrates the PVC covering is not allowed on any form of a vapor barrier system in below ambient process temperature applications.
- H. Aluminum Jacket-Piping systems and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated or with cut aluminum gores to match shape of fitting and of 0.6 mm (0.024 inch) minimum thickness aluminum. Aluminum fittings shall be of same construction with an internal moisture barrier as straight run jackets but need not be of the same alloy. Factory-

fabricated stainless steel bands with wing seals shall be installed on all circumferential joints. Bands shall be 15 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

- I. Aluminum jacket-Rectangular breeching: ASTM B209, 3003 alloy, H-14 temper, 0.5 mm (0.020 inches) thick with 32 mm (1-1/4 inch) corrugations or 0.8 mm (0.032 inches) thick with no corrugations. System shall be weatherproof if used for outside service.

## 2.9 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C (300 degrees F)), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

## 2.10 ADHESIVE, MASTIC, CEMENT

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.

- C. Mil. Spec. MIL-A-24179A, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Mil. Spec. MIL-PRF-19565C, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-PRFC-19565C, Type I or Type II: Vapor barrier compound for indoor use.
- F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- G. Other: Insulation manufacturers' published recommendations.

## **2.11 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching galvanized steel. Staples are not allowed for below ambient vapor barrier applications.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy or stainless steel.
- D. Bands: 13 mm (1/2 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.
- E. Tacks, rivets, screws or any other attachment device capable of penetrating the vapor retarder shall NOT be used to attach/close the any type of vapor retarder jacketing. Thumb tacks sometimes used on PVC jacketing and preformed fitting covers closures are not allowed for below ambient vapor barrier applications.

## **2.12 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668/D1668M, Type III (resin treated) and Type I (asphalt or white resin treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079H, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.

- E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535E, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 10 to 121 degrees C (50 to 250 degrees F). Below 10 degrees C (50 degrees F) and above 121 degrees C (250 degrees F) provide mitered pipe insulation of the same type as insulating straight pipe. Provide double layer insert. Provide vapor barrier pressure sensitive tape matching the color of the PVC jacket.

## **2.13 FIRESTOPPING MATERIAL**

- A. Other than pipe insulation, refer to Section 07 84 00, FIRESTOPPING.

## **2.14 FLAME AND SMOKE**

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM and UL standards and specifications. See paragraph "Quality Assurance".

# **PART 3 - EXECUTION**

## **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of piping joints and connections shall be completed and the work approved by the Contracting Officer's Representative (COR) for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions or as noted, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.
- D. Insulation materials shall be installed with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down and sealed at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A).

- E. Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 15 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- F. Install vapor stops with operating temperature 15 degrees C (60 degrees F) and below at all insulation terminations on either side of valves, pumps, fittings, and equipment and particularly in straight lengths every 4.6 to 6.1 meters (approx. 15 to 20 feet) of pipe insulation. The annular space between the pipe and pipe insulation of approx. 25 mm (1 inch) in length at every vapor stop shall be sealed with appropriate vapor barrier sealant. Bio-based materials shall be utilized when possible.
- G. Construct insulation on parts of equipment such as cold water pumps and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment. Do not insulate over equipment nameplate data.
- H. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer coating (caution about coating's maximum temperature limit) or jacket material.
- I. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- J. Plumbing work not to be insulated unless otherwise noted:
  - 1. Piping and valves of fire protection system.
  - 2. Chromium plated brass piping.
  - 3. Water piping in contact with earth.
  - 4. Distilled water piping.

- K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum wet or dry film thickness. Bio-based materials shall be utilized when possible.
- L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. Use of polyurethane or polyisocyanurate spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- M. Firestop Pipe insulation:
  - 1. Provide firestopping insulation at fire and smoke barriers through penetrations. Firestopping insulation shall be UL listed as defined in Section 07 84 00, FIRESTOPPING.
  - 2. Pipe penetrations requiring fire stop insulation including, but not limited to the following:
    - a. Pipe risers through floors
    - b. Pipe chase walls and floors
    - c. Smoke partitions
    - d. Fire partitions
    - e. Hourly rated walls
- N. Freeze protection of above grade outdoor piping (over heat tracing tape): 20 mm (3/4 inch) thick insulation, for all pipe sizes 75 mm (3 inches) and smaller and 25 mm (1 inch) thick insulation for larger pipes. Provide metal jackets for all pipe insulations. Provide freeze protection for cold water make-up piping and equipment where indicated on the drawings as described in Section 23 21 13, HYDRONIC PIPING (electrical heat tracing systems).
- O. Provide vapor barrier systems as follows:
  - 1. All piping exposed to outdoor weather.
- P. Provide metal jackets over insulation as follows:
  - 1. All plumbing piping exposed to outdoor weather.
  - 2. Piping exposed in building, within 1829 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets



except for cold pipe or tubing applications. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.

3. A 50 mm (2 inch) jacket overlap is required at longitudinal and circumferential joints with the overlap at the bottom.

Q. Provide PVC jackets over insulation as follows:

1. Piping exposed in building, within 1829 mm (6 feet) of the floor, on piping that is not precluded in previous sections.
2. A 50 mm (2 inch) jacket overlap is required at longitudinal and circumferential joints with the overlap at the bottom.

### **3.2 INSULATION INSTALLATION**

A. Mineral Fiber Board:

1. Vapor retarder faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. (Bio-based materials shall be utilized when possible.) Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
2. Plain unfaced board:
  - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
  - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowelled to a smooth finish.
  - c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.

3. Cold equipment: 40 mm (1-1/2inch) thick insulation faced with vapor retarder ASJ or FSK. Seal all facings, laps, and termination points and do not use staples or other attachments that may puncture ASJ or FSK.
    - a. Water filter, chemical feeder pot or tank.
    - b. Pneumatic, cold storage water and surge tanks.
  4. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with unsealed ASJ or FSK.
    - a. Domestic water heaters and hot water storage tanks (not factory insulated).
    - b. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.
- B. Molded Mineral Fiber Pipe and Tubing Covering:
1. Fit insulation to pipe, aligning all longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation except for cold piping. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide cellar glass inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
  2. Contractor's options for fitting, flange and valve insulation:
    - a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 15 degrees C (60 degrees F) or more.
    - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts surface temperature of above 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Provide mitered preformed insulation of the same type as the installed straight pipe insulation for pipe temperatures below 4 degrees C (40 degrees F). Secure first layer of mineral fiber insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
    - c. Factory preformed, ASTM C547 or fabricated mitered sections, joined with adhesive or (hot only) wired in place. (Bio-based materials shall be utilized when possible.) For hot piping finish with a smoothing coat of finishing cement. For

cold fittings, 15 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.

- d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
- 3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

F. Flexible Elastomeric Cellular Thermal Insulation:

- 1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer. External vapor barrier jacketing may be required for expected or anticipated high humidity exposures. See ASTM C1710.
- 2. Pipe and tubing insulation:
  - a. Use proper size material. Do not stretch or strain insulation.
  - b. To avoid undue compression of insulation, use supports as recommended by the elastomeric insulation manufacturer. Insulation shields are specified under Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
  - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Bio-based materials shall be utilized when possible.
- 3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
- 4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section).

### 3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- B. Components provided under this section of the specification will be tested as part of a larger system.

### 3.4 PIPE INSULATION SCHEDULE

- A. Provide insulation for piping systems as scheduled below:

Insulation Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 – 32 (1 – 1¼)	38 – 75 (1½ - 3)	100 (4) and Greater
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Cellular Glass Thermal	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
(4-15 degrees C (40-60 degrees F)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	25 (1.0)	25(1.0)	25 (1.0)	25 (1.0)
4-15 degrees C (40-60 degrees F)	Cellular Glass Thermal	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

--- E N D ---

**SECTION 22 11 00**  
**FACILITY WATER DISTRIBUTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING.
- F. Section 07 92 00, JOINT SEALANTS.
- G. Section 09 91 00, PAINTING.
- H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- I. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- J. Section 22 07 11, PLUMBING INSULATION.
- K. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced.  
The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  - A13.1-2007 (R2013)..... Scheme for Identification of Piping Systems
  - B16.3-2011 ..... Malleable Iron Threaded Fittings: Classes 150 and 300
  - B16.9-2012 ..... Factory-Made Wrought Buttwelding Fittings
  - B16.11-2011 ..... Forged Fittings, Socket-Welding and Threaded

- B16.12-2009 (R2014)..... Cast Iron Threaded Drainage Fittings
- B16.15-2013 ..... Cast Copper Alloy Threaded Fittings: Classes 125 and 250
- B16.18-2012 ..... Cast Copper Alloy Solder Joint Pressure Fittings
- B16.22-2013 ..... Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
- B16.24-2011 ..... Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
- B16.51-2013 ..... Copper and Copper Alloy Press-Connect Fittings
- ASME Boiler and Pressure Vessel Code -
- BPVC Section IX-2015 ..... Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):
- 1010-2004 ..... Performance Requirements for Water Hammer Arresters
- D. American Society for Testing and Materials (ASTM):
- A47/A47M-1999 (R2014) ..... Standard Specification for Ferritic Malleable Iron Castings
- A53/A53M-2012..... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- A183-2014..... Standard Specification for Carbon Steel Track Bolts and Nuts
- A269/A269M-2014e1..... Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- A312/A312M-2015..... Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- A403/A403M-2014..... Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
- A536-1984 (R2014) ..... Standard Specification for Ductile Iron Castings
- A733-2013..... Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
- B32-2008 (R2014)..... Standard Specification for Solder Metal

B43-2014 .....	Standard Specification for Seamless Red Brass Pipe, Standard Sizes
B61-2008 (R2013) .....	Standard Specification for Steam or Valve Bronze Castings
B62-2009 .....	Standard Specification for Composition Bronze or Ounce Metal Castings
B75/B75M-2011 .....	Standard Specification for Seamless Copper Tube
B88-2014 .....	Standard Specification for Seamless Copper Water Tube
B584-2014 .....	Standard Specification for Copper Alloy Sand Castings for General Applications
B687-1999 (R2011) .....	Standard Specification for Brass, Copper, and Chromium- Plated Pipe Nipples
C919-2012 .....	Standard Practice for Use of Sealants in Acoustical Applications
D1785-2012 .....	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D2000-2012 .....	Standard Classification System for Rubber Products in Automotive Applications
D2564-2012 .....	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
D2657-2007 .....	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
D2855-1996 (R2010) .....	Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
D4101-2014 .....	Standard Specification for Polypropylene Injection and Extrusion Materials
E1120-2008 .....	Standard Specification for Liquid Chlorine
E1229-2008 .....	Standard Specification for Calcium Hypochlorite
F2389-2010 .....	Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

- F2620-2013 ..... Standard Practice for Heat Fusion Joining of Polyethylene  
Pipe and Fittings
- F2769-2014 ..... Standard Specification for Polyethylene of Raised  
Temperature (PE-RT) Plastic Hot and Cold-Water Tubing  
and Distribution Systems
- E. American Water Works Association (AWWA):
- C110-2012 ..... Ductile-Iron and Gray-Iron Fittings
- C151-2009 ..... Ductile Iron Pipe, Centrifugally Cast
- C153-2011 ..... Ductile-Iron Compact Fittings
- C203-2008 ..... Coal-Tar Protective Coatings and Linings for Steel Water  
Pipelines - Enamel and Tape - Hot Applied
- C213-2007 ..... Fusion-Bonded Epoxy Coating for the Interior and Exterior  
of Steel Water Pipelines
- C651-2014 ..... Disinfecting Water Mains
- F. American Welding Society (AWS):
- A5.8M/A5.8-2011-AMD1..... Specification for Filler Metals for Brazing and Braze  
Welding
- G. International Code Council (ICC):
- IPC-2012 ..... International Plumbing Code
- H. Manufacturers Specification Society (MSS):
- SP-58-2009 ..... Pipe Hangers and Supports - Materials, Design,  
Manufacture, Selection, Application, and Installation
- SP-72-2010a ..... Ball Valves with Flanged or Butt-Welding Ends for General  
Service
- SP-110-2010 ..... Ball Valves Threaded, Socket-Welding, Solder Joint,  
Grooved and Flared Ends
- I. NSF International (NSF):
- 14-2015 ..... Plastics Piping System Components and Related Materials
- 61-2014a ..... Drinking Water System Components – Health Effects



372-2011 ..... Drinking Water System Components – Lead Content

J. Plumbing and Drainage Institute (PDI):

PDI-WH 201-2010..... Water Hammer Arrestors

K. Department of Veterans Affairs:

H-18-8-2013 ..... Seismic Design Handbook

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 11 00, FACILITY WATER DISTRIBUTIONS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. All items listed in Part 2 - Products.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replacement parts:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Completed System Readiness Checklist provided by the CxA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### **1.5 QUALITY ASSURANCE**

- A. A certificate shall be submitted prior to welding of steel piping showing the Welder's certification. The certificate shall be current and no more than one year old. Welder's qualifications shall be in accordance with ASME BPVC Section IX.
- B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be by the same manufacturer as the groove components.
- C. All pipe, couplings, fittings, and specialties shall bear the identification of the manufacturer and any markings required by the applicable referenced standards.
- D. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

### **1.6 SPARE PARTS**

- A. For mechanical press-connect fittings, provide tools required for each pipe size used at the facility.

### **1.7 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be

furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certificate if applicable that all results of tests were within limits specified. If a certificate is not available, all documentation shall be on the Certifier's letterhead.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead are prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61, Section 9.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

### **2.2 UNDERGROUND WATER SERVICE CONNECTIONS TO BUILDINGS**

- A. From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building and underground inside building, material to be the same for the size specified inside the building.
- B. 75 mm (3 inch) Diameter and Greater: Ductile iron, AWWA C151, 2413 kPa (350 psig) pressure class, exterior bituminous coating, and cement lined. Bio-based materials shall be utilized when possible. Provide flanged and anchored connection to interior piping.

- C. Under 75 mm (3 inch) Diameter: Copper tubing, ASTM B88, Type K, seamless, annealed. Fittings are as specified in paragraph "Above Ground (Interior) Water Piping". Use brazing alloys, AWS A5.8M/A5.8, Classification BCuP.
- D. Flexible Expansion Joint: Ductile iron with ball joints rated for 1725 kPa (250 psig) working pressure conforming to AWWA C153, capable of deflecting a minimum of 20 degrees in each direction. Flexible expansion joint size shall match the pipe size it is connected to and shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213 and shall be factory tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to AWWA C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene. The flexible expansion fitting shall not expand or exert an axial thrust under internal water pressure. Provide piping joint restraints at each mechanical joint end connection and piping restraints at the penetration of the building wall. The restraints shall be provided to address the developed thrust at the change of piping direction.

### **2.3 ABOVE GROUND (INTERIOR) WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, Type K or L, drawn. For pipe 150 mm (6 inches) and larger, stainless steel, ASTM A312, schedule 40 shall be used.
- B. Fittings for Copper Tube:
  - 1. Wrought copper or bronze castings conforming to ASME B16.18 and B16.22. Unions shall be bronze, MSS SP-72, MSS SP-110, solder or braze joints. Use 95/5 tin and antimony for all soldered joints.
  - 2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75/B75M C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, C84400. Mechanical grooved couplings, 2070 kpa (300 psig) minimum ductile iron, ASTM A536 Grade 448-310-12 (Grade 65-45-12), or malleable iron, ASTM A47/A47M Grade 22410 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.

3. Mechanical press-connect fittings for copper pipe and tube shall conform to the material and sizing requirements of ASME B16.51, NSF 61 approved, 50 mm (2 inch) size and smaller mechanical press-connect fittings, double pressed type, with EPDM (ethylene propylene diene monomer) non-toxic synthetic rubber sealing elements and un-pressed fitting identification feature.
  4. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall ensure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze joints.
  5. Flanged fittings, bronze, class 150, solder-joint ends conforming to ASME B16.24.
- C. Fittings for Stainless Steel:
1. Stainless steel butt-welded fittings, Type 316, Schedule 10, conforming to ASME B16.9.
  2. Grooved fittings, stainless steel, Type 316, Schedule 40, conforming to ASTM A403/A403M. Segmentally fabricated fittings are not allowed. Mechanical grooved couplings, ductile iron, 4138 kPa (600 psig), ASTM A536 Grade 448-310-12 (Grade 65-45-12), or malleable iron, ASTM A47/A47M Grade 22410 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
- D. Adapters: Provide adapters for joining pipe or tubing with dissimilar end connections.
- E. Solder: ASTM B32 alloy type Sb5, HA or HB. Provide non-corrosive flux.
- F. Brazing alloy: AWS A5.8M/A5.8, brazing filler metals shall be BCuP series for copper to copper joints and BAg series for copper to steel joints.

## **2.4 EXPOSED WATER PIPING**

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, casework, cabinets, equipment and reagent racks when not

concealed by apron including those furnished by the Government or specified in other sections.

1. Pipe: ASTM B43, standard weight.
2. Fittings: ASME B16.15 cast bronze threaded fittings with chrome finish.
3. Nipples: ASTM B687, Chromium-plated.
4. Unions: MSS SP-72, MSS SP-110, brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

B. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

## **2.6 TRAP PRIMER WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- B. Fittings: Bronze castings conforming to ASME B16.18 Solder joints.
- C. Solder: ASTM B32 alloy type Sb5. Provide non-corrosive flux.

## **2.7 STRAINERS**

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Less than 75 mm (3 inches), brass or bronze; 75 mm (3 inches) and greater, cast iron or semi-steel.

## **2.8 DIELECTRIC FITTINGS**

- A. Provide dielectric couplings or unions between pipe of dissimilar metals.

## **2.9 STERILIZATION CHEMICALS**

- A. Hypochlorite: ASTM E1229.
- B. Liquid Chlorine: ASTM E1120.

## **2.10 WATER HAMMER ARRESTER**

- A. Closed copper tube chamber with permanently sealed 413 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and

lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010. Access shall be provided where devices are concealed within partitions or above ceilings. Size and install in accordance with PDI-WH 201 requirements. Provide water hammer arrestors at:

1. All solenoid valves.
2. All groups of two or more flush valves.
3. All quick opening or closing valves.
4. All medical washing equipment.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General: Comply with the International Plumbing Code and the following:
  1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
  2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.
  3. All pipe runs shall be laid out to avoid interference with other work/trades.
  4. Install union and shut-off valve on pressure piping at connections to equipment.
  5. Pipe Hangers, Supports and Accessories:
    - a. All piping shall be supported per the IPC, H-18-8 Seismic Design Handbook, MSS SP-58, and SMACNA as required.
    - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
    - c. Floor, Wall and Ceiling Plates, Supports, Hangers:
      - 1) Solid or split un-plated cast iron.
      - 2) All plates shall be provided with set screws.

- 3) Pipe Hangers: Height adjustable clevis type.
- 4) Adjustable Floor Rests and Base Flanges: Steel.
- 5) Concrete Inserts: "Universal" or continuous slotted type.
- 6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
- 7) Pipe Hangers and Riser Clamps: Malleable iron or carbon steel. Pipe Hangers and riser clamps shall have a copper finish when supporting bare copper pipe or tubing.
- 8) Rollers: Cast iron.
- 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
- 10) Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (minimum) metal protection shield centered on and welded to the hanger and support. The shield thickness and length shall be engineered and sized for distribution of loads to preclude crushing of insulation without breaking the vapor barrier. The shield shall be sized for the insulation and have flared edges to protect vapor-retardant jacket facing. To prevent the shield from sliding out of the clevis hanger during pipe movement, center-ribbed shields shall be used.
- 11) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.
- 12) With the installation of each flexible expansion joint, provide piping restraints for the upstream and downstream section of the piping at the flexible expansion joint. Provide calculations supporting the restraint length



design and type of selected restraints. Restraint calculations shall be based on the criteria from the manufacturer regarding their restraint design.

6. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
  7. Penetrations:
    - a. Firestopping: Where pipes 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. Completely fill and seal clearances between raceways and openings with the firestopping materials.
    - b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
    - c. Acoustical sealant: Where pipes pass through sound rated walls, seal around the pipe penetration with an acoustical sealant that is compliant with ASTM C919.
  8. Mechanical press-connect fitting connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Ensure the tube is completely inserted to the fitting stop (appropriate depth) and squared with the fitting prior to applying the pressing jaws onto the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer. Minimum distance between fittings shall be in accordance with the manufacturer's requirements. When the pressing cycle is complete, visually inspect the joint to ensure the tube has remained fully inserted, as evidenced by the visible insertion mark.
- B. Domestic Water piping shall conform to the following:
1. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.

2. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.
3. Run domestic water lines in such a manner that there are no dead-end lines. When domestic water lines are modified, remove all water lines such that there are no dead-end lines in the system. This is necessary to prevent the growth of legionella in the water lines.

### **3.2 TESTS**

- A. General: Test system either in its entirety or in sections. Submit testing plan to COR 10 working days prior to test date.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 1035 kPa (150 psig) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested. Pressure gauge shall have 1 psig increments.
- C. All Other Piping Tests: Test new installed piping under 1-1/2 times actual operating conditions and prove tight.
- D. The test pressure shall hold for the minimum time duration required by the applicable plumbing code or authority having jurisdiction.

### **3.3 STERILIZATION**

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
- B. Use liquid chlorine or hypochlorite for sterilization.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 11 23**  
**DOMESTIC WATER PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Hot water circulating pump, hot water recirculation pump and domestic water pressure booster system.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- G. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- H. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  - ASME Boiler and Pressure Code -
  - BPVC Section VIII-1-2015..... Rules for Construction of Pressure Vessels, Division 1
  - BPVC Section VIII-2-2015..... Rules for Construction of Pressure Vessels, Division 2-  
Alternative Rules
- C. American Society for Testing and Materials (ASTM):
  - A48/A48M-2003 (R2012) ..... Standard Specification for Gray Iron Castings

B584-2014 ..... Standard Specification for Copper Alloy Sand Castings for  
General Applications

D. International Code Council (ICC)

IPC-2012 ..... International Plumbing Code

E. National Electrical Manufacturers Association (NEMA):

ICS 6-1993 (R2001, R2006) .... Industrial Control and Systems: Enclosures

250-2014 ..... Enclosures for Electrical Equipment (1000 Volts Maximum)

F. NSF International (NSF)

61-2014a ..... Drinking Water System Components – Health Effects

372-2011 ..... Drinking Water System Components – Lead Content

G. Underwriters' Laboratories, Inc. (UL):

508-1999 (R2013) ..... Standards for Industrial Control Equipment

778-2010 (R2014) ..... Standard for Motor-Operated Water Pumps

#### 1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with  
Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED  
UNDER SECTION 22 11 23, DOMESTIC WATER PUMPS", with applicable paragraph  
identification.

C. Manufacturer's Literature and Data including: Full item description and optional  
features and accessories. Include dimensions, weights, materials, applications, standard  
compliance, model numbers, size, and capacity.

1. Pump:

- a. Manufacturer and model.
- b. Operating speed.
- c. Capacity.
- d. Characteristic performance curves.

2. Motor:

- a. Manufacturer,.

- b. Speed.
  - c. Current Characteristics.
  - d. Efficiency.
- 3. Drive: Information in accordance with Section 26 29 11, MOTOR CONTROLLERS.
- D. Certificate of shop test for domestic water booster system. Provide certified performance curves.
- E. Certified copies of all the factory and construction site test data sheets and reports.
- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- H. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

## **1.5 QUALITY ASSURANCE**

- A. General:
  - 1. UL Compliance: Comply with UL 778 for motor-operated water pumps.
  - 2. Design Criteria:
    - a. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
    - b. Head-capacity curves shall slope up to maximum head at shut-off. Select pumps near the midrange of the curve, and near the point of maximum efficiency, without approaching the pump curve end point and possible cavitation and

- unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
- c. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
  - d. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
  - e. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
  - f. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
  - g. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.
- B. Hot Water Circulating and Recirculating Pumps: Components shall be assembled by a single manufacturer and the pump motor assembly shall be the standard cataloged product of the manufacturer.
- C. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

## **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation

and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall be prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372.

### **2.2 HOT WATER RECIRCULATING PUMP**

- A. General:
  - 1. Centrifugal, single stage, pump. Driver shall be electric motor, close coupled or connected by flexible or magnetic coupling. Pump for hot water system shall be



designed for quiet, trouble-free operation at a minimum of 82 degrees C (180 degrees F) water service and 1,035 kPa (150 psig).

2. Mounting shall be in-line, vertical or horizontal as indicated on drawing schedules.
  3. Stamped or engraved stainless steel nameplate.
  4. Motors: Maximum 40 degrees C (104 degrees F) ambient temperature rise, drip-proof, for operation with current, voltage, phase and cycle shown in schedule on Electrical drawings, conforming to NEMA Type 4. Motors shall be equipped with thermal overload protection. When motor has cooled down it shall re-start automatically if the operating control has been left on and the system requires pump to start.
  5. Pump shall operate continuously with on-off switch, or with an HOA switch for automatically controlled pumps, for manual shut down. In the inlet and outlet piping of the pump, shutoff valves shall be installed to permit service to the pump, strainer, and check valve without draining the system.
  6. A check valve shall be installed in the pump discharge piping immediately downstream of the pump. A strainer with drain valve and removable strainer screen or basket shall be installed immediately upstream of the pump. Flexible pipe connectors and isolation pipe hangers shall be installed to prevent pump vibration from being transferred to adjacent piping and the building structure.
- B. Horizontal, Wet-Rotor Circulators:
1. Maintenance free, close-coupled pump and motor with maximum 3,300 rpm rotational speed.
  2. Bronze body construction with ceramic shaft, plastic impeller, fluid lubricated bearings, no mechanical seal, and flanged connections. Pump shall be capable of pumping the capacity scheduled on drawings.
  3. Bearings: Carbon type.

### **PART 3 - EXECUTION**

#### **3.1 STARTUP AND TESTING**

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. System Test: After installation is completed provide an operational test of the completed system including flow rates, pressure compliance, alarms and all control functions.
- C. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- D. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Contractor shall provide a minimum of 10 working days prior to startup and testing.

#### **3.2 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

#### **3.3 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 13 00**  
**FACILITY SANITARY AND VENT PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.
- B. A complete listing of common acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- F. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- G. Section 07 92 00, JOINT SEALANTS: Sealant products.
- H. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- I. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- J. Section 22 07 11, PLUMBING INSULATION.
- K. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS
- L. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- M. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

### 1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced.

The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.

- B. American Society of Mechanical Engineers (ASME):

A13.1-2007 ..... Identification of Piping Systems

A112.36.2M-1991..... Cleanouts

A112.6.3-2019 ..... Floor and Trench Drains

B1.20.1-2013 ..... Pipe Threads, General Purpose (Inch)

B16.1-2015 ..... Gray Iron Pipe Flanges and Flanged Fittings Classes 25,  
125, and 250

B16.4-2016 ..... Grey Iron Threaded Fittings Classes 125 and 250

B16.15-2018 ..... Cast Copper Alloy Threaded Fittings, Classes 125 and 250

B16.18-2018 ..... Cast Copper Alloy Solder Joint Pressure Fittings

B16.21-2016 ..... Nonmetallic Flat Gaskets for Pipe Flanges

B16.22-2018 ..... Wrought Copper and Copper Alloy Solder-Joint Pressure  
Fittings

B16.23-2016 ..... Cast Copper Alloy Solder Joint Drainage Fittings: DWV

B16.24-2016 ..... Cast Copper Alloy Pipe Flanges and Flanged Fittings, and  
Valves: Classes 150, 300, 600, 900, 1500, and 2500

B16.29-2017 ..... Wrought Copper and Wrought Copper Alloy Solder-Joint  
Drainage Fittings: DWV

B16.39-2014 ..... Malleable Iron Threaded Pipe Unions Classes 150, 250, and  
300

B18.2.1-2012 ..... Square, Hex, Heavy Hex, and Askew Head Bolts and Hex,  
Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch  
Series)

C. American Society of Sanitary Engineers (ASSE):

- 1001-2017 ..... Performance Requirements for Atmospheric Type Vacuum  
Breakers
- 1018-2001 ..... Performance Requirements for Trap Seal Primer Valves –  
Potable Water Supplied
- 1044-2015 ..... Performance Requirements for Trap Seal Primer Devices –  
Drainage Types and Electronic Design Types
- 1079-2012 ..... Performance Requirements for Dielectric Pipe Unions

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

- A53/A53M-2018..... Standard Specification for Pipe, Steel, Black And Hot-  
Dipped, Zinc-coated, Welded and Seamless
- A74-2017 ..... Standard Specification for Cast Iron Soil Pipe and Fittings
- A888-2018a ..... Standard Specification for Hubless Cast Iron Soil Pipe and  
Fittings for Sanitary and Storm Drain, Waste, and Vent  
Piping Applications
- B32-2008(R2014)..... Standard Specification for Solder Metal
- B43-2015 ..... Standard Specification for Seamless Red Brass Pipe,  
Standard Sizes
- B88-2016 ..... Standard Specification for Seamless Copper Water Tube
- B306-2013 ..... Standard Specification for Copper Drainage Tube (DWV)
- B687-1999(R2016)..... Standard Specification for Brass, Copper, and Chromium-  
Plated Pipe Nipples
- B813-2016 ..... Standard Specification for Liquid and Paste Fluxes for  
Soldering of Copper and Copper Alloy Tube
- B828-2016 ..... Standard Practice for Making Capillary Joints by Soldering  
of Copper and Copper Alloy Tube and Fittings
- C564-2014 ..... Standard Specification for Rubber Gaskets for Cast Iron  
Soil Pipe and Fittings

- D2321-2018.....Standard Practice for Underground Installation of  
Thermoplastic Pipe for Sewers and Other Gravity-Flow  
Applications
- D2564-2012(R3018) .....Standard Specification for Solvent Cements for Poly(Vinyl  
Chloride) (PVC) Plastic Piping Systems
- D2665-2014.....Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic  
Drain, Waste, and Vent Pipe and Fittings
- D2855-2015.....Standard Practice for Two-Step (Primer and Solvent  
Cement) Method of Joining Poly(Vinyl Chloride) (PVC) or  
Chlorinated Poly (Vinyl Chloride) CPVCP Pipe and Piping  
Components with Tapered Sockets
- D5926-2015.....Standard Specification for Poly(Vinyl Chloride) (PVC)  
Gaskets for Drain, Waste, and Vent (DWV), Sewer,  
Sanitary, and Storm Plumbing Systems
- F402-2018 .....Standard Practice for Safe Handling of Solvent Cements,  
Primers, and Cleaners Used for Joining Thermoplastic Pipe  
and Fittings
- F477-2014 .....Standard Specification for Elastomeric Seals (Gaskets) for  
Joining Plastic Pipe
- F1545-2015e1 .....Standard Specification for Plastic-Lined Ferrous Metal  
Pipe, Fittings, and Flanges
- E. Cast Iron Soil Pipe Institute (CISPI):
- 2006 .....Cast Iron Soil Pipe and Fittings Handbook
- 301-2012 .....Standard Specification for Hubless Cast Iron Soil Pipe and  
Fittings for Sanitary and Storm Drain, Waste, and Vent  
Piping Applications
- 310-2012 .....Specification for Coupling for Use in Connection with  
Hubless Cast Iron Soil Pipe and Fittings for Sanitary and  
Storm Drain, Waste, and Vent Piping Applications

- F. Copper Development Association, Inc. (CDA):  
A4015-14/19 ..... Copper Tube Handbook
- G. International Code Council (ICC):  
IPC-2018 ..... International Plumbing Code
- H. Manufacturers Standardization Society (MSS):  
SP-123-2018 ..... Non-Ferrous Threaded and Solder-Joint Unions for Use  
with Copper Water Tube
- I. National Fire Protection Association (NFPA):  
70-2020 ..... National Electrical Code (NEC)
- J. Underwriters' Laboratories, Inc. (UL):  
508-99 (R2013)..... Standard For Industrial Control Equipment

#### **1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 13 00, FACILITY SANITARY AND VENT PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Piping.
  - 2. Floor Drains.
  - 3. Cleanouts.
  - 4. Trap Seal Protection.
  - 5. Penetration Sleeves.
  - 6. Pipe Fittings.
  - 7. Traps.
  - 8. Exposed Piping and Fittings.

- D. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.
- E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts, and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- F. Completed System Readiness Checklist provided by the CXA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's bio-based Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopREFERRED.gov>.
- B. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Comply with requirements in Paragraph "AS-BUILT DOCUMENTATION" of Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.



## **PART 2 - PRODUCTS**

### **2.1 SANITARY WASTE, DRAIN, AND VENT PIPING**

- A. Cast iron waste, drain, and vent pipe and fittings.
  - 1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:
    - a. Pipe buried in or in contact with earth.
    - b. Sanitary pipe extensions to a distance of approximately 1500 mm (5 feet) outside of the building.
    - c. Interior waste and vent piping above grade.
  - 2. Cast iron Pipe shall be bell and spigot or hubless (plain end or no-hub or hubless).
  - 3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI 301, ASTM A888, or ASTM A74.
  - 4. Cast iron pipe and fittings shall be made from a minimum of 95 percent post-consumer recycled material.
  - 5. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM C564.
- B. Copper Tube, (DWV):
  - 1. Copper DWV tube sanitary waste, drain and vent pipe may be used for piping above ground, except for urinal drains.
  - 2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
  - 3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME B16.29.
  - 4. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

## **2.2 EXPOSED WASTE PIPING**

- A. Chrome plated brass piping of full iron pipe size shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
1. The Pipe shall meet ASTM B43, regular weight.
  2. The Fittings shall conform to ASME B16.15.
  3. Nipples shall conform to ASTM B687, Chromium-plated.
  4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- B. In unfinished Rooms such as mechanical Rooms and Kitchens, Chrome-plated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09 91 00, PAINTING.

## **2.3 SPECIALTY PIPE FITTINGS**

- A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
  2. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 861 kPa (125 psig) at a minimum temperature of 82 degrees C (180 degrees F). The end connection shall be solder joint copper alloy and threaded ferrous.

- C. Dielectric flange insulating kits shall be of non-conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F1545 with a pressure rating of 2070 kPa (300 psig) at 107 degrees C (225 degrees F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

## **2.4 CLEANOUTS**

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); and not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged sanitary line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts shall be provided where indicated in the contract document and at every building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty type.
- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary

tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.

- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.

## **2.5 FLOOR DRAINS**

- A. General Data: floor drain shall comply with ASME A112.6.3. A caulking flange, inside gasket, or hubless connection shall be provided for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe. The drain connection shall be bottom outlet. A membrane clamp and extensions shall be provided, if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening shall not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe. For drains not installed in connection with a waterproof membrane, a .45 kg (16-ounce) soft copper/ flashing membrane, 600 mm (24 inches) square or another approved waterproof membrane shall be provided.
- B. Type B (FD-B) medium duty (non-traffic) floor drain shall comply with ASME A112.6.3. The type B floor drain shall be constructed of galvanized cast iron with medium duty nickel bronze grate, double drainage pattern, clamping device, without sediment bucket but with secondary strainer in bottom for large debris. The grate shall be 175 mm (7 inches) minimum.
- C. Type C (FD-C) medium duty (non-traffic) floor drain shall comply with ASME A112.6.3. The type C floor drain shall have a cast iron body, double drainage pattern, clamping device, light duty nickel bronze adjustable strainer with round or square grate of 150 mm (6 inches) width or diameter minimum for toilet rooms, showers and kitchens.

- D. Type M (FD-M) medium duty (non-traffic) floor drain shall comply with ASME A112.6.3.

The type M floor drain shall have a cast iron body, nickel bronze adjustable funnel strainer and clamping device. Funnel strainer shall consist of a perforated floor-level square or round grate and funnel extension for indirect waste. Cut-out grate below funnel. Minimum dimensions as follows:

1. Area of strainer and collar – 23,000 square mm (36 square inches).
2. Height of funnel – 95 mm (3-3/4 inches).
3. Diameter of lower portion of funnel – 50 mm (2 inches).
4. Diameter of top portion of funnel – 100 mm (4 inches).
5. Provide paper collars for construction purposes.

- E. Type S (FD-S) floor sink shall comply with ASME A112.6.3. The type S floor sink shall be constructed from type 304 stainless steel and shall be 300 mm (12 inches) square, and 200 mm (8 inches deep). The interior surface shall be polished. The double drainage flange shall be provided with weep holes, internal dome strainer, and heavy duty non-tilting loose set grate. A clamping device shall be provided.

## **2.6 TRAPS**

- A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as the piping they are connected to. Slip joints are prohibited on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture.

## **2.7 PRIMER VALVES AND TRAP SEAL PRIMER SYSTEMS**

- A. Trap Primer (TP-1): The trap seal primer system shall be electronic type conforming to ASSE 1044.
1. The controller shall have a 24 hour programmable timer, solid state, 6 outlet zones, minimum adjustable run time of 1 minute for each zone, 12 hour program battery backup, manual switch for 120VAC power, 120VAC to 24VAC internal transformer,

- fuse protected circuitry, UL listed, 120VAC input-24VAC output, constructed of enameled steel or plastic.
2. The cabinet shall be recessed mounting with a stainless steel cover.
  3. The solenoid valve shall have a brass body, suitable for potable water service, normally closed, 861 kPa (125 psig) rated, 24VAC.
  4. The control wiring shall be copper in accordance with the National Electric Code (NFPA 70), Article 725 and not less than 18 gauge. All wiring shall be in conduit and in accordance with Division 26 of the specifications.
  5. The vacuum breaker shall conform to ASSE 1001.
- B. Trap Primer (TP-2): The trap seal primer valve shall be hydraulic, supply type with a pressure rating of 861 kPa (125 psig) and conforming to standard ASSE 1018.
1. The inlet and outlet connections shall be 15 mm or DN15 (NPS 1/2 inch)
  2. The trap seal primer valve shall be fully automatic with an all brass or bronze body.
  3. The trap seal primer valve shall be activated by a drop in building water pressure, no adjustment required.
  4. The trap seal primer valve shall include a manifold when serving two, three, or four traps.
  5. The manifold shall be omitted when serving only one trap.

## **2.8 PENETRATION SLEEVES**

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that shall extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that shall extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.

## **PART 3 - EXECUTION**

### **3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings where possible.
- F. The piping shall be installed to permit valve servicing or operation.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow greater than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried soil and waste drainage and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.

- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to Copper Development Association's (CDA) "Copper Tube Handbook".
- M. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

### **3.2 JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service.
  - 2. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead-free alloy solder conforming to ASTM B32 shall be used.

### **3.3 SPECIALTY PIPE FITTINGS**

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.



### **3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES**

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be painted according to Section 09 91 00, PAINTING. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
  - 1. 40 mm or DN40 to 50 mm or DN50 (NPS 1-1/2 inch to NPS 2 inch): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
  - 2. 75 mm or DN75 (NPS 3 inch): 1500 mm (60 inches) with 15 mm (1/2 inch) rod.
  - 3. 100 mm or DN100 to 125 mm or DN125 (NPS 4 inch to NPS 5 inch): 1500 mm (60 inches) with 18 mm (5/8 inch) rod.
  - 4. 150 mm or DN150 to 200 mm or DN200 (NPS 6 inch to NPS 8 inch): 1500 mm (60 inches) with 20 mm (3/4 inch) rod.
  - 5. 250 mm or DN250 to 300 mm or DN300 (NPS 10 inch to NPS 12 inch): 1500 mm (60 inch) with 23 mm (7/8 inch) rod.
- E. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.6 m (15 feet).
- F. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, Floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:
  - 1. Solid or split unplated cast iron.
  - 2. All plates shall be provided with set screws.

3. Height adjustable clevis type pipe hangers.
  4. Adjustable floor rests and base flanges shall be steel.
  5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  6. Riser clamps shall be malleable iron or steel.
  7. Rollers shall be cast iron.
  8. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- G. Miscellaneous materials shall be provided as specified, required, directed or as noted in the contract documents for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- H. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- I. Penetrations:
1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
  2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- J. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

### 3.5 TESTS

- A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.

- B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
  2. For an air test, an air pressure of 34 kPa (5 psig) gauge shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gauge shall be used for the air test.
  3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.
  4. Final Tests: Either one of the following tests may be used.
    - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of .25 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce 60 ml (2 ounces) of peppermint into each line or stack.

### **3.6 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification shall be tested as part of a larger system.

### **3.7 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hour to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 14 00  
FACILITY STORM DRAINAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for storm drainage systems, including piping and all necessary accessories as designated in this section.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- F. Section 07 92 00, JOINT SEALANTS.
- G. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- I. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- J. Section 22 05 33, HEAT TRACING FOR PLUMBING PIPING.
- K. Section 22 07 11, PLUMBING INSULATION.
- L. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):  
A112.6.4-2003 (R2012) .....Roof, Deck, and Balcony Drains

- A13.1-2007 (R2013)..... Scheme for Identification of Piping Systems
- B1.20.1-2013 ..... Pipe Threads, General Purpose, Inch
- B16.3-2011..... Malleable Iron Threaded Fittings: Classes 150 and 300
- B16.9-2012..... Factory-Made Wrought Buttwelding Fittings
- B16.11-2011 ..... Forged Fittings, Socket-Welding and Threaded
- B16.12-2009 (R2014)..... Cast Iron Threaded Drainage Fittings
- B16.15-2013 ..... Cast Copper Alloy Threaded Fittings: Classes 125 and 250
- B16.18-2012 ..... Cast Copper Alloy Solder-Joint Pressure Fittings
- B16.22-2013 ..... Wrought Copper and Copper Alloy Solder-Joint Pressure  
Fittings
- B16.23-2011 ..... Cast Copper Alloy Solder Joint Drainage Fittings - DWV
- B16.29-2012 ..... Wrought Copper and Wrought Copper Alloy Solder-Joint  
Drainage Fittings – DWV
- C. American Society of Sanitary Engineering (ASSE)
  - 1079-2012 ..... Performance Requirements for Dielectric Pipe Unions
- D. American Society for Testing and Materials (ASTM):
  - A47/A47M-1999 (R2014) ..... Standard Specification for Ferritic Malleable Iron Castings
  - A53/A53M-2012..... Standard Specification for Pipe, Steel, Black And Hot-  
Dipped, Zinc-coated Welded and Seamless
  - A74-2013a ..... Standard Specification for Cast Iron Soil Pipe and Fittings
  - A183-2014 ..... Standard Specification for Carbon Steel Track Bolts and  
Nuts
  - A312/A312M-2015..... Standard Specification for Seamless, Welded, and Heavily  
Cold Worked Austenitic Stainless Steel Pipes
  - A536-1984(R2014) ..... Standard Specification for Ductile Iron Castings
  - A733-2013 ..... Standard Specification for Welded and Seamless Carbon  
Steel and Austenitic Stainless Steel Pipe Nipples

A888-2013a .....	Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
B32-2008 (R2014).....	Standard Specification for Solder Metal
B61-2008 (R2013).....	Standard Specification for Steam or Valve Bronze Castings
B62-2009 .....	Standard Specification for Composition Bronze or Ounce Metal Castings
B75/B75M-2011 .....	Standard Specification for Seamless Copper Tube
B88-2014 .....	Standard Specification for Seamless Copper Water Tube
B306-2013 .....	Standard Specification for Copper Drainage Tube (DWV)
B584-2014 .....	Standard Specification for Copper Alloy Sand Castings for General Applications
B687-1999 (R2011).....	Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
B828-2002 (R2010).....	Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
B813-2010 .....	Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
C564-2014 .....	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
C1173-2010 (R2014).....	Standard Specification for Flexible Transition Couplings for Underground Piping Systems
D1785-2012 .....	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
D2000-2012 .....	Standard Classification System for Rubber Products in Automotive Applications
D2321-2014e1 .....	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

- D2564-2012..... Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
- D2665-2014..... Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- D2855-1996 (R2010) ..... Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
- D4101-2014..... Standard Specification for Polypropylene Injection and Extrusion Materials
- D5926-2011..... Standard for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
- F477-2014 ..... Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- F656-2010 ..... Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- F1545-2015 ..... Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges
- E. American Welding Society (AWS):
- A5.8M/A5.8 AMD1-2011..... Specification for Filler Metals for Brazing and Braze Welding
- F. Copper Development Association (CDA):
- A4015-2011..... Copper Tube Handbook
- G. Cast Iron Soil Pipe Institute (CISPI):
- 301-2012 ..... Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications



310-2012 ..... Standard Specification for Coupling for Use in Connection  
with Hubless Cast Iron Soil Pipe and Fittings for Sanitary  
and Storm Drain, Waste, and Vent Piping Applications

H. International Code Council (ICC):

IPC-2012 ..... International Plumbing Code

I. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

SP-72-2010a ..... Ball Valves with Flanged or Butt-Welding Ends for General  
Service

SP-110-2010 ..... Ball Valves Threaded, Socket-Welding, Solder Joint,  
Grooved and Flared Ends

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 14 00, FACILITY STORM DRAINAGE", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Pipe and Fittings.
  - 2. Specialty Pipe Fittings.
  - 3. Cleanouts.
  - 4. Roof Drains.
  - 5. Expansion Joints.
  - 6. Downspout Nozzles.
  - 7. Sleeve Flashing Devices.
- D. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.

- E. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification

testing. As-built drawings are to be provided, and a copy of them in Auto-CAD provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 STORM WATER DRAIN PIPING**

- A. Cast Iron Storm Pipe and Fittings:
1. Cast iron storm pipe and fittings shall be used for the following applications:
    - a. Pipe buried in or in contact with earth.
    - b. Extension of pipe to a distance of approximately 1500 mm (5 feet) outside of building walls.
    - c. Interior storm piping above grade.
    - d. All mechanical equipment rooms or other areas containing mechanical air handling equipment.
  2. The cast iron storm pipe shall be bell and spigot, or hubless (plain end or no-hub) as required by selected jointing method.
  3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI 301, ASTM A888, or ASTM A74.
  4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM C564.

B. Copper Tube, (DWV): May be used for piping above ground.

1. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
2. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.
3. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

C. Polyvinyl Chloride (PVC):

1. PVC storm sewer pipe and fittings are permitted for single story structures except for mechanical equipment rooms and other areas containing air handling equipment or hot water generation equipment.
2. PVC storm sewer pipe and fittings shall be schedule 40 solid core piping conforming to ASTM D1785 and ASTM D2665, Sewer and Drain Series, with ends for solvent cemented joints.
3. PVC joints shall be solvent welded socket type using solvent cement conforming to ASTM D2564 and adhesive primer conforming to ASTM F656. Bio-based materials shall be utilized when possible.

D. Roof drain piping and body of drain in locations where the outdoor conditions are subject to freezing shall be insulated.

## **2.2 SPECIALTY PIPE FITTINGS**

A. Transition pipe couplings shall join piping with small differences in outside diameters or be of different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be unshielded, elastomeric, sleeve type reducing or transition pattern conforming with ASTM C1173 and include shear ring and corrosion resistant metal tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:

1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.

2. For PVC soil pipes, the sleeve material shall be elastomeric seal conforming to ASTM F477 or PVC conforming to ASTM D5926.
  3. dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. Dielectric fittings shall conform to ASSE 1079 with a pressure rating of 1035 kPa (150 psig) at a minimum temperature of 82 degrees C (180 degrees F). The end connection shall be solder joint copper alloy and threaded ferrous.
  - C. Dielectric flanges shall conform to ASSE 1079 with a pressure rating of 1035 kPa (150 psig) The flange shall be a factory fabricated, bolted, companion flange assembly. The end connection shall be threaded or solder-joint copper alloy and threaded ferrous.
  - D. Dielectric flange insulating kits shall be of non-conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
  - E. Dielectric nipples shall be electroplated steel and shall conform with ASTM F1545 with a pressure ratings of 2070 kPa (300 psig) at 107 degrees C (225 degrees F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene. Bio-based materials shall be utilized when possible.

## **2.3 CLEANOUTS**

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. A minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged storm sewer line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside caulk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in

the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts shall be provided where indicated on the drawings and at each building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty.

- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel bronze square frame and stainless steel cover with minimum opening of 150 mm by 150 mm (6 inch by 6 inch) shall be provided at each wall cleanout.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

## **2.4 ROOF DRAINS AND CONNECTIONS**

- A. Roof Drains: Roof Drains (RD) shall be cast iron with clamping device for making watertight connection and shall conform with ASME A112.6.4. Free openings through strainer shall be twice area of drain outlet. For roof drains not installed in connection with a waterproof membrane, a soft copper membrane shall be provided 300 mm (12 inches) in diameter greater than outside diameter of drain collar. An integral gravel stop shall be provided for drains installed on roofs having built up roofing covered with gravel or slag. Integral no-hub, soil pipe gasket or threaded outlet connection shall be provided.
  - 1. Flat Roofs: The roof drain shall have a beehive or dome shaped strainer with integral flange not less than 300 mm (12 inches) in diameter. For an insulated roof, a roof drain with an adjustable drainage collar shall be provided, which can be raised or lowered to meet required insulation heights, sump receiver and deck clamp. The

- bottom section shall serve as roof drain during construction before insulation is installed.
2. Canopy Roofs: The roof drain shall have a beehive or dome shaped strainer with the integral flange no greater than 200 mm (8 inches) in diameter. For an insulated roof, the roof drain shall be provided with an adjustable drainage collar, which can be raised or lowered to meet the required insulation heights, sump receiver and deck clamp. Bottom section shall serve as roof drain during construction before insulation is installed.
  3. Promenade Decks: the roof drain shall be the same as for canopy roofs, except decks shall have flat, round, loose, non-slip, bronze grate set in square, non-slip, bronze frame.
  4. Portico Roofs and Gutters: Roof drains shall be horizontal angle type drain with flat bottom and horizontal outlet at the same elevation as the pipe to which it is connected. Strainer shall be removable angle grate type.
  5. Protective Roof Membrane Insulation Assembly: The roof drain shall have a perforated stainless steel extension filter, non-puncturing clamp ring, large sump with extra wide roof flange and deck clamp.
    - a. Non pedestrian Roofs: The roof drain shall have large polypropylene or aluminum locking dome.
    - b. Pedestrian Roof: The roof drain shall have a bronze promenade top 356 mm (14 inches) square, set in square secured frame support collar.
  6. Roof Drains, Overflow or Secondary (Emergency): Roof Drains identified as overflow or secondary (emergency) drains shall have a 50 mm (2 inch) water dam integral to the drain body.
  7. Roof drains in areas subject to freezing shall have heat tape and shall be insulated.
- B. Expansion Joints: Expansions joints shall be heavy cast iron with cast brass or PVC expansion sleeve having smooth bearing surface working freely against a packing ring held in place and under pressure of a bolted gland ring, forming a water and air tight flexible joint. Asbestos packing is prohibited.

- C. Interior Downspouts: An expansion joint shall be provided, specified above, at top of run on straight, vertical runs of downspout piping 12 m (40 feet) long or greater.
- D. Downspout Nozzle: The downspout nozzle fitting shall be of brass, unfinished, with internal pipe thread for connection to downspout.

## **2.5 WATERPROOFING**

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproofed caulked joint shall be provided at the top hub.

## **PART 3 - EXECUTION**

### **3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the IPC and these specifications.
- B. Branch piping shall be installed from the piping system and connect to all drains and outlets.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.
- D. All pipe runs shall be laid out to avoid interference with other work/trades.
- E. The piping shall be installed above accessible ceilings to allow for ceiling panel removal.
- F. Unless otherwise stated on the documents, minimum horizontal slope shall be one inch for every 2.44 m (8 feet) (1 percent slope) of pipe length.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for storm drainage piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep ¼ bends may be



used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and 1/8 bend fittings shall be used if two drains are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- J. Buried storm drainage piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements. Bio-based materials shall be utilized when possible.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to CDA A4015.
- M. Aboveground PVC piping shall be installed according to ASTM D2665. Underground PVC piping shall be installed according to ASTM D2321.

### **3.2 JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service

2. Pipe sections with damaged threads shall be replaced with new undamaged sections of pipe at no additional time or cost to Government.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.
- F. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendices.

### **3.3 SPECIALTY PIPE FITTINGS**

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

### **3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES**

- A. All piping shall be supported according to the IPC, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications.
- B. Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
  1. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
  2. NPS 3 (DN 80): 1500 mm (60 inches) with 15 mm (1/2 inch) rod.
  3. NPS 4 to NPS 5 (DN 100 to DN 125): 1500 mm (60 inches) with 18 mm (5/8 inch) rod.
  4. NPS 6 to NPS 8 (DN 150 to DN 200): 1500 mm (60 inches) with 20 mm (3/4 inch) rod.

5. NPS 10 to NPS 12 (DN 250 to DN 300): 1500 mm (60 inches) with 23 mm (7/8 inch) rod.
- E. The maximum support spacing for horizontal plastic shall be 1.22 m (4 feet).
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.6 m (15 feet).
- G. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, wall and ceiling plates shall have the following characteristics:
  1. Solid or split unplated cast iron.
  2. All plates shall be provided with set screws.
  3. Height adjustable clevis type pipe hangers.
  4. Adjustable Floor Rests and Base Flanges shall be steel.
  5. Hanger Rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  6. Riser Clamps shall be malleable iron or steel.
  7. Roller shall be cast iron.
  8. Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (minimum) metal protection shield centered on and welded to the hanger and support. The shield shall be 100 mm (4 inches) in length and be 1.6 mm (16 gage) steel. The shield shall be sized for the insulation.
- H. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- I. Cast escutcheon with set screw shall be installed at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

J. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
2. Water proofing: At floor penetrations, Clearances around the pipe shall be completely sealed and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.

**3.5 INSULATION**

- A. Insulate horizontal sections and 600 mm (2 feet) past changes of direction to vertical sections for interior section of roof drains. Install insulation in accordance with the requirements of Section 22 07 11, PLUMBING INSULATION.

**3.6 TESTS**

- A. Storm sewer system shall be tested either in its entirety or in sections.
- B. Storm Water Drain tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
  1. If entire system is tested with water, tightly close all openings in pipes except the highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
  2. For an air test, an air pressure of 34 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the test.

3. Final Tests: While either one of the following tests may be used, Contractor shall check with VA as to which test will be performed.
  - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 0.25 kPa (1 inch of water) with a smoke machine. **Chemical smoke is prohibited.**
  - b. Peppermint Test: Introduce .06 liters (2 ounces) of peppermint into each line or stack.
- C. COR shall witness all tests. Contractor shall coordinate schedules with the COR and CxA. Contractor shall provide a minimum of 10 working days prior to flushing, disinfection/sterilization, startup, and testing.

### **3.7 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.8 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 35 00**  
**DOMESTIC WATER HEAT EXCHANGERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for domestic hot water heat exchangers including thermometers and all necessary accessories, connections and equipment.
- B. Application is for indirect water heating utilizing steam or hot water as a medium and can be used for heat recovery or solar systems for pre-heating water prior to primary water heating equipment.
- C. A complete listing of common acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENT FOR NON STRUCTURAL COMPONENTS: Seismic Restraint for equipment.
- G. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- H. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING.
- I. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING.
- J. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- K. Section 22 11 23, DOMESTIC WATER PUMPS: Circulating Pump.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.

- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - 90.1-2019 ..... Energy Standard for Buildings Except Low-Rise Residential Buildings
- C. American National Standard Institute (ANSI):
  - Z21.22-2015 ..... Relief Valves for Hot Water Supply Systems
- D. American Society of Mechanical Engineers (ASME):
  - ASME Boiler and Pressure Vessel Code –
  - BPVC Section IV-2019 ..... Rules for Construction of Heating Boilers
  - BPVC Section VIII-1-2019 ..... Rules for Construction of Pressure Vessels, Division 1
  - Form U-1 ..... Manufacturer's Data Report for Pressure Vessels
  - B1.20.1-2013 ..... Pipe Threads, General Purpose (Inch)
  - B16.5-2017 ..... Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24  
Metric/Inch Standard
  - B16.24-2016 ..... Cast Copper Alloy Pipe Flanges, Flanged Fittings, and  
Valves: Classes 150, 300, 600, 900, 1500, and 2500
  - PTC 25-2018 ..... Pressure Relief Devices
- E. National Fire Protection Association (NFPA):
  - 70-2020 ..... National Electrical Code (NEC)
- F. NSF International (NSF):
  - 61-2018 ..... Drinking Water System Components – Health Effects
  - 372-2016 ..... Drinking Water System Components – Lead Content
- G. Underwriter Laboratories (UL):
  - 207-2009(R2020) ..... Standard for Refrigerant-Containing Components and  
Accessories, Nonelectrical
  - 778-2016(R2019) ..... Standard for Motor-Operated Water Pumps

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 35 00, DOMESTIC WATER HEAT EXCHANGERS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Heat Exchangers.
  - 2. Pressure and Temperature Relief Valves.
  - 3. Steam Control Valves.
  - 4. Heating Hot Water Control Valves.
  - 5. Thermometers.
  - 6. Pressure Gauges.
  - 7. Vacuum Breakers.
  - 8. Safety Valves.
  - 9. Expansion Tanks.
  - 10. Circulating Pumps.
  - 11. Heat Traps.
- D. A Form U-1 or other documentation stating compliance with the ASME Boiler and Pressure Vessel Code.
- E. Shop drawings shall include wiring diagrams for power, signal and control functions.
- F. Seismic qualification certificates shall be submitted that details equipment anchorage components, identifies equipment center of gravity with mounting and anchorage provisions, and whether the seismic qualification certificate is based on an actual test or calculations.
- G. Submit documentation indicating compliance with applicable requirements of ASHRAE 90.1, Unfired Storage Tanks, for Service Water Heating.
- H. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts, and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.



2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- I. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
  - J. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### **1.5 QUALITY ASSURANCE**

- A. Equipment components in contact with potable water shall meet compliance requirements in documents NSF 61 and NSF 372.
- B. Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 for efficiency performance.
- C. The domestic water heat exchanger shall conform to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENT FOR NON-STRUCTURAL COMPONENTS on seismic restraint requirements, withstanding Seismic movement without separation of any parts from the equipment when subjected to a seismic event.
- D. The heat exchanger shall be certified and labeled by an independent testing agency.
- E. Circulating pump power shall be installed per NFPA 70.
- F. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <https://www.biopreferred.gov>.
- G. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

## **1.6 AS-BUILT DOCUMENTATION**

- A. Comply with requirements in Paragraph AS-BUILT DOCUMENTATION of Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

## **PART 2 - PRODUCTS**

### **2.1 PLATE DOMESTIC WATER HEAT EXCHANGERS**

- A. Brazed-Plate heat exchanger with assembly of stainless-steel heat exchanger plates not less than 0.6 mm (0.025 inch) thick, permanently brazed together for heating hot water to heat domestic water. The working pressure shall be rated at 1034 kPa (150 psig).
- B. Connections shall be threaded for piping 50 mm (2 inch) and smaller or flanged for piping 63 mm (2-1/2 inch) and larger of stainless-steel.

### **2.2 HOT WATER STORAGE TANK**

- A. Description: Hot-water storage tank with integral heat-exchanger coil, controls, and specialties for storage of heated domestic water.
- B. Storage-Tank Shell Construction: Stainless steel with 150-psig working-pressure rating.
  - 1. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
  - 2. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
  - 3. Insulation: Complying with ASHRAE/IESNA 90.1 or ASHRAE 90.2, and suitable for operating temperature. Surround entire storage tank except connections and controls.
  - 4. Jacket: Steel with enameled finish unless otherwise indicated.
  - 5. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
  - 6. Anode Rods: Factory installed, magnesium.
- C. Temperature Control: Adjustable thermostat.
- D. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relief valve with relieving capacity at least as great as heat input,

and include pressure setting less than working-pressure rating of heat exchanger. Select relief valve with sensing element that extends into storage tank.

## **2.3 THERMOMETERS**

- A. Thermometers shall be rigid stem or remote sensing, scale or dial type with an aluminum, black metal, stainless-steel, or chromium plated brass case. The thermometer shall be back connected, red liquid (alcohol or organic-based) fill, vapor, bi-metal or gas actuated, with 228 mm (9 inches) high scale dial or circular dial 50 to 127 mm (2 to 5 inches) in diameter graduated from 4 to 100 degrees C (40 to 212 degrees F), with two-degree graduations guaranteed accurate within one scale division. The socket shall be separable, double-seat, micrometer-fittings, with extension neck not less than 63 mm (2 1/2 inches) to clear tank or pipe covering. The thermometer shall be suitable for 19 mm (3/4 inch) pipe threads. Thermometers may be console-mounted with sensor installed in separate thermometer well.

## **2.4 SAFETY VALVES FOR SHELL AND COIL HEATERS**

- A. Separate combination pressure/temperature relief valves shall be provided on each water heater.
- B. A double solenoid safety system shall be provided for each shell and coil heater to function as a safety over temperature prevention system. System shall consist of aquastat, pilot light, solenoid safety valve and solenoid water safety valve located in the control circuit. The aquastat shall be set at 60 degrees C (140 degrees F). Shutoff valves shall comply with Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING.

## **2.5 DOMESTIC HOT WATER EXPANSION TANKS**

- A. A steel pressure rated tank constructed with welded joints and factory installed butyl rubber diaphragm shall be installed as scheduled. The air precharge shall be set to minimum system operating pressure at tank.
- B. The tappings shall be factory-fabricated steel, welded to the tank and include ASME B1.20.1 pipe thread.

- C. The interior finish shall comply with NSF 61 and NSF 372 for barrier materials for potable water tank linings and the liner shall extend into and through the tank fittings and outlets.
- D. The air charging valve shall be factory installed.

## **2.6 HEAT TRAPS**

- A. Heat traps shall be installed in accordance with ASHRAE 90.1 unless provided integrally with the heaters.

## **2.7 COMBINATION TEMPERATURE AND PRESSURE RELIEF VALVES**

- A. The combination pressure and temperature relief Valve shall be ANSI Z21.22 and ASME rated and constructed of all brass or bronze with a self-closing reseating valve. The relief valves shall include a relieving capacity greater than the heat input and include a pressure setting less than the water heater's working pressure rating. Sensing element shall extend into storage tank.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.
- B. The water heaters shall be installed on concrete bases. Refer to Specification Section 03 30 00, CAST-IN-PLACE CONCRETE and Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- C. The water heaters shall be installed level and plumb and securely anchored.
- D. Water heaters shall be installed and connected in accordance with manufacturer's written instructions with manufacturer's recommended clearances.
- E. All pressure and temperature relief valves discharge shall be piped to nearby floor drains with air gap or break.
- F. Thermometers and isolation valves shall be installed on water heater inlet and outlet piping and shall be positioned such that they can be read by an operator or staff standing on floor or walkway.

- G. The thermostatic control shall be set for a minimum setting of 60 degrees C (140 degrees F) for storage heaters.
- H. Shutoff valves shall be installed on the domestic water supply piping to the water heater and on the domestic hot water outlet piping.
- I. All manufacturer's required clearances shall be maintained.
- J. The domestic water heaters shall be installed with seismic restraint devices.
- K. A combination temperature and pressure relief valve shall be installed at the top portion of the storage tank. The sensing element shall extend into the tank. The relief valve outlet drain piping shall discharge by air gap into a floor drain.
- L. Piping type heat traps shall be installed on the inlet and outlet piping of the domestic water heater storage tanks, unless provided integrally with the tanks.
- M. Water heater drain piping shall be installed as indirect waste to spill by air gap into open drains or over floor drains. Hose end drain valves shall be installed at low points in water piping for gas fueled domestic hot water heaters without integral drains.
- N. Dielectric unions shall be provided if there are dissimilar metals between the water heater connections and the attached piping.
- O. Provide vacuum breakers per ANSI Z21.22 on the inlet pipe if the water heater is bottom fed.

### **3.2 LEAKAGE TEST**

- A. Before piping connections are made, the water heaters shall be tested at a hydrostatic pressure of 1380 kPa (200 psig) for water heaters rated at less than 1104 kPa (160 psig) and 1654 kPa (240 psig) for units with an maximum working pressure of 1104 kPa (160 psig) or over. Any failed test shall be corrected and the water heater shall be replaced with a new unit at no additional cost or time to the Government.

### **3.3 PERFORMANCE TEST**

- A. Ensure that all the remote water outlets are always tested to a minimum of 43 degrees C (110 degrees F) and a maximum of 49 degrees C (120 degrees F) water flow. If necessary, make all correction to balance the return water system or reset the thermostat to make the system comply with design requirements.

### **3.4 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. The tests shall include system capacity, control function, and alarm functions.
- C. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- D. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.6 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hour to instruct each VA Personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 22 40 00  
PLUMBING FIXTURES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The contractor shall provide labor, material, equipment, and incidentals required to centrifugal pumps as specified herein.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 92 00, JOINT SEALANTS: Sealing between fixtures and other finish surfaces.
- F. Section 08 31 13, ACCESS DOORS AND FRAMES: Flush panel access doors.
- G. Section 10 21 13, TOILET COMPARTMENTS: Through bolts.
- H. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- I. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.
- J. 22 13 00, FACILITY SANITARY AND VENT PIPING.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. The American Society of Mechanical Engineers (ASME):
  - A112.6.1M-1997 (R2012) ..... Supports for Off-the-Floor Plumbing Fixtures for Public Use
  - A112.19.1-2013 ..... Enameled Cast Iron and Enameled Steel Plumbing Fixtures
  - A112.19.2-2013 ..... Ceramic Plumbing Fixtures
  - A112.19.3-2008 ..... Stainless Steel Plumbing Fixtures

- C. American Society for Testing and Materials (ASTM):
  - A276-2013a ..... Standard Specification for Stainless Steel Bars and Shapes
  - B584-2008 ..... Standard Specification for Copper Alloy Sand Castings for  
General Applications
- D. CSA Group:
  - B45.4-2008 (R2013)..... Stainless Steel Plumbing Fixtures
- E. National Association of Architectural Metal Manufacturers (NAAMM):
  - AMP 500-2006..... Metal Finishes Manual
- F. American Society of Sanitary Engineering (ASSE):
  - 1016-2011 ..... Automatic Compensating Valves for Individual Showers  
and Tub/Shower Combinations
- G. NSF International (NSF):
  - 14-2013 ..... Plastics Piping System Components and Related Materials
  - 61-2013 ..... Drinking Water System Components – Health Effects
  - 372-2011 ..... Drinking Water System Components – Lead Content
- H. American with Disabilities Act (A.D.A)
- I. International Code Council (ICC):
  - IPC-2015 ..... International Plumbing Code

#### **1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 22 40 00, PLUMBING FIXTURES”, with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, connections, and capacity.
- D. Operating Instructions: Comply with requirements in Section 01 00 00, GENERAL REQUIREMENTS.



- E. Completed System Readiness Checklist provided by the CxA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

### **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification

testing. As-built drawings are to be provided, and a copy of them in AutoCAD provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead is prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

### **2.2 STAINLESS STEEL**

- A. Corrosion-resistant Steel (CRS):
  - 1. Plate, Sheet and Strip: CRS flat products shall conform to chemical composition requirements of any 300 series steel specified in ASTM A276.
  - 2. Finish: Exposed surfaces shall have standard polish (ground and polished) equal to NAAMM finish Number 4.
- B. Die-cast zinc alloy products are prohibited.

### **2.3 STOPS**

- A. Provide lock-shield loose key or screw driver pattern angle stops, straight stops or stops integral with faucet, with each compression type faucet whether specifically called for or not, including sinks in solid-surface, wood and metal casework, laboratory furniture and pharmacy furniture. Locate stops centrally above or below fixture in accessible

location. Stops shall be lead free and rated for a minimum of 250 psi and 250 degrees F.  
Basis of design is Dahl-ECO mini ball valve.

- B. Furnish keys for lock shield stops to the COR.
- C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.
- D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe, i.e. red brass pipe nipple, chrome plated where exposed.
- E. Mental Health Area: Provide stainless steel drain guard for all lavatories not installed in casework.

## **2.4 ESCUTCHEONS**

- A. Heavy type, chrome plated, with set screws. Provide for piping serving plumbing fixtures and at each wall, ceiling and floor penetrations in exposed finished locations and within cabinets and millwork.

## **2.5 LAMINAR FLOW CONTROL DEVICE**

- A. Smooth, bright stainless steel or satin finish, chrome plated metal laminar flow device shall provide non-aeration, clear, coherent laminar flow that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.

**Aerators are prohibited.**

- B. Flow Control Restrictor:
  - 1. Capable of restricting flow from 32 ml/s to 95 ml/s (0.5 gpm to 1.5 gpm) for lavatories; 125 ml/s to 140 ml/s (2.0 gpm to 2.2 gpm) for sinks P-505 through P-520, P-524 and P-528; and 174 ml/s to 190 ml/s (2.75 gpm to 3.0 gpm) for dietary food preparation and rinse sinks or as specified.
  - 2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 170 kPa and 550 kPa (25 psig and 80 psig).
  - 3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-cleaning action, and is capable of easy manual cleaning.

## 2.6 CARRIERS

- A. ASME A112.6.1M, with adjustable gasket faceplate chair carriers for wall hung closets with auxiliary anchor foot assembly, hanger rod support feet, and rear anchor tie down.
- B. ASME A112.6.1M, lavatory, chair carrier for thin wall construction. All lavatory chair carriers shall be capable of supporting the lavatory with a 250-pound vertical load applied at the front of the fixture.
- C. Where water closets, lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. The drainage fitting of the back to back carrier shall be so constructed that it prevents the discharge from one fixture from flowing into the opposite fixture.

## 2.7 WATER CLOSETS

- A. (P-115) Water Closet (Floor Mounted, ASME A112.19.2) siphon jet, dual flush oscillating bio-guard handle, 4.2 L/6 L (1.1 gallon/1.6 gallon) per flush. Top of seat shall be 280 mm to 430 mm (11 to 19 inches) above finish floor, depending on age group (refer to ADA standard for guidance).
  - 1. Seat: Commercial weight, chemical resistant, solid plastic open front less cover for infant bowls, integrally molded bumpers, concealed check hinge with stainless steel post. Color shall be white.
  - 2. Fitting and Accessories: Gaskets-neoprene, bolts with chromium plated cap nuts and washers.
  - 3. Flush valve: Large chloramines resistant diaphragm, semi-red brass body, non-hold open ADA approved side oscillating handle dual flush non-hold open ADA approved side oscillating handle exposed chrome plated, water saver design, 25 mm (1 inch) screwdriver angle check stop, adjustable tailpiece, high pressure vacuum breaker, cast set screw wall flanges and spud flanges, sweat solder adapter with cover tube, spud coupling for 40 mm (1-1/2 inch) top spud, solid-ring pipe support, and wall and spud flanges. Set centerline inlet 292 mm (11-1/2 inches) above seat. Valve body, cover, tailpiece, and control stop shall be in conformance with ASTM alloy classification for semi-red brass.

## 2.8 LAVATORIES

- A. Dimensions for lavatories are specified, Length by width (distance from wall) and depth.
- B. Brass components in contact with water shall contain no more than 0.25 percent lead content by dry weight. Faucet flow rates shall be 3.9 L/m (1.5 gpm) for private lavatories and either 1.9 L/m (0.5 gpm) or 1.0 liter (0.25 gallons) per cycle for public lavatories.
- C. (P-401) Lavatory (Single Lever Handle Control ASME A112.19.2) straight back, approximately 508 mm by 457 mm (20 inches by 18 inches) and a 102 mm (4 inches) maximum apron, first quality vitreous china. Punching for faucet on 102 mm (4 inches) centers. Set with rim 864 mm (34 inches) above finished floor.
  - 1. Faucet: Solid cast brass construction, vandal resistant, heavy-duty single lever handle, center set. Control shall be washerless ceramic disc cartridge type. Provide laminar flow control device, adjustable hot water limit stop, and vandal proof screws. Flow shall be limited to 1.9 L/m (0.5 gpm) .
  - 2. Drain: Cast or wrought brass with flat grid strainer offset tailpiece, chrome plated. Provide cover per A.D.A 4-19.4.
  - 3. Stops: Angle type, see paragraph "Stops". Provide cover per A.D.A 4-19.4.
  - 4. Trap: Cast copper alloy, 38 mm by 32 mm (1 1/2 inches by 1 1/4 inches) P-trap. Adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extensions to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall. Provide cover per A.D.A 4-19.4.
- D. (P-413) Lavatory (Exam Room, CRS, Single Compartment, Counter Top ASME A112.19.2, Kitchen Sinks) self-rimming, back faucet ledge, approximately 381 mm by 432 mm (15 inches by 17 inches) with single compartment inside dimensions approximately 304 mm by 304 mm by 254 mm (12 inches by 12 inches by 10 inches) deep. Shall be minimum of 1.3 mm thick (18 gauge) CRS. Corners and edges shall be well rounded:
  - 1. Faucet: Solid cast brass construction with washerless ceramic disc mixing cartridge type, rigid gooseneck spout with outlet 102 mm to 127 mm (4 inches to 5 inches) above slab with 102 mm (4 inches) wrist blade handles. Provide laminar flow control

device. Faucet, wall and floor escutcheons shall be either copper alloy or CRS.

Exposed metal parts shall be chrome plated with a smooth bright finish.

2. Drain: cast or wrought brass with flat grid strainer, offset tailpiece, brass, chrome plated.
3. Stops: Angle type. See paragraph "Stops".
4. Trap: Cast copper alloy, 38 mm by 32 mm (1 1/2 inches by 1 1/4 inches) P-trap, adjustable with connected elbow and 1.4mm thick (17 gauge) tubing extension to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to the wall.

## **2.9 SINKS AND LAUNDRY TUBS**

- A. Dimensions for sinks and laundry tubs are specified, length by width (distance from wall) and depth.
- B. (P-502) Service Sink (Corner, Floor Mounted) stain resistant terrazzo, 711 mm by 711 mm by 305 mm (28 inches by 28 inches by 12 inches) with 152 mm (6 inches) drop front. Terrazzo, composed of marble chips and white Portland cement, shall develop compressive strength of 20684 kPa (3000 psig) seven days after casting. Provide extruded aluminum cap on front side.
  1. Faucet: Solid brass construction, 9.5 L/m (2.5 gpm) combination faucet with replaceable Monel seat, removable replacement unit containing all parts subject to wear, integral check/stops, mounted on wall above sink. Spout shall have a pail hook, 19 mm (3/4 inch) hose coupling threads, vacuum breaker, and top or bottom brace to wall. Four-arm handles on faucets shall be cast, formed, or drop forged copper alloy. Escutcheons shall be either forged copper alloy or CRS. Exposed metal parts, including exposed part under valve handle when in open position, shall have a smooth bright finish. Provide 914 mm (36 inches) hose with wall hook. Centerline of rough in is 1219 mm (48 inches) above finished floor.
  2. Drain: Seventy six millimeter (3 inches) cast brass drain with nickel bronze strainer.
  3. Trap: P-trap, drain through floor.

- O. (P-524) Sink, (CRS, Triple Compartment, Counter Top, ASME A112.19.3, Kitchen Sinks)  
self-rimming, approximately 1372 mm by 559 mm (54 inches by 22 inches) with three  
compartments inside dimensions approximately 406 mm by 406 mm by 257 mm (16  
inches by 16 inches by 10 1/8 inches), minimum 20 gage CRS. Corners and edges shall be  
well rounded.
1. Faucet: Kitchen sink, solid brass construction, 8.3 L/m (2.2 gpm) swing spout,  
chrome plated copper alloy with spray and hose.
  2. Drain: Drain plug with cup strainer, stainless steel.
  3. Trap: Cast copper alloy, 38 mm (1 1/2 inches) P-trap with cleanout plug, continuous  
drain with wall connection and escutcheon.
- E. (P-528) Sink (CRS, Single Compartment, Counter Top ASME A112.19.2, Kitchen Sinks)  
self-rimming, back faucet ledge, approximately 533 mm by 559 mm (21 inches by 22  
inches) with single compartment inside dimensions approximately 406 mm by 483 mm  
by 191 mm (16 inches by 19 inches by 7 1/2 inches) deep. Shall be minimum of 1.3 mm  
thick (18 gauge) CRS. Corners and edges shall be well rounded:
1. Faucet: Solid brass construction, 8.3 L/m (2.2 gpm) deck mounted combination  
faucet with Monel or ceramic seats, removable replacement unit containing all parts  
subject to wear, swivel gooseneck spout with approximately 203 mm (8 inches)  
reach with spout outlet 152 mm (6 inches above deck and single lever with hose  
spray. Faucet shall be polished chrome plated.
  2. Drain: Drain plug with cup strainer, stainless steel.
  3. Trap: Cast copper alloy 38 mm (1 1/2 inches) P-trap with cleanout plug. Provide wall  
connection and escutcheon.
  4. Provide cover for exposed piping, drain, stops and trap per A.D.A.
- F. (P-531) Sink (CRS, Single Compartment, Counter Top ASME A112.19.2, Kitchen Sinks)  
self-rimming, back faucet ledge, approximately 533 mm by 559 mm (15 inches by 15  
inches) with single compartment inside dimensions approximately 406 mm by 483 mm  
by 191 mm (12 inches by 10 inches by 6 1/8 inches) deep. Shall be minimum of 1.3 mm  
thick (18 gauge) CRS. Corners and edges shall be well rounded:

1. Faucet: Solid brass construction, 8.3 L/m (2.2 gpm) deck mounted combination faucet with Monel or ceramic seats, removable replacement unit containing all parts subject to ware, swivel gooseneck spout with approximately 203 mm (8 inches) reach with spout outlet 152 mm (6 inches above deck and single lever with hose spray. Faucet shall be polished chrome plated.
2. Drain: Drain plug with cup strainer, stainless steel.
3. Trap: Cast copper alloy 38 mm (1 1/2 inches) P-trap with cleanout plug. Provide wall connection and escutcheon.F. (P-532) Sink (CRS, Single Compartment, Counter Top ASME A112.19.2, Kitchen Sinks) self-rimming, back faucet ledge, approximately 559 mm by 483 mm (22 inches by 19 inches) with single compartment inside dimensions approximately 457 mm by 356 mm by 191 mm (18 inches by 14 inches by 7 5/8 inches) deep. Shall be minimum of 1.3 mm thick (18 gauge) CRS. Corners and edges shall be well rounded:
  1. Faucet: Solid brass construction, 8.3 L/m (2.2 gpm) deck mounted combination faucet with Monel or ceramic seats, removable replacement unit containing all parts subject to ware, swivel gooseneck spout with approximately 203 mm (8 inches) reach with spout outlet 152 mm (6 inches above deck and dual handle with 4" wristblade levers. Faucet shall be polished chrome plated.
  2. Drain: Drain plug with cup strainer, stainless steel.
  3. Trap: Cast copper alloy 38 mm (1 1/2 inches) P-trap with cleanout plug. Provide wall connection and escutcheon.

## **2.10 DISPENSER, DRINKING WATER**

- A. Standard rating conditions: 10 degrees C (50 degrees F) water with 27 degrees C (80 degrees F) inlet water temperature and 32 degrees C (90 degrees F) ambient air temperature.
- B. (P-608) Electric Water Cooler (Mechanically Cooled, Wall Hung, Wheelchair, with Glass Filler) bubbler style, air cooled compressor, 15 ml/s (15 gph) minimum capacity, lead free. Top shall be one piece type 304 CRS anti-splash design. Cabinet, CRS satin finish, approximately 457 mm by 457 mm by 635 mm (18 inches by 18 inches by 25 inches)



high with mounting plate. Unit shall be push bar operated with front and side bars, automatic stream regulator, and heavy chrome plated brass push down glass filler with adjustable flow control, and all trim chrome plated. Set bubbler 914 mm (36 inches) above finished floor. Provide with bottle filler option.

## **2.11 EMERGENCY FIXTURES**

- A. (P-708) Emergency Eye and Face Wash (Wall Mounted): CRS, wall mounted, foot pedal control. Mount eye and face wash spray heads 1067 mm (42 inches) above finished floor. Pedal shall be wall mounted, entirely clear of floor, and be hinged to permit turning up. Receptor shall be complete with drain plug with perforated strainer, P-trap and waste connection to wall with escutcheon. Provide with thermostatic mixing valve to provide tepid water from 30 to 35 degrees C (85 to 95 degrees F). Flow rate shall be 11.4 L/m (3 gpm).

## **2.12 HYDRANT, HOSE BIBB AND MISCELLANEOUS DEVICES**

- A. (P-801) Wall Hydrant: Cast bronze non-freeze hydrant with detachable T-handle. Brass operating rod within casing of bronze pipe of sufficient length to extend through wall and place valve inside building. Brass valve with coupling and union elbow having metal-to-metal seat. Valve rod and seat washer removable through face of hydrant; 19 mm (3/4 inch) hose thread on spout; 19 mm (3/4 inch) pipe thread on inlet. Finish may be rough; exposed surfaces shall be chrome plated. Set not less than 457 mm (18 inches) nor more than 914 mm (36 inches) above grade. On porches and platforms, set approximately 762 mm (30 inches) above finished floor. Provide integral vacuum breaker which automatically drains when shut off.
- G. (P-812) Water Supply Box Units: Fabricate of 16-gage steel with highly corrosion resistant epoxy finish. Unit to have 13 mm (1/2 inch) combination MPT brass sweat connection, ball type shut-off valve. Size 229 mm by 298 mm (9 inches by 11 3/4 inches) rough wall opening 203 mm by 254 mm by 92 mm (8 inches by 10 inches by 3 5/8 inches). Bottom of box shall be 457 mm (18 inches) above finished floor.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed as specified under Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
- B. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls and related finish surfaces. Exposed heads of bolts and nuts in finished rooms shall be hexagonal, polished chrome plated brass with rounded tops.
- C. Through Bolts: For free standing marble and metal stud partitions refer to Section 10 21 13, TOILET COMPARTMENTS.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 6 mm (1/4 inch) diameter bolts, and to extend at least 76 mm (3 inches) into masonry and be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.
- F. Power Set Fasteners: May be used for concrete walls, shall be 6 mm (1/4 inch) threaded studs, and shall extend at least 32 mm (1 1/4 inches) into wall.
- G. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- H. Where water closet waste pipe has to be offset due to beam interference, provide correct and additional piping necessary to eliminate relocation of water closet.
- I. Aerators are prohibited on lavatories and sinks.
- J. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost or additional time to the Government.

### **3.2 CLEANING**

- A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

### **3.3 WATERLESS URINAL**

- A. Manufacturer shall provide an operating manual and onsite training for the proper care and maintenance of the urinals.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

--- E N D ---

**SECTION 23 05 11**  
**COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
  - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
  - 2. Exterior: Piping, ductwork, and equipment exposed to weather be it temperature, humidity, precipitation, wind, or solar radiation.
- C. Abbreviations/Acronyms:
  - 1. ac: Alternating Current
  - 2. AC: Air Conditioning
  - 3. ACU: Air Conditioning Unit
  - 4. ACR: Air Conditioning and Refrigeration
  - 5. AI: Analog Input
  - 6. AISI: American Iron and Steel Institute
  - 7. AO: Analog Output
  - 8. ASJ: All Service Jacket
  - 9. AWG: American Wire Gauge
  - 10. BACnet: Building Automation and Control Networking Protocol
  - 11. BAg: Silver-Copper-Zinc Brazing Alloy
  - 12. BAS: Building Automation System
  - 13. BCuP: Silver-Copper-Phosphorus Brazing Alloy
  - 14. bhp: Brake Horsepower
  - 15. Btu: British Thermal Unit
  - 16. Btu/h: British Thermal Unit Per Hour
  - 17. CDA: Copper Development Association
  - 18. C: Celsius

- 19. CD: Compact Disk
- 20. CFM: Cubic Foot Per Minute
- 21. CH: Chilled Water Supply
- 22. CHR: Chilled Water Return
- 23. CLR: Color
- 24. CO: Carbon Monoxide
- 25. COR: Contracting Officer's Representative
- 26. CPD: Condensate Pump Discharge
- 27. CPM: Cycles Per Minute
- 28. CPVC: Chlorinated Polyvinyl Chloride
- 29. CRS: Corrosion Resistant Steel
- 30. CTPD: Condensate Transfer Pump Discharge
- 31. CTPS: Condensate Transfer Pump Suction
- 32. CW: Cold Water
- 33. CWP: Cold Working Pressure
- 34. CxA: Commissioning Agent
- 35. dB: Decibels
- 36. dB(A): Decibels (A weighted)
- 37. DDC: Direct Digital Control
- 38. DI: Digital Input
- 39. DO: Digital Output
- 40. DVD: Digital Video Disc
- 41. DN: Diameter Nominal
- 42. DWV: Drainage, Waste and Vent
- 43. EPDM: Ethylene Propylene Diene Monomer
- 44. EPT: Ethylene Propylene Terpolymer
- 45. ETO: Ethylene Oxide
- 46. F: Fahrenheit
- 47. FAR: Federal Acquisition Regulations

- 48. FD: Floor Drain
- 49. FED: Federal
- 50. FG: Fiberglass
- 51. FGR: Flue Gas Recirculation
- 52. FOS: Fuel Oil Supply
- 53. FOR: Fuel Oil Return
- 54. FSK: Foil-Scrim-Kraft facing
- 55. FWPD: Feedwater Pump Discharge
- 56. FWPS: Feedwater Pump Suction
- 57. GC: Chilled Glycol Water Supply
- 58. GCR: Chilled Glycol Water Return
- 59. GH: Hot Glycol Water Heating Supply
- 60. GHR: Hot Glycol Water Heating Return
- 61. gpm: Gallons Per Minute
- 62. HDPE: High Density Polyethylene
- 63. Hg: Mercury
- 64. HOA: Hands-Off-Automatic
- 65. hp: Horsepower
- 66. HPS: High Pressure Steam (414 kPa (60 psig) and above)
- 67. HPR: High Pressure Steam Condensate Return
- 68. HW: Hot Water
- 69. HWH: Hot Water Heating Supply
- 70. HWHR: Hot Water Heating Return
- 71. Hz: Hertz
- 72. ID: Inside Diameter
- 73. IPS: Iron Pipe Size
- 74. kg: Kilogram
- 75. klb: 1000 lb
- 76. kPa: Kilopascal

- 77. lb: Pound
- 78. lb/hr: Pounds Per Hour
- 79. L/s: Liters Per Second
- 80. L/min: Liters Per Minute
- 81. LPS: Low Pressure Steam (103 kPa (15 psig) and below)
- 82. LPR: Low Pressure Steam Condensate Gravity Return
- 83. MAWP: Maximum Allowable Working Pressure
- 84. MAX: Maximum
- 85. MBtu/h: 1000 Btu/h
- 86. MBtu: 1000 Btu
- 87. MED: Medical
- 88. m: Meter
- 89. MFG: Manufacturer
- 90. mg: Milligram
- 91. mg/L: Milligrams Per Liter
- 92. MIN: Minimum
- 93. MJ: Megajoules
- 94. ml: Milliliter
- 95. mm: Millimeter
- 96. MPS: Medium Pressure Steam (110 kPa (16 psig) through 414 kPa (60 psig))
- 97. MPR: Medium Pressure Steam Condensate Return
- 98. MW: Megawatt
- 99. NC: Normally Closed
- 100. NF: Oil Free Dry (Nitrogen)
- 101. Nm: Newton Meter
- 102. NO: Normally Open
- 103. NOx: Nitrous Oxide
- 104. NPT: National Pipe Thread
- 105. NPS: Nominal Pipe Size

- 106. OD: Outside Diameter
- 107. OSD: Open Sight Drain
- 108. OS&Y: Outside Stem and Yoke
- 109. PC: Pumped Condensate
- 110. PID: Proportional-Integral-Differential
- 111. PLC: Programmable Logic Controllers
- 112. PP: Polypropylene
- 113. PPE: Personal Protection Equipment
- 114. ppb: Parts Per Billion
- 115. ppm: Parts Per Million
- 116. PRV: Pressure Reducing Valve \
- 117. PSIA: Pounds Per Square Inch Absolute
- 118. psig: Pounds Per Square Inch Gauge
- 119. PTFE: Polytetrafluoroethylene
- 120. PVC: Polyvinyl Chloride
- 121. PVDC: Polyvinylidene Chloride Vapor Retarder Jacketing, White
- 122. PVDF: Polyvinylidene Fluoride
- 123. rad: Radians
- 124. RH: Relative Humidity
- 125. RO: Reverse Osmosis
- 126. rms: Root Mean Square
- 127. RPM: Revolutions Per Minute
- 128. RS: Refrigerant Suction
- 129. RTD: Resistance Temperature Detectors
- 130. RTRF: Reinforced Thermosetting Resin Fittings
- 131. RTRP: Reinforced Thermosetting Resin Pipe
- 132. SCFM: Standard Cubic Feet Per Minute
- 133. SPEC: Specification
- 134. SPS: Sterile Processing Services



- 135. STD: Standard
- 136. SDR: Standard Dimension Ratio
- 137. SUS: Saybolt Universal Second
- 138. SW: Soft water
- 139. SWP: Steam Working Pressure
- 140. TAB: Testing, Adjusting, and Balancing
- 141. TDH: Total Dynamic Head
- 142. TEFC: Totally Enclosed Fan-Cooled
- 143. TFE: Tetrafluoroethylene
- 144. THERM: 100,000 Btu
- 145. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 146. THWN: Thermoplastic Heat & Water-Resistant Nylon Coated Wire
- 147. T/P: Temperature and Pressure
- 148. USDA: U.S. Department of Agriculture
- 149. V: Volt
- 150. VAC: Vacuum
- 151. VA: Veterans Administration
- 152. VAC: Voltage in Alternating Current
- 153. VA CFM: VA Construction & Facilities Management
- 154. VA CFM CSS: VA Construction & Facilities Management, Consulting Support Service
- 155. VAMC: Veterans Administration Medical Center
- 156. VHA OCAMES: Veterans Health Administration – Office of Capital Asset  
Management Engineering and Support
- 157. VR: Vacuum condensate return
- 158. WCB: Wrought Carbon Steel, Grade B
- 159. WG: Water Gauge or Water Column
- 160. WOG: Water, Oil, Gas

## **1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.

- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- G. Section 05 31 00, STEEL DECKING.
- H. Section 05 50 00, METAL FABRICATIONS.
- I. Section 07 84 00, FIRESTOPPING.
- J. Section 07 92 00, JOINT SEALANTS.
- K. Section 09 51 00, ACOUSTICAL CEILINGS.
- L. Section 09 91 00, PAINTING.
- M. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- N. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION.
- O. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- P. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- Q. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- R. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- S. Section 23 09 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT
- T. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- U. Section 23 36 00, AIR TERMINAL UNITS.
- V. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- W. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- X. Section 26 29 11, MOTOR CONTROLLERS.

### **1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced.  
The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.

- B. Air Movement and Control Association (AMCA):
  - 410-1996 ..... Recommended Safety Practices for Users and Installers of  
Industrial and Commercial Fans
- C. American Society of Mechanical Engineers (ASME):
  - B31.1-2014 ..... Power Piping
  - B31.9-2014 ..... Building Services Piping
  - ASME Boiler and Pressure Vessel Code:  
BPVC Section IX-2019 Welding, Brazing, and Fusing Qualifications
- D. American Society for Testing and Materials (ASTM):
  - A36/A36M-2014 ..... Standard Specification for Carbon Structural Steel
  - A575-1996(R2013) ..... Standard Specification for Steel Bars, Carbon, Merchant  
Quality, M-Grades
- E. Association for Rubber Products Manufacturers (ARPM):
  - IP-20-2015 ..... Specifications for Drives Using Classical V-Belts and  
Sheaves
  - IP-21-2009 ..... Specifications for Drives Using Double-V (Hexagonal) Belts
  - IP-24-2010 ..... Specifications for Drives Using Synchronous Belts
  - IP-27-2015 ..... Specifications for Drives Using Curvilinear Toothed  
Synchronous Belts
- F. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc.:
  - SP-58-2009 ..... Pipe Hangers and Supports-Materials, Design,  
Manufacture, Selection, Application, and Installation
  - SP-127-2014a ..... Bracing for Piping Systems: Seismic-Wind-Dynamic  
Design, Selection, and Application
- G. Military Specifications (MIL):
  - MIL-P-21035B-2003 ..... Paint High Zinc Dust Content, Galvanizing Repair (Metric)
- H. National Fire Protection Association (NFPA):
  - 70-2014 ..... National Electrical Code (NEC)
  - 101-2015 ..... Life Safety Code

I. Department of Veterans Affairs (VA):

PG-18-10-2016 ..... Physical Security and Resiliency Design Manual

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 11, COMMON WORK RESULTS FOR HVAC", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements, and all equipment that requires regular maintenance, calibration, etc are accessible from the floor or permanent work platform. It is the Contractor's responsibility to ensure all submittals meet the VA specifications and requirements and it is assumed by the VA that all submittals do meet the VA specifications unless the Contractor has requested a variance in writing and approved by COR prior to the submittal. If at any time during the project it is found that any item does not meet the VA specifications and there was no variance approval the Contractor shall correct at no additional cost or time to the Government even if a submittal was approved.
- D. If equipment is submitted which differs in arrangement from that shown, provide documentation proving equivalent performance, design standards and drawings that show the rearrangement of all associated systems. Additionally, any impacts on ancillary equipment or services such as foundations, piping, and electrical shall be the Contractor's responsibility to design, supply, and install at no additional cost or time to the Government. VA approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, Contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed contract

documents, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

- F. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together. Coordinate and properly integrate materials and equipment to provide a completely compatible and efficient installation.
- G. Coordination/Shop Drawings:
1. Submit complete consolidated and coordinated shop drawings for all new systems.
  2. The coordination/shop drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed coordination/shop drawings of all piping and duct systems. The drawings should include all lockout/tagout points for all energy/hazard sources for each piece of equipment. Coordinate lockout/tagout procedures and practices with local VA requirements.
  3. Do not install equipment foundations, equipment or piping until coordination/shop drawings have been approved.
  4. In addition, for HVAC systems, provide details of the following:
    - a. Mechanical equipment rooms.
    - b. Hangers, inserts, supports, and bracing.
    - c. Pipe sleeves.
    - d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- H. Manufacturer's Literature and Data: Include full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity. Submit under the pertinent section rather than under this section.

1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the COR.
  2. Submit electric motor data and variable speed drive data with the driven equipment.
  3. Equipment and materials identification.
  4. Fire-stopping materials.
  5. Hangers, inserts, supports and bracing. Provide complete stress analysis for variable spring and constant support hangers.
  6. Wall, floor, and ceiling plates.
- I. Rigging Plan: Provide documentation of the capacity and weight of the rigging and equipment intended to be used. The plan shall include the path of travel of the load, the staging area and intended access, and qualifications of the operator and signal person.
- J. HVAC Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  2. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
    - a. Include complete list indicating all components of the systems.
    - b. Include complete diagrams of the internal wiring for each item of equipment.
    - c. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
  3. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- K. Provide copies of approved HVAC equipment submittals to the TAB and Commissioning Subcontractor.

- L. Completed System Readiness Checklist 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 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- M. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

### **1.5 QUALITY ASSURANCE**

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC.
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
  - 1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
  - 2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
- D. Products Criteria:
  - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices,

software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.

2. Refer to all other sections for quality assurance requirements for systems and equipment specified therein.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 33 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the COR.
5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be of the same manufacturer and model number, or if different models are required they shall be of the same manufacturer and identical to the greatest extent possible (i.e., same model series).
6. Assembled Units: Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
8. Use of asbestos products or equipment or materials containing asbestos is prohibited.



- E. HVAC Equipment Service Providers: Service providers shall be authorized and trained by the manufacturers of the equipment supplied. These providers shall be capable of responding onsite and provide acceptable service to restore equipment operations within 4 hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shutdown of equipment; or within 24 hours in a non-emergency. Submit names, mail and e-mail addresses and phone numbers of service personnel and companies providing service under these conditions for (as applicable to the project): fans, air handling units, chillers, cooling towers, control systems, pumps, critical instrumentation, computer workstation and programming.
- F. HVAC Mechanical Systems Welding: Before any welding is performed, Contractor shall submit a certificate certifying that welders comply with the following requirements:
  - 1. Qualify welding processes and operators for piping according to ASME BPVC Section IX. Provide proof of current certification.
  - 2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  - 3. Certify that each welder and welding operator has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  - 4. All welds shall be stamped according to the provisions of the AWS or ASME as required herein and by the associated code.
- G. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR with submittals. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material and removal by the Contractor and no additional cost or time to the Government.
- H. Execution (Installation, Construction) Quality:
  - 1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract

documents to the COR for resolution. Provide written hard copies and computer files on CD or DVD of manufacturer's installation instructions to the COR with submittals prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received and approved by the VA. Failure to furnish these recommendations is a cause for rejection of the material.

2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to, all types of valves, filters and strainers, transmitters, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract documents to the COR for resolution. Failure of the Contractor to resolve, or point out any issues will result in the Contractor correcting at no additional cost or time to the Government.
3. Complete coordination/shop drawings shall be required in accordance with Article, SUBMITTALS. Construction work shall not start on any system until the coordination/shop drawings have been approved by VA.
4. Workmanship/craftsmanship will be of the highest quality and standards. The VA reserves the right to reject any work based on poor quality of workmanship this work shall be removed and done again at no additional cost or time to the Government.
  - I. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with current telephone numbers and e-mail addresses.
  - J. Guaranty: Warranty of Construction, FAR Clause 52.246-21.

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

### **A. Protection of Equipment:**

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage or theft.
2. Large equipment such as boilers, chillers, cooling towers, fans, and air handling units if shipped on open trailer trucks shall be covered with shrink on plastics or water proof tarpaulins that provide protection from exposure to rain, road salts and other transit hazards. Protection shall be kept in place until equipment is moved into a building or installed as designed.
3. Repair damaged equipment in first class, new operating condition and appearance; or, replace same as determined and directed by the COR. Such repair or replacement shall be at no additional cost or time to the Government.
4. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
5. Protect plastic piping and tanks from ultraviolet light (sunlight).

### **B. Cleanliness of Piping and Equipment Systems:**

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.

5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

## **1.7 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing Contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing Contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
  1. As-built drawings are to be provided, with a copy of them on AutoCAD provided on CD or DVD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.

- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics\_), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **PART 2 - PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
1. All components of an assembled unit need not be products of same manufacturer.
  2. Constituent parts that are alike shall be products of a single manufacturer.
  3. Components shall be compatible with each other and with the total assembly for intended service.
  4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Equipment and components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a nameplate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions must be approved by the VA, but may be permitted if performance requirements cannot be met.

## **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

## **2.3 V-BELT DRIVES**

- A. Type: ARPM standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ARPM IP-20 and ARPM IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ARPM service factor (not less than 20 percent) in addition to the ARPM allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ARPM standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ARPM specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  - 1. Material: Pressed steel, or close-grained cast iron.
  - 2. Bore: Fixed or bushing type for securing to shaft with keys.
  - 3. Balanced: Statically and dynamically.
  - 4. Groove spacing for driving and driven pulleys shall be the same.
- I. Drive Types, Based on ARI 435:
  - 1. Provide adjustable-pitch or fixed-pitch drive as follows:

- a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
- b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
2. Provide fixed-pitch drives for drives larger than those listed above.
3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling the design air flow branch, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.
- J. Final Drive Set: If adjustment is required beyond the capabilities of the factory drive set, the final drive set shall be provided as part of this contract at no additional cost or time to the Government.

## **2.4 SYNCHRONOUS BELT DRIVES**

- A. Type: ARPM synchronous belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ARPM IP-24 and ARPM IP-27.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ARPM service factor (not less than 20 percent) in addition to the ARPM allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ARPM standard allowances for installation and take-up.
- F. Drives may utilize a single belt of manufacturer's standard width for the application.
- G. Multiple Belts: Matched to ARPM specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  1. Material: Pressed steel, or close-grained cast iron.
  2. Bore: Fixed or bushing type for securing to shaft with keys.
  3. Balanced: Statically and dynamically.

- I. Final Drive Set: The final fan speeds required to just meet the system CFM and pressure requirements, without throttling the design air flow branch, shall be determined by fan law calculation. If adjustment is required beyond the capabilities of the factory drive set, the final drive set shall be provided as part of this contract at no additional cost or time to the Government.

## **2.5 DRIVE GUARDS**

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory-fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gauge sheet steel; all edges shall be hemmed and ends shall be bent into flanges and the flanges shall be drilled and attached to pump base with minimum of four 6 mm (1/4 inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gauge sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (1 inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- D. Materials: Sheet steel, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (1 inch) diameter hole at each shaft center.

## **2.6 LIFTING ATTACHMENTS**

- A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.



## **2.7 ELECTRIC MOTORS**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; Section 26 29 11, MOTOR CONTROLLERS; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

## **2.8 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR CONTROLLERS for specifications.
- B. Coordinate variable speed motor controller communication protocol with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- C. Provide variable speed motor controllers with or without a bypass contactor as indicated in contract drawings.
- D. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.
- E. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- F. Controller shall not add any current or voltage transients to the input ac power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the ac power system.

## **2.9 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the contract documents and shown in the maintenance manuals. Refer to Section 09 51 00 for access

identification markers and Section 09 91 00 for identity marking and painting of systems to be accomplished by Mechanical Contractors.

- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 5 mm (3/16 inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment.  
Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 5 mm (3/16 inch) high riveted or bolted to the equipment.
- D. Control Items: Label all instrumentation, temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  - 1. HVAC and Mechanical Rooms: Provide for all valves other than for equipment in Section 23 82 00, CONVECTION HEATING AND COOLING UNITS and Section 23 36 00, AIR TERMINAL UNITS.
  - 2. Valve tags: Engraved black filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 6 mm (1/4 inch) for service designation on 19-gauge 40 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
  - 3. Valve lists: Typed or printed plastic coated card(s), sized 215 mm (8-1/2 inches) by 275 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
  - 4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color-coded thumb tack in ceiling.
- F. Ceiling Grid Labels:
  - 1. 50 mm (2 inch) long by 15 mm (1/2 inch) wide by 0.025 mm (1 mil) thick UV resistant metalized polyester label with red border color and black custom

lettering on white background interior. Peel and stick adhesive backing. Label and adhesive manufactured specifically for use in equipment inventory tagging.

2. Custom print labels with above ceiling HVAC equipment numbers.

## **2.10 FIRESTOPPING**

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

## **2.11 GALVANIZED REPAIR COMPOUND**

- A. Mil-P-21035B, paint form.

## **2.12 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- B. Supports for Roof Mounted Items:
  1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 by 100 mm (2 by 4 inches) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 275 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
  2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
- C. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-58. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- D. Attachment to Concrete Building Construction:
  1. Concrete insert: MSS SP-58, Type 18.

2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
  3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- E. Attachment to Steel Building Construction:
1. Welded attachment: MSS SP-58, Type 22.
  2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- F. Attachment to Metal Pan or Deck: As required for materials specified in Section 05 31 00, STEEL DECKING.
- G. Attachment to Wood Construction: Wood screws or lag bolts.
- H. Hanger Rods: Hot-rolled steel, ASTM A36/A36M or ASTM A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 40 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- I. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (12 gauge), designed to accept special spring held, hardened steel nuts.
1. Allowable hanger load: Manufacturers rating less 91 kg (200 pounds).
  2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4 inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 15 mm (1/2 inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- J. Supports for Piping Systems:
1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium

silicate shield at all other types of supports and hangers including those for preinsulated piping.

2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
  - a. Standard clevis hanger: Type 1; provide locknut.
  - b. Riser clamps: Type 8.
  - c. Wall brackets: Types 31, 32 or 33.
  - d. Roller supports: Type 41, 43, 44 and 46.
  - e. Saddle support: Type 36, 37 or 38.
  - f. Turnbuckle: Types 13 or 15. Preinsulate.
  - g. U-bolt clamp: Type 24.
  - h. Copper Tube:
    - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non-adhesive isolation tape to prevent electrolysis.
    - 2) For vertical runs use epoxy painted or plastic-coated riser clamps.
    - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
    - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
  - i. Supports for plastic piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.

K. Pre-insulated Calcium Silicate Shields:

1. Provide 360-degree water resistant high density 965 kPa (140 psig) compressive strength calcium silicate shields encased in galvanized metal.
2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
3. Shield thickness shall match the pipe insulation.
4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.

- a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 25 mm (1 inch) past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
- b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS SP-58. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psig) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36/A36M) wear plates welded to the bottom sheet metal jacket.
- 5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.
- L. Seismic Restraint of Piping and Ductwork: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Comply with MSS SP-127.

## **2.13 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations through beams or ribs are prohibited, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of COR.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

## **2.14 DUCT PENETRATIONS**

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 450 mm (18 inches) high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.
- B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

## **2.15 SPECIAL TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the COR, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- E. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

## **2.16 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025 inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035 inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **2.17 ASBESTOS**

- A. Materials containing asbestos are prohibited.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

### **3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. The coordination/shop drawings shall be



submitted for review. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities.

Equipment coordination/shop drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review. Follow manufacturer's published recommendations for installation methods not otherwise specified.

- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gauges and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the contract documents.
- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
  - 1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill is prohibited, except as permitted by COR where working area space is limited.
  - 2. Locate holes to avoid interference with structural members such as slabs, columns, ribs, beams or reinforcing. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
  - 3. Do not penetrate membrane waterproofing.
- F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.

- G. Electrical Interconnection of Instrumentation or Controls: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Devices shall be located so they are easily accessible for testing, maintenance, calibration, etc. The COR has the final determination on what is accessible and what is not. Comply with NFPA 70.
- H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced.
  2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Concrete and Grout: Use concrete and non-shrink grout 20 MPa (3000 psig) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- J. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- K. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and data/telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall not be located in the space equal to the width and depth of the

equipment and extending from to a height of 1.8 m (6 feet) above the equipment or to ceiling structure, whichever is lower (NFPA 70).

L. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance or inspections, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost or time to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to motors, fans, pumps, belt guards, transformers, high voltage lines, conduit and raceways, piping, hot surfaces, and ductwork. The COR has final determination on whether an installation meets this requirement or not.

### **3.3 TEMPORARY PIPING AND EQUIPMENT**

- A. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Article, ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING apply.
- B. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

### **3.4 RIGGING**

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service requirements as well as structural integrity of the building.

- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Follow approved rigging plan.
- G. Restore building to original condition upon completion of rigging work.

### **3.5 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels designed by a structural engineer, secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the COR.
- B. Use of chain pipe supports; wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above are prohibited. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work.
- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-58. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.

E. HVAC Vertical Pipe Supports:

1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.

F. Overhead Supports:

1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
3. Tubing and capillary systems shall be supported in channel troughs.

G. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Chiller foundations shall have horizontal dimensions that exceed chiller base frame dimensions by at least 150 mm (6 inches) on all sides. Structural contract documents shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill

the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.6 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
  1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
  2. The following material and equipment shall not be painted:
    - a. Motors, controllers, control switches, and safety switches.
    - b. Control and interlock devices.
    - c. Regulators.
    - d. Pressure reducing valves.
    - e. Control valves and thermostatic elements.
    - f. Lubrication devices and grease fittings.
    - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
    - h. Valve stems and rotating shafts.
    - i. Pressure gauges and thermometers.
    - j. Glass.
    - k. Nameplates.
  3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.

4. Pumps, motors, steel and cast-iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump manufacturer.
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats. This may include painting exposed metals where hangers were removed or where equipment was moved or removed.
6. Paint shall withstand the following temperatures without peeling or discoloration:
  - a. Condensate and Feedwater: 38 degrees C (100 degrees F) on insulation jacket surface and 121 degrees C (250 degrees F) on metal pipe surface.
7. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.
8. Lead based paints are prohibited.

### **3.7 IDENTIFICATION SIGNS**

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16 inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.
- D. Attach ceiling grid label on ceiling grid location directly underneath above-ceiling air terminal, control system component, valve, filter unit, fan etc.

### **3.8 MOTOR AND DRIVES**

- A. Use synchronous belt drives only on equipment controlled by soft starters or variable frequency drive motor controllers without a bypass contactor. Use V-belt drives on all other applications.

- B. Alignment of V-Belt Drives: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- C. Alignment of Synchronous Belt Drives: Set driving and driven shafts parallel and align so that the corresponding pulley flanges are in the same plane.
- D. Alignment of Direct-Connect Drives: Securely mount motor in accurate alignment so that shafts are per coupling manufacturer's tolerances when both motor and driven machine are operating at normal temperatures.

### **3.9 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. Field-check all devices for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings or devices. A minimum of 0.95 liter (1 quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to COR in unopened containers that are properly identified as to application.
- C. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- D. All lubrication points shall be extended to one side of the equipment.

### **3.10 STARTUP, TEMPORARY OPERATION AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and Contractor testing of selected equipment. Coordinate the startup and Contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.



- D. Startup of equipment shall be performed as described in equipment specifications.  
Vibration within specified tolerance shall be verified prior to extended operation.  
Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

### **3.11 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS Article, TESTS, and in individual Division 23 specification sections and submit the test reports and records to the COR.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost or time to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.
- D. No adjustments may be made during the acceptance inspection. All adjustments shall have been made by this point.
- E. Perform tests as required for commissioning provisions in accordance with Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

### **3.12 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.13 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hour to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

--- E N D ---

**SECTION 23 05 12**  
**GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- H. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced.  
The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Bearing Manufacturers Association (ABMA):
  - 9-2015 ..... Load Ratings and Fatigue Life for Ball Bearings
  - 11-2014 ..... Load Ratings and Fatigue Life for Roller Bearings
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - 90.1-2013 ..... Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

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

112-2017 ..... Standard Test Procedure for Polyphase Induction Motors  
and Generators

841-2009 ..... IEEE Standard for Petroleum and Chemical Industry-  
Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-  
Cooled (TEFC) Squirrel Cage Induction Motors--Up to and  
Including 370 kW (500 hp)

E. National Electrical Manufacturers Association (NEMA):

MG 1-2019 ..... Motors and Generators

MG 2-2014..... Safety Standard for Construction and Guide for Selection,  
Installation and Use of Electric Motors and Generators

250-2014 ..... Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Fire Protection Association (NFPA):

70-2014 ..... National Electrical Code (NEC)

#### 1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with  
Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED  
UNDER SECTION 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM  
GENERATION EQUIPMENT", with applicable paragraph identification.

C. Submit motor submittals with driven equipment.

D. Shop Drawings:

1. Provide documentation to demonstrate compliance with contract documents.
2. Motor nameplate information shall be submitted including electrical ratings,  
efficiency, bearing data, power factor, frame size, dimensions, mounting details,  
materials, horsepower, voltage, phase, speed (RPM), enclosure, starting  
characteristics, torque characteristics, code letter, full load and locked rotor  
current, service factor, and lubrication method.

- E. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Certification: Two weeks prior to final inspection, unless otherwise noted, certification shall be submitted to the COR stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.
- H. Completed System Readiness Checklist 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 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- I. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

#### **1.5 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of

recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
  - 1. As-built drawings are to be provided, with a copy of them on AutoCAD provided on CD or DVD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **PART 2 - PRODUCTS**

### **2.1 MOTORS**

- A. For alternating current, fractional and integral horsepower motors, NEMA MG 1 and NEMA MG 2 shall apply.

- B. For severe duty TEFC motors, IEEE 841 shall apply.
- C. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, MOTOR CONTROLLERS; and Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- D. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
  - 1. Two Speed Motors: Each two-speed motor shall have two separate windings.  
Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- F. Voltage ratings shall be as follows:
  - 1. Single phase:
    - a. Motors connected to 120-volt systems: 115 volts.
    - b. Motors connected to 208-volt systems: 200 volts.
    - c. Motors connected to 240-volt or 480-volt systems: 230/460 volts, dual connection.
  - 2. Three phase:
    - a. Motors connected to 208-volt systems: 200 volts.
    - b. Motors, less than 74.6 kW (100 hp), connected to 240-volt or 480-volt systems: 208-230/460 volts, dual connection.
    - c. Motors, 74.6 kW (100 hp) or larger, connected to 240-volt systems: 230 volts.
    - d. Motors, 74.6 kW (100 hp) or larger, connected to 480-volt systems: 460 volts.
    - e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA MG 1 for connection to the nominal system voltage shown on the drawings.

G. Number of phases shall be as follows:

1. Motors, less than 373 W (1/2 hp): Single phase.
2. Motors, 373 W (1/2 hp) and larger: 3 phase.
3. Exceptions:
  - a. Hermetically sealed motors.
  - b. Motors for equipment assemblies, less than 746 W (1 hp), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.

H. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.

I. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting, acceleration, and running torque without exceeding nameplate ratings or considering service factor.

J. Motor Enclosures:

1. Shall be the NEMA types as specified and/or shown in the Contract Documents.
2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types per NEMA 250, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
  - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
  - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
  - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.



K. Electrical Design Requirements:

1. Motors shall be continuous duty.
2. The insulation system shall be rated minimum of Class B, 130 degrees C (266 degrees F).
3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80 degrees C (176 degrees F).
4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
5. Motors shall be suitable for full voltage starting, unless otherwise noted. Coordinate motor features with applicable motor controllers.
6. Motors for variable frequency drive applications shall adhere to NEMA MG 1, Part 30, Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General-Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both, or NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors.

L. Mechanical Design Requirements:

1. Bearings shall be rated in accordance with ABMA 9 or ABMA 11 for a minimum fatigue life of 26,280 hours for belt-driven loads and 100,000 hours for direct-drive loads based on L10 (Basic Rating Life) at full load direct coupled, except vertical high thrust motors which require a 40,000 hours rating. A minimum fatigue life of 40,000 hours is required for VFD drives.
2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30 percent of normal down thrust.
3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
4. Grease fittings, if provided, shall be Alemite type or equivalent.
5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.

6. Vibration shall not exceed 3.8 mm (0.15 inch) per second, unfiltered peak.
7. Noise level shall meet the requirements of the application.
8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
9. All external fasteners shall be corrosion resistant.
10. Condensation heaters, when specified, shall keep motor windings at least 5 degrees C (9 degrees F) above ambient temperature.
11. Winding thermostats, when specified shall be normally closed, connected in series.
12. Grounding provisions shall be in the main terminal box.

M. Special Requirements:

1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional cost or time to the Government.
2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
  - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
  - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
  - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.

5. Motors utilized with variable frequency drives shall be rated “inverter-duty” per NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- N. Additional requirements for specific motors, as indicated in the other sections listed in Article, RELATED SECTIONS shall also apply.
- O. NEMA Premium Efficiency Electric Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 W (1 hp) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 W (1 hp) or more with open, drip-proof, or TEFC enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled (TEFC)			
Rating kW (hp)	1200 RPM	1800 RPM	3600 RPM	Rating kW (hp)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%

37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

- P. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM, and 3600 RPM. Power factor correction capacitors shall be provided unless the motor meets the 0.90 requirement without it or if the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.
- Q. Energy Efficiency of Small Motors (Motor Efficiencies): All motors under 746 W (1 hp) shall meet the requirements of the DOE Small Motor Regulation.

Polyphase Open Motors Average full load efficiency				Capacitor-start capacitor-run and capacitor-start induction run open motors Average full load efficiency			
Rating kW (hp)	6 poles	4 poles	2 poles	Rating kW (hp)	6 poles	4 poles	2 poles
0.18 (0.25)	67.5	69.5	65.6	0.18 (0.25)	62.2	68.5	66.6
0.25 (0.33)	71.4	73.4	69.5	0.25 (0.33)	66.6	72.4	70.5
0.37 (0.5)	75.3	78.2	73.4	0.37 (0.5)	76.2	76.2	72.4
0.55 (0.75)	81.7	81.1	76.8	0.55 (0.75)	80.2	81.8	76.2

## 2.2 LOW-VOLTAGE VARIABLE SPEED MOTOR CONTROLLERS (VSMC)

- A. VSMC shall be in accordance with applicable portions of 2.1 above.
- B. VSMC shall be electronic, with adjustable frequency and voltage, three phase output, capable of driving standard NEMA B three-phase induction motors at full rated speed.

The control technique shall be pulse width modulation (PWM), where the VSMC utilizes a full wave bridge design incorporating diode rectifier circuitry. Silicon controlled rectifiers or other control techniques are not acceptable.

- C. VSMC shall be suitable for variable torque loads, and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.
- D. VSMC shall be capable of operating within voltage parameters of plus 10 to minus 15 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- E. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
- F. The displacement power factor of the VSMC shall not be less than 95 percent under any speed or load condition.
- G. VSMC current and voltage harmonic distortion shall not exceed the values allowed by IEEE 519.
- H. Operating and Design Conditions:
  - 1. Elevation: 2730 feet Above Mean Sea Level (AMSL)
  - 2. Temperatures: Maximum +90oF, Minimum 10oF
  - 3. Relative Humidity:95%
- I. VSMC shall have the following features:
  - 1. Isolated power for control circuits.
  - 2. Manually resettable overload protection for each phase.
  - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
  - 4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 2000 seconds. Set timers to the equipment manufacturer's recommended time in the above range.
  - 5. Control input circuitry that will accept 4 to 20 mA current or 0-10 VDC voltage control signals from an external source.

6. Automatic frequency adjustment from 1 Hz to 300 Hz.
7. Circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The VSMC shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The VSMC shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
  - a. Incorrect phase sequence.
  - b. Single phasing.
  - c. Overvoltage in excess of 10 percent.
  - d. Undervoltage in excess of 15 percent.
  - e. Running overcurrent above 110 percent (VSMC shall not automatically reset for this condition.)
  - f. Instantaneous overcurrent above 150 percent (VSMC shall not automatically reset for this condition).
  - g. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
8. Automatic Reset/Restart: Attempt three restarts after VSMC fault or on return of power after an interruption and before shutting down for manual reset or fault correction, with adjustable delay time between restart attempts.
9. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
10. Bidirectional Autospeed Search: Capable of starting VSMC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to VSMC, motor, or load.
- J. VSMC shall include an input circuit breaker which will disconnect all input power, interlocked with the door so that the door cannot be opened with the circuit breaker in the closed position.
- K. VSMC shall include a 5% line reactor and a RFI/EMI filter.

- L. Surge Suppression: Provide three-phase protection against damage from supply voltage surges in accordance with UL 1449.
- M. VSMC shall include front-accessible operator station, with sealed keypad and digital display, which allows complete programming, operating, monitoring, and diagnostic capabilities.
  - 1. Typical control functions shall include but not be limited to:
    - a. HAND OFF AUTOMATIC-RESET, with manual speed control in HAND mode.
    - b. NORMAL-BYPASS.
    - c. NORMAL-TEST, which allows testing and adjusting of the VSMC while in bypass mode.
  - 2. Typical monitoring functions shall include but not be limited to:
    - a. Output frequency (Hz).
    - b. Motor speed and status (run, stop, fault).
    - c. Output voltage and current.
  - 3. Typical fault and alarm functions shall include but not be limited to:
    - a. Loss of input signal, under- and over-voltage, inverter overcurrent, motor overload, critical frequency rejection with selectable and adjustable deadbands, instantaneous line-to-line and line-to-ground overcurrent, loss-of-phase, reverse-phase, and short circuit.
    - b. System protection indicators indicating that the system has shutdown and will not automatically restart.
- N. VSMC shall include two N.O. and two N.C. dry contacts rated 120 Volts, 10 amperes, 60 Hz.
- O. Hardware, software, network interfaces, gateways, and programming to control and monitor the VSMC by control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- P. Network communications ports: As required for connectivity to control systems specified in other specification sections, including but not limited to Divisions 22 and 23.

- Q. Communications protocols: As required for communications with control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- R. Bypass controller: Provide contactor-style bypass, arranged to bypass the inverter.
  - 1. Inverter Output Contactor and Bypass Contactor: Load-break NEMA-rated contactor.
  - 2. Motor overload relays.
  - 3. HAND OFF AUTOMATIC bypass control.
- S. Bypass operation: Transfers motor between inverter output and bypass circuit, manually, automatically, or both. VSMC shall be capable of stable operation (starting, stopping, and running), and control by fire alarm and detection systems, with motor completely disconnected from the inverter output. Transfer between inverter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- T. Inverter Isolating Switch: Provide non-load-break switch arranged to isolate inverter and permit safe troubleshooting and testing of the inverter, both energized and de-energized, while motor is operating in bypass mode. Include padlockable, door-mounted handle mechanism.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.
- B. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

#### **3.2 FIELD TESTS**

- A. All tests shall be witnessed by the Commissioning Agent or by the COR.
- B. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before startup. All shall test free from grounds.
- C. Perform Load test in accordance with IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.



- D. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.
- E. All test data shall be compiled into a report form for each motor and provided to the contracting officer or their representative.

### **3.3 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for one hour to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

--- E N D ---

**SECTION 23 05 41**  
**NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the application of noise control measures, seismic restraint for equipment and vibration control techniques to boiler plant rotating equipment and parts including chillers, cooling towers, boilers, pumps, fans, compressors, motors and steam turbines.
- B. A complete listing of all common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.  
Noise criteria, seismic restraints for equipment, vibration tolerance and vibration isolation for HVAC and plumbing work.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA and SAMPLES.
- B. Section 23 05 10, COMMON WORK RESULTS FOR HVAC.
- C. Section 23 31 00, HVAC DUCTS and CASINGS.
- D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

**1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Noise Criteria:
  - 1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	40
Conference Rooms	35
Corridors (Nurse Stations)	40
Corridors (Public)	40
Examination Rooms	35

Lobbies, Waiting Areas	40
Offices, Large Open	40
Offices, Small Private	35
Treatment Rooms	35
X-Ray and General Work Rooms	40

2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the fore-going noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 8, Sound and Vibration.
3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.

C. Seismic Restraint Requirements:

1. Equipment:
  - a. All mechanical equipment not supported with isolators external to the unit shall be securely anchored to the structure. Such mechanical equipment shall be properly supported to resist a horizontal force of 50 percent of the weight of the equipment furnished.
  - b. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints capable of resisting a horizontal force of 100 percent of the weight of the equipment furnished.

2. Piping: Refer to specification Section 23 05 10, COMMON WORK RESULTS FOR HVAC.
  3. Ductwork: Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.
- D. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  1. Vibration isolators:
    - a. Floor mountings
    - b. Hangers
    - c. Snubbers
    - d. Thrust restraints
  2. Bases.
  3. Seismic restraint provisions and bolting.
  4. Acoustical enclosures.
- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.
- D. Seismic Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic Lateral Force requirements as shown on drawings.

### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced.  
The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.  
(ASHRAE):  
Handbook 2017 ..... Fundamentals Handbook, Chapter 8, Sound and Vibration
- C. American Society for Testing and Materials (ASTM):  
A123/A123M-2017 ..... Standard Specification for Zinc (Hot-Dip Galvanized)  
Coatings on Iron and Steel Products  
A307-2016 ..... Standard Specification for Carbon Steel Bolts and Studs,  
60,000 PSI Tensile Strength  
D2240-05(2010) ..... Standard Test Method for Rubber Property - Durometer  
Hardness
- D. Manufacturers Standardization (MSS):  
SP-58-2018 ..... Pipe Hangers and Supports-Materials, Design and  
Manufacture
- E. Occupational Safety and Health Administration (OSHA):  
29 CFR 1960.95 ..... Occupational Noise Exposure
- F. American Society of Civil Engineers (ASCE):  
ASCE 7-2016 ..... Minimum Design Loads for Buildings and Other Structures.
- G. American National Standards Institute / Sheet Metal and Air Conditioning Contractor's  
National Association (ANSI/SMACNA):  
001-2008 ..... Seismic Restraint Manual: Guidelines for Mechanical  
Systems, 3rd Edition.
- H. International Code Council (ICC):  
IBC 2018 ..... International Building Code.
- I. Department of Veterans Affairs (VA):  
H-18-8 2019 ..... Seismic Design Requirements.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

- A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- B. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.
- C. Exposure to weather: Isolator housings to be either hot dipped galvanized or powder coated to ASTM B117 salt spray testing standards. Springs to be powder coated or electro galvanized. All hardware to be electro galvanized. In addition provide limit stops to resist wind velocity. Velocity pressure established by wind shall be calculated in accordance with section 1609 of the International Building Code. A minimum wind velocity of 75 mph shall be employed.
- D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- E. Color code isolators by type and size for easy identification of capacity.

### **2.2 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENTS**

- A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting material.
- B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment Size and material required for the base shall be as recommended by the isolator manufacturer.
- C. On all sides of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment.

### **2.3 VIBRATION ISOLATORS**

- A. Floor Mountings:

1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
3. Captive Spring Mount for Seismic Restraint (Type SS):
  - a. Design mounts to resiliently resist seismic forces in all directions. Snubbing shall take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4-inch) before contacting snubbers. Mountings shall have a minimum rating of one G coefficient of gravity as calculated and certified by a registered structural engineer.
  - b. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.
4. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting. Isolators shall have a minimum seismic rating of one G.
6. Seismic Pad (Type DS): Pads shall be natural rubber / neoprene waffle with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
  1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum

- additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
  3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
  4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
  6. Hangers used in seismic applications shall be provided with a neoprene and steel rebound washer installed  $\frac{1}{4}$ ' clear of bottom of hanger housing in operation to prevent spring from excessive upward travel
- C. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.
- D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch)



when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

## **2.4 BASES**

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.
- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (four inches).
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating prelocated equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (six inches). Form shall include 13-mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (eight inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).
- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

## **2.5 SOUND ATTENUATING UNITS**

Refer to specification Section 23 31 00, HVAC DUCTS and CASINGS.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

A. Vibration Isolation:

1. No metal-to-metal contact will be permitted between fixed and floating parts.
2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports with a deflection equal to that used on the corresponding equipment.
3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

- B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

#### **3.2 ADJUSTING**

- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.

- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 – COMMISSIONING OF HVAC 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

--- E N D ---

**SELECTION GUIDE FOR VIBRATION ISOLATORS**

EQUIPMENT		ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
REFRIGERATION MACHINES																
RECIPROCATING:																
ALL	---	D	0.3	---	SP	0.8	R	SP	2.0	R	SP	2.5	R	SP	3.5	
COMPRESSORS AND VACUUM PUMPS																
UP THROUGH 1-1/2 HP	---	D,L, W	0.8	----	D,L, W	0.8	---	D,L, W	1.5	---	D,L, W	1.5	---	D,L, W	---	
2 HP AND OVER:																
500 - 750 RPM	---	D	0.8	---	S	0.8	---	S	1.5	---	S	1.5	---	S	2.5	
750 RPM & OVER	---	D	0.8	---	S	0.8	---	S	1.5	---	S	1.5	---	S	2.5	
PUMPS																
CLOSE COUPLED	UP TO 1-1/2 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	2 HP & OVER	---	---	---	I	S	0.8	I	S	1.5	I	S	1.5	I	S	2.0

EQUIPMENT		ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
LARGE INLINE	Up to 25 HP	---	---	---	---	S	0.75	---	S	1.50	---	S	1.50	---	---	NA
	26 HP THRU 30 HP	---	---	---	---	S	1.0	---	S	1.50	---	S	2.50	---	---	NA
BASE MOUNTED	UP TO 10 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	15 HP THRU 40 HP	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.0	I	S	2.0
	50 HP & OVER	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.5	I	S	2.5
<b>ROOF FANS</b>																
ABOVE OCCUPIED AREAS:																
5 HP & OVER		---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
<b>CENTRIFUGAL FANS</b>																

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
UP TO 50 HP:															
UP TO 200 RPM	B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201 - 300 RPM	B	N	0.3	B	S	2.0	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.5	B	S	3.5
501 RPM & OVER	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.0	B	S	2.5
<b>AIR HANDLING UNIT PACKAGES</b>															
SUSPENDED:															
UP THRU 5 HP	---	---	---	---	H	1.0	---	H	1.0	---	H	1.0	---	H	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	---	---	---	H, THR	1.5	---	H, THR	2.5	---	H, THR	2.5	---	H, THR	2.5
501 RPM & OVER	---	---	---	---	H, THR	0.8	---	H, THR	0.8	---	H,TH R	0.8	---	H,TH R	2.0
FLOOR MOUNTED:															
UP THRU 5 HP	---	D	---	---	S	1.0	---	S	1.0	---	S	1.0	---	S	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	D	---	R	S, THR	1.5	R	S, THR	2.5	R	S, THR	2.5	R	S, THR	2.5

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
501 RPM & OVER	---	D	---	---	S, THR	0.8	---	S, THR	0.8	R	S, THR	1.5	R	S, THR	2.0
<b>HEAT PUMPS</b>															
ALL	---	S	0.75	---	S	0.75	---	S	0.75	CB	S	1.5	---	---	NA
<b>CONDENSING UNITS</b>															
ALL	---	SS	0.25	---	SS	0.75	---	SS	1.5	CB	SS	1.5	---	---	NA
<b>IN-LINE CENTRIFUGAL AND VANE AXIAL FANS, FLOOR MOUNTED: (APR 9)</b>															
UP THRU 50 HP:															
UP TO 300 RPM	---	D	---	R	S	2.5	R	S	2.5	R	S	2.5	R	S	3.5
301 - 500 RPM	---	D	---	R	S	2.0	R	S	2.0	R	S	2.5	R	S	2.5
501 - & OVER	---	D	---	---	S	1.0	---	S	1.0	R	S	2.0	R	S	2.5

**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:
  - 1. Planning systematic TAB procedures.
  - 2. Design Review Report.
  - 3. Systems Inspection report.
  - 4. Duct Air Leakage test report.
  - 5. Systems Readiness Report.
  - 6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
  - 7. Vibration and sound measurements.
  - 8. Recording and reporting results.
  - 9. Document critical paths of flow on reports.
- B. Definitions:
  - 1. Basic TAB used in this Section: Chapter 39, "Testing, Adjusting and Balancing" of 2019 ASHRAE Handbook, "HVAC Applications".
  - 2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
  - 3. AABC: Associated Air Balance Council.
  - 4. NEBB: National Environmental Balancing Bureau.
  - 5. TABB: Testing Adjusting and Balancing Bureau
  - 6. SMACNA: Sheet Metal Contractors National Association
  - 7. Hydronic Systems: Includes heating hot water
  - 8. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.



9. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

## **1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- D. Section 23 07 11, HVAC, AND BOILER PLANT INSULATION.
- E. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- G. Section 23 31 00, HVAC DUCTS AND CASINGS.
- H. Section 23 36 00, AIR TERMINAL UNITS.

## **1.3 QUALITY ASSURANCE**

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC, Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION, and Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Qualifications:
  - 1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
  - 2. The TAB agency shall be either a certified member of AABC, NEEB, TABB or NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the COR and submit another qualified TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC, TABB or NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract

completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.

3. TAB Specialist: The TAB specialist shall be either a member of AABC or TABB or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
  - a. Shall directly supervise all TAB work.
  - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC, TABB or NEBB.
  - c. Would follow all TAB work through its satisfactory completion.
  - d. Shall provide final markings of settings of all HVAC adjustment devices.
  - e. Permanently mark location of duct test ports.
  - f. Shall document critical paths from the fan or pump. These critical paths are ones in which are 100% open from the fan or pump to the terminal device. This will show the least amount of restriction is being imposed on the system by the TAB firm.

5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC, TABB or NEBB
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards, TABB/SMACNA International Standards, or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.
- D. TAB Criteria:
  1. One or more of the applicable AABC, NEBB, TABB or SMACNA publications, supplemented by ASHRAE Handbook "2019 HVAC Applications" Chapter 39, and requirements stated herein shall be the basis for planning, procedures, and reports.
  2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow 2011 ASHRAE Handbook "2019 HVAC Applications", Chapter 39, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
    - a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute):  
Minus 0 percent to plus 10 percent.
    - b. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
    - c. Exhaust hoods/cabinets: 0 percent to plus 10 percent.
    - d. Minimum outside air: 0 percent to plus 10 percent.
    - e. Individual room air outlets and inlets, and air flow rates not mentioned above:  
Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
    - f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
  3. Systems shall be adjusted for energy efficient operation as described in PART 3.

4. Typical TAB procedures and critical path results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the COR one of which shall be a critical path) and one hydronic system (pumps and three coils) as follows:
  - a. When field TAB work begins.
  - b. During each partial final inspection and the final inspection for the project if requested by VA.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the Resident Engineer staff, submit one complete set of applicable AABC, NEBB or TABB publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:
  1. Design Review Report within 90 days for conventional design projects after the system layout on air and water side is completed by the Contractor.
  2. Systems inspection report on equipment and installation for conformance with design.
  3. Duct Air Leakage Test Report.
  4. Systems Readiness Report.
  5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
  6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
  7. Include in each report the critical path for each balanced branch (air and hydronic. Every branch shall have at least one terminal device damper 100% open.

- E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area with noted critical paths.

## **1.5 APPLICABLE PUBLICATIONS**

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):  
Handbook 2019 ..... HVAC Applications ASHRAE Handbook, Chapter 39,  
Testing, Adjusting, and Balancing and Chapter 49, Sound  
and Vibration Control
- C. Associated Air Balance Council (AABC):  
7<sup>th</sup> Edition 2016 ..... AABC National Standards for Total System Balance
- D. National Environmental Balancing Bureau (NEBB):  
9<sup>th</sup> Edition 2019 ..... Procedural Standards for Testing, Adjusting, Balancing of  
Environmental Systems  
3<sup>rd</sup> Edition 2015 ..... Procedural Standards for the Measurement of Sound and  
Vibration  
2<sup>rd</sup> Edition 2019 ... Standard for Whole Building Technical Commissioning of New  
Construction
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):  
3<sup>rd</sup> Edition 2005 ..... HVAC SYSTEMS Testing, Adjusting and Balancing  
TABB- TAB Procedural Guide Current Edition

## **PART 2 - PRODUCTS**

### **2.1 PLUGS**

Provide plastic plugs to seal holes drilled in ductwork for test purposes.

### **2.2 INSULATION REPAIR MATERIAL**

See Section 23 07 11, HVAC and BOILER PLANT INSULATION Provide for repair of insulation removed or damaged for TAB work.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Refer to TAB Criteria in Article, Quality Assurance.
- B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

### **3.2 DESIGN REVIEW REPORT**

The TAB Specialist shall review the Contract Plans and specifications and advise the Resident Engineer of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

### **3.3 SYSTEMS INSPECTION REPORT**

- A. Inspect equipment and installation for conformance with design.
- B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
- C. Reports: Follow check list format developed by AABC, NEBB or SMACNA (TABB), supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

### **3.4 DUCT AIR LEAKAGE TEST REPORT**

TAB Agency shall perform the leakage test as outlined in "Duct leakage Tests and Repairs" in Section 23 31 00, HVAC DUCTS and CASINGS for TAB agency's role and responsibilities in witnessing, recording and reporting of deficiencies.

### **3.5 SYSTEM READINESS REPORT**

- A. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to RE in standard format and forms prepared and or approved by the Commissioning Agent.
- B. Verify that all items such as ductwork piping, dampers, valves, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

### **3.6 TAB REPORTS**

- A. Submit an intermediate report for 50 percent of systems and equipment tested and balanced to establish satisfactory test results.
- B. The TAB contractor shall provide raw data immediately in writing to the Resident Engineer if there is a problem in achieving intended results before submitting a formal report.
- C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated after engineering and construction have been evaluated and re-submitted for approval at no additional cost to the owner.
- D. Do not proceed with the remaining systems until intermediate report is approved by the Resident Engineer.

### **3.7 TAB PROCEDURES**

- A. TAB shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC, TABB or NEBB. Balancing shall be done proportionally to all applicable systems.
  - 1. At least one trunk damper shall be 100% open.
  - 2. At least one branch damper shall be 100%open per trunk.
  - 3. At least one terminal device duct be 100% open per branch.
- B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution

systems to simulate design operation of variable volume air or water systems for test and balance work.

- C. Allow 30 days time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.
- E. Air Balance and Equipment Test: Include air handling units, fans, terminal units, room diffusers/outlets/inlets, computer room AC units.
  - 1. Artificially load air filters by partial blanking to produce static air pressure drop of manufacturer's recommended pressure drop.
  - 2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
  - 3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other HVAC controls function properly.
  - 4. Variable air volume (VAV) systems:
    - a. Coordinate TAB, including system volumetric controls, with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
    - b. Section 23 36 00, AIR TERMINAL UNITS, specifies that maximum and minimum flow rates for air terminal units (ATU) be factory set. Check and readjust ATU flow rates if necessary to meet design criteria. Balance air distribution from ATU on full cooling maximum scheduled cubic meters per minute (cubic feet per minute). Reset room thermostats and check ATU operation from maximum to minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the ATU is in the maximum heating mode. Record and report outdoor air flow rates under all operating conditions (The test shall demonstrate that the minimum outdoor air ventilation rate shall remain constant under all operating conditions).
    - c. Adjust operating pressure control setpoint to maintain the design flow to each space with the lowest setpoint.



5. Record final measurements for air handling equipment performance data sheets.
- F. Water Balance and Equipment Test: Include circulating pumps, coils:
  2. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
  3. Primary-secondary (variable volume) systems: Coordinate TAB with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Balance systems at design water flow and then verify that variable flow controls function as designed.
  4. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

### **3.8 VIBRATION TESTING**

- A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the Resident Engineer. Where vibration readings exceed the allowable tolerance Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Resident Engineer.

### **3.9 SOUND TESTING**

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
  1. Take readings in rooms, approximately five percent of all rooms. The Resident Engineer may designate the specific rooms to be tested.

- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC, TABB or NEBB.
- C. Sound reference levels, formulas and coefficients shall be according to 2019 ASHRAE Handbook, "HVAC Applications", Chapter 49, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:
  - 1. When sound pressure levels are specified, including the NC Criteria in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT:
    - a. Reduce the background noise as much as possible by shutting off unrelated audible equipment.
    - b. Measure octave band sound pressure levels with specified equipment "off."
    - c. Measure octave band sound pressure levels with specified equipment "on."
    - d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE:	0	1	2	3	4	5 to 9	10 or More
FACTOR:	10	7	4	3	2	1	0

Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.

- e. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.
- 2. When sound power levels are specified:
  - a. Perform steps 1.a. thru 1.d., as above.
  - b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
  - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound

pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 10 meters (30 feet) for sound level location.

3. Where sound pressure levels are specified in terms of dB(A), as in Section 23 65 00, COOLING TOWERS, measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.
- E. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Resident Engineer and the necessary sound tests shall be repeated.
- F. Test readings for sound testing could go higher than 15 percent if determination is made by the Resident Engineer based on the recorded sound data.

### **3.10 MARKING OF SETTINGS**

Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Resident Engineer.

### **3.11 IDENTIFICATION OF TEST PORTS**

The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

### **3.12 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.13 CRITICAL FLOW PATH**

- A. Provide a documented critical path for all fluid flows. There shall be at least one terminal device that can be traced back to the fan or pump where there is no damper or valves that are less than 100% open.

-- E N D --

**SECTION 23 07 11**  
**HVAC AND BOILER PLANT INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for
  - 1. HVAC piping, ductwork and equipment.
- B. Definitions
  - 1. ASJ: All service jacket, white finish facing or jacket.
  - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
  - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
  - 4. Concealed: Ductwork and piping above ceilings and in chases, and pipe spaces.
  - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
  - 6. FSK: Foil-scrim-kraft facing.
  - 7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC equipment or piping handling media above 41 degrees C (105 degrees F)
  - 8. Density:  $\text{kg/m}^3$  - kilograms per cubic meter (Pcf - pounds per cubic foot).
  - 9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.
  - 10. Thermal conductance: Heat flow rate through materials.
    - a. Flat surface: Watt per square meter (BTU per hour per square foot).
    - b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).

11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.
13. HPS: High pressure steam (415 kPa [60 psig] and above).
14. HPR: High pressure steam condensate return.
15. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig]).
16. MPR: Medium pressure steam condensate return.
17. LPS: Low pressure steam (103 kPa [15 psig] and below).
18. LPR: Low pressure steam condensate gravity return.
19. PC: Pumped condensate.
20. HWH: Hot water heating supply.
21. HWHR: Hot water heating return.
22. GH: Hot glycol-water heating supply.
23. GHR: Hot glycol-water heating return.
24. FWPD: Feedwater pump discharge.
25. FWPS: Feedwater pump suction.
26. CTPD: Condensate transfer pump discharge.
27. CTPS: Condensate transfer pump suction.
28. VR: Vacuum condensate return.
29. CPD: Condensate pump discharge.
30. R: Pump recirculation.
31. FOS: Fuel oil supply.
32. FOR: Fuel oil return.
33. CW: Cold water.
34. SW: Soft water.

- 35. HW: Hot water.
- 36. CH: Chilled water supply.
- 37. CHR: Chilled water return.
- 38. GC: Chilled glycol-water supply.
- 39. GCR: Chilled glycol-water return.
- 40. RS: Refrigerant suction.
- 41. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## 1.2 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 07 84 00, FIRESTOPPING.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- E. Section 23 21 13, HYDRONIC PIPING.

## 1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC

- B. Criteria:

- 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

**4.3.3.1** Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

**4.3.3.1.1** Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)

**4.3.3.1.2** The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are

located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

4.3.3.2 Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:

(1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors

(2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

4.3.3.3 Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

4.3.3.4 Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.

4.3.3.5\* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.

4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.



4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

- (1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides
- (2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

2. Test methods: ASTM E84, UL 723, or NFPA 255.

3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.

4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

#### **1.4 SUBMITTALS**

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

B. Shop Drawings:

1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.

- a. Insulation materials: Specify each type used and state surface burning characteristics.
  - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
  - c. Insulation accessory materials: Each type used.
  - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
  - e. Make reference to applicable specification paragraph numbers for coordination.
- C. Samples:
1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/blanket; 150 mm (6 inches) long, full diameter for round types.
  2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
  3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

### **1.5 STORAGE AND HANDLING OF MATERIAL**

Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
- L-P-535E (2)- 1999 ..... Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
- MIL-A-3316C -1987 Adhesives, Fire-Resistant, Thermal Insulation
- MIL-A-24179A (1)- 2016 Adhesive, Flexible Unicellular-Plastic Thermal Insulation

MIL-C-19565C (1)- 2016 Coating Compounds, Thermal Insulation, Fire-and Water-  
Resistant, Vapor-Barrier

MIL-C-20079H-1987 ..... Cloth, Glass; Tape, Textile Glass; and Thread, Glass and  
Wire-Reinforced Glass

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

A167-99 2014 ..... Standard Specification for Stainless and Heat-Resisting  
Chromium-Nickel Steel Plate, Sheet, and Strip

B209-2014 ..... Standard Specification for Aluminum and Aluminum-Alloy  
Sheet and Plate

C411-2019 ..... Standard test method for Hot-Surface Performance of  
High-Temperature Thermal Insulation

C449-2019 ..... Standard Specification for Mineral Fiber Hydraulic-Setting  
Thermal Insulating and Finishing Cement

C533-2017 ..... Standard Specification for Calcium Silicate Block and Pipe  
Thermal Insulation

C534-2017... ..... Standard Specification for Preformed Flexible Elastomeric  
Cellular Thermal Insulation in Sheet and Tubular Form

C547-2017 ..... Standard Specification for Mineral Fiber pipe Insulation

C552-07 ..... Standard Specification for Cellular Glass Thermal Insulation

C553-2015 ..... Standard Specification for Mineral Fiber Blanket Thermal  
Insulation for Commercial and Industrial Applications

C585-2016 ..... Standard Practice for Inner and Outer Diameters of Rigid  
Thermal Insulation for Nominal Sizes of Pipe and Tubing  
(NPS System) R (1998)

C612-2014 ..... Standard Specification for Mineral Fiber Block and Board  
Thermal Insulation

C1126- 2019 ..... Standard Specification for Faced or Unfaced Rigid Cellular  
Phenolic Thermal Insulation

- C1136- 2017 ..... Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
- D1668-97a 2017 ..... Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
- E84-2014 ..... Standard Test Method for Surface Burning Characteristics of Building Materials
- E119-2007 ..... Standard Test Method for Fire Tests of Building Construction and Materials
- E136-2019 ..... Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C (1380 F)
- E. National Fire Protection Association (NFPA):
- 90A-2018 ..... Standard for the Installation of Air Conditioning and Ventilating Systems
- 96-2018 ..... Standards for Ventilation Control and Fire Protection of Commercial Cooking Operations
- 101-2018 ..... Life Safety Code
- 251-2014 ..... Standard methods of Tests of Fire Endurance of Building Construction Materials
- 255-2006 ..... Standard Method of tests of Surface Burning Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):
- 723-2018 ..... UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 09/08
- G. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):
- SP58-2018 ..... Pipe Hangers and Supports Materials, Design, and Manufacture

## **PART 2 - PRODUCTS**

### **2.1 MINERAL FIBER OR FIBER GLASS**

- A. ASTM C612 (Board, Block), Class 1 or 2, density  $48 \text{ kg/m}^3$  (3 pcf),  $k = 0.037$  (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-3, Density  $16 \text{ kg/m}^3$  (1 pcf),  $k = 0.045$  (0.31) at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1,  $k = 0.037$  (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

### **2.2 MINERAL WOOL OR REFRACTORY FIBER**

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

### **2.3 RIGID CELLULAR PHENOLIC FOAM**

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1,  $k = 0.021$  (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1,  $k = 0.021$  (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket.

### **2.4 CELLULAR GLASS CLOSED-CELL**

- A. Comply with Standard ASTM C177, C518, density  $120 \text{ kg/m}^3$  (7.5 pcf) nominal,  $k = 0.033$  (0.29) at 24 degrees C (75 degrees F).
- B. Pipe insulation for use at temperatures up to 200 degrees C (400 degrees F) with all service vapor retarder jacket.

## **2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

ASTM C177, C518,  $k = 0.039$  (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

## **2.9 INSULATION FACINGS AND JACKETS**

- A. Vapor Retarder, higher strength with low water permeance  $\leq 0.02$  or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- E. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.

- G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
- H. Aluminum Jacket-Piping systems: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

## 2.10 REMOVABLE INSULATION JACKETS

- A. Insulation and Jacket:
1. Non-Asbestos Glass mat, type E needled fiber.
  2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
  3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
  4. Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.

## 2.11 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

## **2.12 ADHESIVE, MASTIC, CEMENT**

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
- F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- G. Other: Insulation manufacturers' published recommendations.

## **2.13 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching monel or galvanized steel.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.



- D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

## **2.14 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.
- E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

## **2.15 FIRESTOPPING MATERIAL**

Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

## **2.16 FLAME AND SMOKE**

Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface

shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- F. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- G. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- H. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- I. HVAC work not to be insulated:
  - 1. Internally insulated ductwork and air handling units.

2. Relief air ducts (Economizer cycle exhaust air).
  3. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
  4. Equipment: Expansion tanks, hot water pumps,
  5. In hot piping: Unions, flexible connectors, control valves, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.
- K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- M. Firestop Pipe and Duct insulation:
1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
  2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
    - a. Pipe risers through floors
    - b. Pipe or duct chase walls and floors
    - c. Smoke partitions
    - d. Fire partitions
- N. Freeze protection of above grade outdoor piping (over heat tracing tape): 26 mm (10 inch) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide for cold water make-up to cooling towers and condenser water piping and chilled water piping as described in Section 23 21 13, HYDRONIC PIPING (electrical heat tracing systems).
- O. Provide vapor barrier jackets over insulation as follows:

1. All piping and ductwork exposed to outdoor weather.
- P. Provide metal jackets over insulation as follows:
  1. All piping and ducts exposed to outdoor weather.
  2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
  3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

### **3.2 INSULATION INSTALLATION**

- A. Mineral Fiber Board:
  1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
  2. Plain board:
    - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
    - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
    - c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
  3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics, and duct work exposed to outdoor weather:

- a. 40 mm (1-1/2 inch) thick insulation faced with ASJ (white all service jacket):  
Supply air duct and after filter housing.
  - b. 40 mm (1-1/2 inch) thick insulation faced with ASJ: Return air duct, mixed air plenums and prefilter housing.
  - c. Outside air intake ducts: 25 mm (one inch) thick insulation faced with ASJ.
  - d. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a maximum water vapor permeability of 0.001 perms.
6. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
- a. Convertors, air separators.
  - c. Domestic water heaters and hot water storage tanks (not factory insulated).
  - d. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.
7. Laundry: Hot exhaust ducts from dryers and from ironers, where duct is exposed in the laundry.
- B. Flexible Mineral Fiber Blanket:
1. Adhere insulation to metal with 75 mm (3 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
  2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To

prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.

3. Concealed supply air ductwork.

- a. Above ceilings at a roof level, in attics, and duct work exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with FSK.
- b. Above ceilings for other than roof level: 40 mm (1 ½ inch) thick insulation faced with FSK.

4. Concealed return air duct:

- a. Above ceilings at a roof level, unconditioned areas, and in chases with external wall; 40 mm (1-1/2 inch) thick, insulation faced with FSK.
- b. Concealed return air ductwork in other locations need not be insulated.

5. Concealed outside air duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.

6. Exhaust air branch duct from autopsy refrigerator to main duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.

C. Molded Mineral Fiber Pipe and Tubing Covering:

- 1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.

2. Contractor's options for fitting, flange and valve insulation:

- a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
- b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.

- c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
  - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

G. Flexible Elastomeric Cellular Thermal Insulation:

- 1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
- 2. Pipe and tubing insulation:
  - a. Use proper size material. Do not stretch or strain insulation.
  - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC
  - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
- 3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
- 4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section).

5. Minimum 20 mm (0.75 inch) thick insulation for pneumatic control lines for a minimum distance of 6 m (20 feet) from discharge side of the refrigerated dryer.
6. Use Class S (Sheet), 20 mm (3/4 inch) thick for the following:
  - a. Chilled water pumps
  - b. Bottom and sides of metal basins for winterized cooling towers (where basin water is heated).
  - c. Chillers, insulate any cold chiller surfaces subject to condensation which has not been factory insulated.
  - d. Piping inside refrigerators and freezers: Provide heat tape under insulation.
7. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.

### 3.7 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 – COMMISSIONING OF HVAC 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

### 3.8 PIPE INSULATION SCHEDULE

Provide insulation for piping systems as scheduled below:

Insulation Wall Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 – 32 (1 – 1¼)	38 – 75 (1½ - 3)	100 (4) and Above
	Insulation Wall Thickness Millimeters (Inches)				



38-94 degrees C (100-200 degrees F) (HWH, HWHR, GH and GHR)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-94 degrees C (100-200 degrees F) (HWH, HWHR, GH and GHR)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	----	----
(40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

--- E N D ---

**SECTION 23 09 23**  
**CONTROLS AND INSTRUMENTATION (DDC)**

**PART 1 - SYSTEM OVERVIEW**

**1.1 DDC CONTROL SYSTEM**

A. Statement of Intent

The intent of this specification is to furnish a totally native WebCTRL, high-quality Direct Digital Control system with Web based software front end and top-of-the-line control hardware. System is to include a Graphical User Interface (GUI) residing on a WebServer accessible with an industry standard non-proprietary Web Browser. Connectivity shall be over the owner's internal Ethernet system and, when allowed, over the Internet using the servers IP address. Connection to the WebServer software shall be thin client access. The graphic user interface shall display real time values of all system operating conditions. Additionally, it shall include graphic displays of system programming, operating logic and logic flow. It shall display logic flow with real time values of logical inputs and outputs. This graphical display capability is required for system diagnostics of both the mechanical systems controlled by the DDC system and of the operating logic and sequences themselves. The features of the system must be fully installed, configured and demonstrated in a manner that provides maximum benefit to the end user.

B. Specification Compliance

These specifications are intended to provide minimum capability for the DDC system. Manufacturer's data sheets included in the submittals will be reviewed to verify significant hardware and software system features. Key system features must be documented by manufacturer's data sheets in the submittals or by demonstration of an existing installation.

C. Approved DDC Contractor and System

1. DDC Control System approved for use must be able to tie into existing BVAMC WebCTRL DDC Management Server on the BVAMC Network. No new DDC Servers

will be built. This includes:

Automated Logic WebCTRL by Clima-Tech Corporation

2. Contractor wishing to provide ATC control system for this project shall submit system capabilities to the project Engineer. This is to allow for system demonstration for owner and design team.
- D. Provide and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.
- E. Provide as-built documentation on approved media in .dwg or VISIO, the sum total of which accurately represents the final system. The Contractor will provide an updated sequence of operation in digital format indicating all changes made to the original sequence.
- F. Provide new sensors, dampers, and valves where required to meet plans and sequences of operation. Install only new electronic actuators. No used components shall be used as any part or piece of installed system. All reusable valves and equipment will be turned over to the VA.
- G. Demolish all equipment, controls, wiring and material as required to complete work specified. Remove from VA property and properly dispose of all resulting waste materials.

## **1.2 SCOPE OF WORK**

### **A. Control Hardware and Software**

The Automatic Temperature Control (ATC) Contractor shall be responsible for furnishing and installing all control hardware and software necessary for a complete DDC control system as specified. ATC contractor shall furnish all modules, temperature sensors, flow sensors, humidity sensors, IAQ sensors, control valves, control valve actuators, dampers, damper actuators, and any other items necessary for a complete system and sequence of control, except those valves, dampers, and actuators specified to be furnished by equipment supplier. When actuators are specified to be furnished by equipment supplier, that supplier shall be responsible for coordination of actuator control input for interface with the DDC system without use of transducers. Automatic control valves,

dry wells for fluid temperature sensors, dampers, and actuators shall be installed by the mechanical contractor.

Specifically the ATC Contractor shall furnish the following:

1. Individual unitary control modules for each unitary system:

*(Following are potential applications:*

*VAV boxes*

*Split system air handlers and condensing units*

*Unitary package rooftop units*

*Reheat Coils*

*Unit Heaters*

2. Individual control modules for all non-unitary air handlers or package units:

*(Following are potential applications:*

*VAV air handling units*

*Exhaust Fans*

3. Required peripheral mechanical components to be furnished by ATC contractor:

*(Following are potential applications:*

*Zone damper actuators*

*Economizer damper actuators not specified as part of mechanical equipment*

*Control dampers not specified as part of mechanical equipment*

*Hot water valves and actuators*

*Chilled water valves and actuators*

*Supply air pressure sensor for VFD control*

*Building air pressure sensors*

*Water pressure sensors*

*Variable frequency drives*

*Air flow measuring systems*

*Electrical demand monitoring hardware)*

4. Required non HVAC controls to be furnished by ATC contractor:

*(Following are potential applications:*

*Lighting control panels*

*Electrical Metering*

*Gas Metering*

*Heating Water Metering*

*Domestic Water Metering)*

5. Required software integration to other digital control systems:

*(Following are potential applications:*

*Interface to variable frequency drives*

*Interface to HVAC air handlers or package units*

*Interface to energy monitoring systems)*

B. Control Wiring and Interface to Line Voltage Control

ATC Contractor shall be responsible for control wiring to all control modules, sensors, pilot duty control relays, and actuators required to provide Sequences of Operation as noted in Part 5. ATC contractor shall provide control interface to boilers, chillers, pumps, and fans. This shall include pilot duty relays where interface to line voltage switching devices is required. ATC Contractor shall provide all required conduit for low voltage wiring within mechanical rooms or at equipment locations unless specifically shown on Division 16 drawings. Electrical Contractor shall provide all required conduit for line voltage wiring, all contactors, magnetic starters, and motor control centers required for operation of mechanical systems except where specifically noted to be provided by equipment manufacturer. *The Electrical Contractor shall also be responsible for line voltage circuits and connection to ATC panels.* Unitary equipment will be supplied with required fan relays, compressor contactors, electric heat sequencers, and transformers ready for connection to ATC provided control modules.

C. Control Integration with Third Party Digital Controls Supplied by Others

*Automatic Temperature Control (ATC) Contractor shall be responsible for all integration of controls furnished by Third Party Supplier to accomplish the required integration. ATC Contractor shall provide necessary hardware to maintain these programs. Local area network wiring required for connection to interface hardware provided under the ATC*

*project scope is the responsibility of the ATC Contractor. If Ethernet connection to third party controls is required, that network connection shall be the responsibility of the VA. Suppliers of equipment that is required to be integrated with the DDC system shall be responsible to coordinate integration software protocol and connectivity with ATC Contractor prior to bid to ensure satisfactory integration and system operation. Equipment suppliers are required to confirm that their factory installed controls are capable of achieving sequences of operation listed under this section, and that required points are available to the DDC system. If specified sequences cannot be met with factory installed controls, the equipment supplier shall be responsible for furnishing and installing required external controls or peripheral devices. Any required communication wiring between digital control devices provided by equipment suppliers shall be the responsibility of that supplier. This may be under separate agreement with the ATC Contractor.*

*Equipment suppliers shall provide complete points list including Usage Description, Addresses, Device ID numbers and Network Number with the capability of conformance to the owners DDC Network. A copy of all third party controls software shall be provided to the owner. All third party software shall be BTL certified.*

*Acceptable protocols:*

*Variable Frequency Drives, lighting systems, or power monitoring systems shall use BACnet software protocols for integration to this DDC system.*

#### D. Commissioning

ATC Contractor shall be responsible for self-commissioning of all hardware and software programming furnished with the project. Completed point checkout commissioning sheets shall be included with the final "as-built" O&M manuals. These sheets shall include validation check fields for each physical and software or network input and output, with date and time of verification and initials of individual performing the checkout. Physical point checkout lists shall include check offs for point type, address, scaling range, and any calibration offset. Software point checkout lists shall include check offs for mapped address and communication verification. Point checkout lists

shall use logical names for future reference by the owner.

Each graphic file will be checked for visual accuracy and to verify that point mapping on those files is correct. Each unique operating program shall be functionally tested to confirm that operation conforms to the Sequence of Operation. Documentation of graphic commissioning and Functional Performance Testing shall be included in the project O&M manuals.

E. Training and Technical Support

*Contractor shall provide 24 hours of factory approved classroom training for owner representatives on operation and servicing of the automatic temperature control system. Training shall be oriented to make the owner self-sufficient in the day to day use and operation of the DDC system. Additionally, the training shall include information specifically focused on showing the owners representative methods for troubleshooting the mechanical systems using the DDC system. For this purpose, the trainer must be well grounded in both DDC system operation and in mechanical systems service.*

*The contractor shall provide unlimited phone technical support to the owner's representative during the one year warranty period. If the technical support location of the contractor is outside of the toll free calling area for the customer, the contractor shall have a toll free number or accept collect calls for the purpose of providing technical support.*

### **1.3 RELATED WORK**

- A. Section 230511, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Section 232113 & 232213, HVAC PIPING SYSTEMS.
- C. Section 230593, TESTING, ADJUSTING AND BALANCING.
- D. Section 270533, CONDUIT SYSTEMS.
- E. Section 260521, CABLES, LOW VOLTAGE.

### **1.4 SUBMITTALS**

- A. Submittals shall include the following sections:

- 1. Shop Drawings with:

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  - actuators
  - flow switches
  - current sensors
  - transducers

If the contractor wishes to substitute any item after approval of submittal they shall submit appropriate data sheets for approval before including substituted product on the project.

**B. O&M Manuals**

O&M Manuals shall be furnished upon project completion and include technical instructions for all items originally included in the submittal with "as built" modifications and completed Commissioning Worksheets. O&M Manuals shall be in a separate three ring binder. Contractor's toll free technical support number or the words "Call Collect" with the contractor's regular phone number shall be on the front of the manual.

**1.5 SYSTEM SOFTWARE**

**A. System Software shall include the following:**

1. DDC operating system



2. Any software required for control logic programming
  3. Any software required for graphics generation
  4. Any other software used to create a fully functional system
  5. Site specific database
- B. All software programs shall be installed on the owner's server.
- C. All licenses shall become the property of the Owner

## **1.6 WARRANTY**

- A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from acceptance of the system; including all installation, graphics, training, and control drawings.
- B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.
- C. This warranty shall apply equally to both hardware and software.

## **1.7 CONTRACTOR CAPABILITY**

- A. Contractor shall maintain toll-free technical support phone line or accept collect phone calls during warranty period.
- B. Contractor shall provide service within 24 hours.
- C. Contractor service and installation technicians shall be technically proficient in both control systems and mechanical service.

## **PART 2 – PRODUCTS**

### **2.1 HARDWARE**

- A. SYSTEM SERVER

*Software shall be installed on owner furnished server.*

*Current upgrade of operating software shall be installed on owner furnished server.*

*If server requirements have changed since previous installations, specifications for this server will be provided to the owner prior to installation.*

## B. FIELD HARDWARE

### 1. BACnet

The system shall be fully native BACnet at the time of installation. The system shall use BACnet as the native communication protocol between distributed controllers communicating on the controller network (i.e. Field Bus) and must, as a minimum, support the following Objects and Application Services (Conformance Class 3):

Objects	>	Binary Input	Services	>	Readproperty
		Binary Output			Writeproperty
		Binary Value			I-Am
		Analog Input			I-Have
		Analog Output			ReadMultiple Property
		Analog Value			WriteMultiple Property
		Calendar			Who-Has
		Schedules			Who-Is

### 2. Distributed Control

System shall observe the concept of distributed control. All modules shall have “stand alone” capability and shall maintain operator setpoints without connection to primary controllers or central station equipment. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network. Equipment operating logic, schedules and current trends shall reside in control modules serving each system. Use of global modules required to maintain programming, schedules, or current trend data is not acceptable.

### 3. Ethernet Gateway Routers

System shall include an Ethernet Router/Gateway between the control module network and owners Ethernet. This gateway shall route BACnet communications between the control module network and the owners IP network. MAC addresses

for each Ethernet Router/Gateway over IP shall be provided to the owner prior to beginning device installation. This includes all third-party devices. (Non-Automated Logic WebCTRL native BACnet)

4. Control Modules

1. Control modules shall include required inputs and outputs to meet sequence of operation and points list. Digital outputs shall be dry contact relays and analog outputs shall be industry standard 0-10 vdc, 2-10 vdc or 4-20 milli-amp. Triac digital outputs are not acceptable.
2. Modules shall be fully programmable for maximum system flexibility. Application specific controllers are not acceptable.
3. All modules shall have battery backup capable of maintaining all programs, setpoints, schedules, and trend information for a minimum of 7 days.
4. All schedules and current trends shall be maintained in the individual control modules. The modules shall be capable of maintaining sufficient trend samples to report 24 hours of trend history in 5 minute increments for each input or output.
5. Control Modules shall communicate via BACnet over either:
  1. ARCnet at a speed of 156 kbaud
  2. MS/TP at a speed of 76.8 kbaud
  3. ARCnet systems shall also be capable of supporting slower MS/TP communications buss when required for interface to other BACnet devices.

5. Temperature Sensors (analog)

1. Wall mounted zone temperature sensors shall be 10 k ohm thermistor.
  1. Zone sensors in primary occupied areas other than restrooms, hallways, or storage rooms shall have setpoint adjustment to allow the occupants to raise or lower the setpoint within operator defined parameters. Additionally sensors in these primary areas shall have a push button to return the system to normal occupancy setpoints for an operator defined period. Exception will be common areas.

2. Zone sensors for restrooms, hallways, storage rooms, gymnasiums, auditoriums, and locker rooms shall be mounted on the back of an aluminum electrical box cover plate designed for zone sensing application.
2. All other temperature sensors shall be industry standard thermistor or 4-20 milli-amp.
3. Minimum of two outside air sensors are required for each router or gateway. One of these sensor shall be the campus primary sensor located at Building 77.
4. Immersion sensors shall be mounted in a blind well for future serviceability.
6. AHU Freeze Protection Thermostats (binary)
  1. All Air Handling Units with outside air and Heating Water shall have a manual reset binary freeze protection thermostat installed downstream of each coil. Exceptions shall be made when water circuits are protected with glycol.
  2. Freeze protection thermostats shall be wired to directly open the control circuits for the fans. Control module outputs for freeze protection shall only be used for redundancy.
  3. An auxiliary switch on the freeze protection shall be wired to the AHU control module for alarming and additional control actions.
7. Current Transformers
  1. Current transformers used for fan status on belt drive constant volume air handlers shall be adjustable type. These shall be calibrated to indicate fan failure on belt loss.
  2. Current transformers used for pump status on pumps larger than 1 horsepower shall be adjustable type. These shall be calibrated to indicate pump failure when the pump cavitates on flow loss.
  3. Current transformers used for fan status on variable frequency drives shall be analog type. Software should note max flow amperage. Equipment program will indicate fan loss if amp draw drops below 60% of max flow amperage and software requests drive speed above 50 hz.
8. Pressure Sensors (analog)

1. Duct pressure sensors used for control of variable air flow air handling units shall be located in the longest duct run approximately 2/3 of the total duct length from the AHU.
  2. Building pressure sensors used for control of outside or relief air shall have more than one OA pressure reference point to minimize wind effects. OA pressure pickup shall be protected against blockage by insects.
  3. Hydronic pressure sensors used for control of variable flow pumps shall be located across a unit without a two way valve and pressure differential set 1.5 times the design pressure drop across that unit.
9. Hi Pressure Safety (binary)
1. Variable air flow air handling units shall have a manual high static pressure safety located at the AHU outlet to provide safety shut down if pressure exceeds 5" for more than 30 seconds. Variable frequency drives should be programmed for soft start to prevent nuisance tripping on startup.
10. Valve and Damper Actuators
1. Actuators shall be manufactured by Belimo.
  2. Torque shall be rated 20% above required load.
  3. Modulated actuator input shall be industry standard 0-10 vdc, 2-10 vdc, 4-20 milli-amp, floating motor (tri-state), or pulse width modulation. Two or three position operation is not acceptable for economizers, VAV dampers, multi-zone dampers, valves, or any other application where modulated operation is specified.
  4. Damper actuators used on any damper where one side is exposed to outside air shall have spring return to close dampers upon loss of power.
  5. Valve actuators used on any Heating Water Valve shall have spring return to open valve upon loss of power.
11. Dampers
1. Any damper where one side is exposed to outside air shall have neoprene or vinyl-grip blade seals, stainless spring steel edge seals and a specified leakage

rate of not more than 65 CFM/damper face area at 2" W.G. static pressure drop. Exception will be combustion intake dampers and air to air heat exchange relief dampers.

2. When outside air intake dampers for economizers are furnished by ATC Contractor those dampers shall be opposed blade style.
3. Individual damper blades shall not exceed 48".

#### 12. Wire

1. All wiring in open areas at heights below 12 feet must be run in conduit.
2. Control wiring may be run open in accessible ceiling or under floor areas.
3. Control wiring in non-accessible ceilings, walls or floors shall be in conduit.
4. All wiring not in conduit or control cabinets shall be rated for plenum installation.
5. Communication wiring shall be run in data cable tray whenever possible.

## 2.2 SOFTWARE

### A. MULTIPLE OPERATING PLATFORMS

The front end server software furnished as a part of the DDC system shall be capable of operating on multiple operating systems such as Microsoft Windows, Linux or Sun Solaris.

### B. MULTI-BROWSER ACCESS

Internet, Intranet or Local Host access to the system shall be via thin client browser access using any standard browser, such as Internet Explorer, Firefox or Chrome

### C. GRAPHICAL PROGRAMMING

The system shall be programmed using a graphical programming language for ease of operator understanding. Operating sequences and logic flow shall be assembled in a schematic format using visually descriptive micro-blocks or icons representing inputs, outputs, and logical functions such as and/or logic, setpoints, switches, limits, relays, PIDs, etc. The programming software shall be furnished within this scope of work.

Full simulation capability shall also be provided with the graphic programming. User shall be able to fully simulate the constructed sequence on screen before the sequences

are downloaded into the controllers. The system shall also include the ability to simulate multiple graphic programs communicating with each other on a simulated network.

#### D. GRAPHICAL INTERFACE SOFTWARE

##### 1. System and Equipment Graphics

The operator's interface software shall be graphics based and display in 256 colors at a minimum 1024 x 768 pixel resolution. Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Additionally the system hierarchy shall be displayed in a fashion similar to Windows Explorer to enable the user to navigate to any graphical screen in the system by expanding building levels or floor levels and selecting a particular zone or system. Graphics shall be accessed by using a mouse or other pointer device. The system shall provide a visual indication of which building, floor, and zone the user is accessing at any time. System shall be capable of changing all parameters and schedules, as well as downloading operating software from the same Graphical User Interface software program as that used for viewing system operation.

Thermal graphic floor plans shall display each temperature zone in

Mechanical equipment pictorial graphics shall be displayed by the use of point-and-shoot selection using a mouse or other pointer device. Graphics shall be provided for all mechanical equipment and devices controlled by the DDC system. These graphics shall provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.

##### 2. Graphical Screen Replay

The system shall have the ability to replay up to 24 hours of thermal graphic floorplans, equipment graphics, alarms or trend pages, starting at a specified date

and time as a troubleshooting tool.

3. Software Graphic Programming Live User Interface

The system shall be able to display the graphic displays of system programming, operating logic, and logic flow with real time conditions displayed at each input, output, and logical function. This display will allow the operator to observe each step of a control logic process and facilitate system software troubleshooting.

Operator shall have the ability to select any mirco-block in the graphical program to change parameters including the ability to lock values.

- a. If the project work results in changes to the current DDC floorplans, either because of architectural changes or changes to the HVAC system, the DDC contractor is responsible for updating the DDC floorplan in the DDC system to make it current and accurate.
- b. The DDC contractor is responsible for creating accurate graphical floorplans showing the HVAC system for each floor created as a result of the project and adding them to the DDC system. The VA reserves the right to approve any floorplans before they are uploaded.
- c. If the project has altered the look of a building compared to the building photo in the DDC system, the DDC contractor is responsible for updating the photo in the DDC system to make it current. The VA reserves the right to approve any photo before it is uploaded.
- d. The DDC contractor is responsible for adding a new photo to the DDC system for each new building added to the campus as a result of the project. The VA reserves the right to approve any photo before it is uploaded.
- e. All new graphics are to be approved by the VA prior to implementation in the system.

E. FACILITY MANAGEMENT AND ENERGY MANAGEMENT FUNCTIONS

1. Scheduling

1. For maximum flexibility, schedules shall reside in the local control modules or Central Control Modules.



2. Schedules shall be at the zone level. Central plant or fan operations shall not be scheduled, rather they shall run based on requests from the zones that they serve.
  3. The DDC system shall have the ability to schedule each individual zone, each building or floor, or the entire network of buildings for any user with a single entry. Additionally the operator shall have the capability of assembling groups of zones, buildings or floors for single entry programming, e.g. several offices may be grouped for scheduling of operations.
  4. Available schedule types shall include normal operation, unoccupied operation, setback override, and holidays.
  5. Dated schedules shall be self-managing and automatically delete after execution.
2. Demand Control

*The system shall have the ability to receive an analog or digital input of electrical usage/demand through any open input on a general purpose module. If demand control is implemented in the future, this capability shall not require any additional DDC hardware except the single input point and, when implemented, the digital or analog devices required to read electrical demand levels.*

*The system shall include required demand control hardware and software for monitoring electrical usage and controlling demand.*

*Demand control shall be achieved by adjusting zone temperature setpoints as electrical demand thresholds are reached. Zone setpoint offset shall be individually adjustable to allow prioritization of zone comfort conditions. Multiple demand level threshold parameters shall be available to allow more aggressive control as building demand rises. Additionally the demand control strategy shall automatically adjust the demand level thresholds based on ambient temperature to meet peak space conditioning requirements and minimize peak demand during mild temperature months.*

The system shall be capable of rotating greater or lower demand levels every 10 minutes to alternate zones throughout the facility to minimize long term setpoint offset.

### 3. Interactive Operations

The system shall have the ability to send run requests, heating requests, and cooling requests from one module to another for the purpose of optimizing run operations of central plant equipment. Additionally the system shall be capable of limiting operation of various equipment if another mechanical point elsewhere in the system allows that operation. e.g. a boiler loop circulating pump shall run only when requested by a zone requiring heating operation and will shut down during hours that zone demand is satisfied.

### 4. Energy Reporting Tools

System shall include an easily configured energy reporting tool that provides the capabilities described in this section. This reporting software shall be resident on the customer server and shall not have any additional subscription support cost.

#### 1. The energy reporting tool shall:

1. Be accessible through the same user interface (Web browser or operator workstation software) that is used to manage the BAS.
2. Be preconfigured by the Contractor to gather and store energy demand and consumption data from each energy source that provides metered data to the BAS. Meter data shall be stored at 5 minute intervals unless otherwise specified in the Sequence of Operation below. This data shall be maintained in an industry standard SQL database for a period of not less than five years.
3. Allow the operator to select an energy source and a time period of interest (day, week, month, year, or date range) and shall provide options to view the data in a table, line graph, bar graph, or pie chart.
4. Allow the operator to select two or more data sources and display a comparison of the energy used over this period in any of the listed graph

formats, or to total the energy used by the selected sources and display that data in the supported formats.

5. Allow the operator to select an energy source and two time periods of interest (day, week, month, year, or date range) and display a graph that compares the energy use over the two time periods in any of the graph formats listed in the previous paragraph.
  6. Allow the operator to select multiple energy sources and display a graph that compares the total energy used by these sources over the two time periods.
  7. Allow the operator to easily generate the previously described graphs "on the fly," and shall provide an option to store the report format so the operator can select that format to regenerate the graph at a future date.
  8. Allow the user to schedule these reports to run on a recurring basis using relative time periods, such as automatically generating a consumption report on the first Monday of each month showing consumption over the previous month.
2. System shall be capable of automatically generating reports that can be archived on the server in a common industry format such as Adobe PDF or Microsoft Excel. System shall be capable of e-mailing reports to a user editable list of recipients.
  3. The energy reporting tool shall be capable of collecting and displaying data from the following types of meters:
    1. Electricity
    2. Potable Water
    3. Heating and cooling degree days. (May be calculated from sensor data rather than metered.)
  4. The system shall be capable of using kW (kWh) or Btu/hr (Btu), or multiples of these units, e.g. MWH, kBtu, as the units for demand and consumption reports. All selected sources shall be automatically converted to the selected units. The user shall similarly have the option of entering facility area and occupancy hours

and creating reports that are normalized on an area basis, an annual use basis, or an occupied hour basis.

5. Capability shall include the option of entering benchmark data for an individual facility or a group of facilities.
6. Capability shall include the option of displaying any or all of the following data on any chart, line, or bar graph generated by the energy reporting tool:
  1. Low/High/Average value of the metered value being displayed.
  2. Heating and/or Cooling Degree Days for the time period(s) being displayed.
  3. The Environmental Index for the facilities and time periods being displayed.
5. Environmental Index

System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling setpoint. If humidity is being measured within the zone then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trend logs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.

#### F. ALARMS, TRENDS, AND REPORTS

1. System and Temperature Alarms

The system shall have the capability of monitoring conditions throughout the system and sending alarms via text or messages to an e-mail address, local PC or printer, or to remote PC's, printers, or to dial-up pagers. Alarms and messages shall be able to be prioritized for various levels of reporting and action. The operator shall have the ability to customize alarm text and messages.

2. Trends

The system shall be capable of trending any input or output, or any logical point within an operating program, e.g. output of a PID. There shall be no limitation to the number of points that can be trended at any particular time. Modules shall store in live memory 288 trend samples points for each trended item. The interval between trend samples shall be adjustable from 1 second to 24 hours. Trends from one or more modules shall be able to be simultaneously displayed on a single trend graph. Operator shall be able to "window" any segment of a trend to enlarge the view by dragging a mouse to form the "window". The system shall also have the ability of automatically downloading trend information from any module to the server or other computer connected to the network for historical trend storage. This trend information shall be able to be displayed on the trend graph along with live current trends in seamless fashion. Trend data collection requiring the use of a locally connected PC for data storage is unacceptable.

3. Reports

The system shall be capable of generating reports of equipment run times, all trended points, temperature conditions, electric demand and usage, and alarms or messages. The system shall also have the ability of automatically downloading report information from any module to the server or other computer connected to the network. The operator shall have the ability to create custom report and logging formats.

## 2.3 ENCLOSURES

- A. All controllers, power supplies and relays shall be mounted in enclosures.

- B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean interior environment.
- C. Enclosures shall have hinged, locking doors.
- D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.
- E. All enclosures that have any wire or devices inside will have an accurate, complete and legible wiring diagram placed on the inside of the enclosure door. After any modification the wiring diagram will be corrected and made complete, accurate and legible.

### **PART 3 – SEQUENCES OF OPERATION**

#### **3.1 GENERAL**

- A. The sequences of operation shall be strictly observed. All temperature setpoints, static pressure setpoints, percentage of PI/PID output trip points and reset ratios within this specification shall be changeable by operator using the operator software furnished with the system.
- B. System shall observe the concept of distributed control. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network.
- C. Control of all central fan systems, chillers, boilers, and pumping stations shall be based on run requests, heating requests, or cooling requests from zone controls, unless specified otherwise. Reset of supply air static pressure, supply air temperature, chilled water temperature, and hot water temperature shall be based on zone temperature conditions and heating or cooling requests from zones.
- D. For maximum flexibility all occupancy schedules shall be stored in global controllers or zone control modules. Central fans or pumps shall start when commanded from any associated zones that call for occupancy or for operation to meet setback heating or cooling requirements and shall not require separate scheduling unless required for the sequence of operation.

### **3.2 LOCATION AND INSTALLATION OF COMPONENTS**

- A. Locate and install components for easy accessibility; in general, mount 60" above floor with minimum 36" clear access space in front of units. Obtain approval on locations from owner's representative prior to installation.
- B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
- C. Identify all equipment and panels. Provide permanently mounted tags for all panels.
- D. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.

### **3.3 INTERLOCKING AND CONTROL WIRING**

- A. Provide all low voltage interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with all national, state and local electrical codes.
- B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.
- C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.
- D. Provide auxiliary pilot duty relays on motor starters as required for control function.
- E. Use existing underground raceways to run wiring between buildings as required.  
Coordinate exact routing of wiring with VA prior to installation.

### **3.4 EXAMINATION**

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
- B. Notify the owners' representative in writing of conditions detrimental to the proper and timely completion of the work.
- C. Notify the owner's representative in writing of conditions that are Contractor or sub-contractor caused such as duct, mechanical, structural or piping that will interfere with

the service, operation and maintenance of control valves, balance valves, wye strainers, changing belts or filters, high point vents, drains or blow downs. All valves must be placed or installed in such a way as to be accessible and serviceable from a ladder. If installed above a suspended ceiling, the valves must be accessible through the grid ceiling. Each valve will be able to fully open or close without the valve handle interfering, touching or obstructing any other part of the system. Do not begin work until all unsatisfactory conditions are resolved.

### **3.5 INSTALLATION (GENERAL)**

- A. Install in accordance with manufacturer's instructions.
- B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.
- C. Installation control components shall be the full responsibility of, and provided by, the control contractor. The control contractor may subcontract out the installation to qualified electricians.

### **3. SEQUENCE OF OPERATION:** Verify with owner and receive approval prior to programming.

- A. At the conclusion of the work, provide a detailed written sequence of operation in digital, "Microsoft Word", format. Sample sequences of operation are available from the VA upon request.

--- E N D ---



**SECTION 23 21 13**  
**HYDRONIC PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Water piping to connect HVAC equipment, including the following:
  - 1. Heating hot water and drain piping.
  - 2. Extension of domestic water make-up piping for HVAC systems.
  - 3. Glycol-water piping.
  - 4. Below Grade pre-engineered, direct-buried, drainable-dryable-testable (DDT)
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for piping.
- F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- G. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- H. Section 23 07 11, HVAC AND BOILER PLANT INSULATION: Piping insulation.
- I. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.
- K. Section 23 21 23, HYDRONIC PUMPS: Pumps.
- L. Section 23 25 00, HVAC WATER TREATMENT: Water treatment for open and closed systems.

M. Section 31 20 00, EARTHWORK: Excavation and backfill.

### 1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced.

The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.

B. American Society of Mechanical Engineers (ASME):

B1.20.1-2013 ..... Pipe Threads, General Purpose (Inch)

B16.3-2016 ..... Malleable Iron Threaded Fittings: Classes 150 and 300

B16.4-2016 ..... Gray Iron Threaded Fittings: (Classes 125 and 250)

B16.5-2017 ..... Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24  
Metric/Inch Standard

B16.9-2018 ..... Factory Made Wrought Buttwelding Fittings

B16.11-2016 ..... Forged Fittings, Socket-Welding and Threaded

B16.18-2018 ..... Cast Copper Alloy Solder Joint Pressure Fittings

B16.22-2018 ..... Wrought Copper and Copper Alloy Solder-Joint Pressure  
Fittings

B16.24-2016 ..... Cast Copper Alloy Pipe Flanges and Flanged Fittings:  
Classes 150, 300, 600, 900, 1500, and 2500

B16.39-2014 ..... Malleable Iron Threaded Pipe Unions: Classes 150, 250,  
and 300

B16.42-2016 ..... Ductile Iron Pipe Flanges and Flanged Fittings

B31.9-2014 ..... Building Services Piping

B40.100-2013 ..... Pressure Gauges and Gauge Attachments

ASME Boiler and Pressure Vessel Code:

BPVC Section VIII-2015 ..... Rules for Construction of Pressure Vessels

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

A47/A47M-2018 ..... Standard Specification for Ferritic Malleable Iron Castings

A53/A53M-2018 ..... Standard Specification for Pipe, Steel, Black and Hot-  
Dipped, Zinc-Coated, Welded and Seamless

- A106/A106M-2019..... Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- A126-2004(R2019) ..... Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
- A183-2014 ..... Standard Specification for Carbon Steel Track Bolts and Nuts
- A216/A216M-2018..... Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
- A307-2016..... Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
- A536-1984(R2019) ..... Standard Specification for Ductile Iron Castings
- B62-2017 ..... Standard Specification for Composition Bronze or Ounce Metal Castings
- B88-2016 ..... Standard Specification for Seamless Copper Water Tube
- F439-2019 ..... Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
- F441/F441M-2015..... Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
- D. American Welding Society (AWS):
- B2.1/B2.1M-2014 ..... Standard for Welding Procedure and Performance Specification
- E. Expansion Joint Manufacturer's Association, Inc. (EJMA):
- EJMA 2017..... Expansion Joint Manufacturer's Association Standards, Tenth Edition
- F. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:
- SP-67-2017 ..... Butterfly Valves
- SP-70-2014 ..... Gray Iron Gate Valves, Flanged and Threaded Ends
- SP-71-2014 ..... Gray Iron Swing Check Valves, Flanged and Threaded Ends
- SP-80-2014 ..... Bronze Gate, Globe, Angle, and Check Valves

SP-85-2014 ..... Gray Iron Globe and Angle Valves, Flanged and Threaded  
Ends

SP-110-2014 ..... Ball Valves Threaded, Socket-Welding, Solder Joint,  
Grooved and Flared Ends

SP-125-2018 ..... Gray Iron and Ductile Iron In-line, Spring-Loaded, Center-  
Guided Check Valves

G. Tubular Exchanger Manufacturers Association (TEMA):

TEMA Standards 2015 ..... 9th Edition

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 21 13, HYDRONIC PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Pipe and equipment supports.
  - 2. Pipe and tubing, with specification, class or type, and schedule.
  - 3. Pipe fittings, including miscellaneous adapters and special fittings.
  - 4. Flanges, gaskets and bolting.
  - 5. Couplings and fittings.
  - 6. Valves of all types.
  - 7. Strainers.
  - 8. Flexible connectors for water service.
  - 9. Pipe alignment guides.
  - 10. Expansion joints.
  - 11. Expansion compensators.
  - 12. All specified hydronic system components.
  - 13. Water flow measuring devices.

14. Gauges.
15. Thermometers and test wells.
16. Seismic bracing details for piping.
- D. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
  1. Air separators.
  2. Expansion tanks.
- E. Submit the welder's qualifications in the form of a current (less than one-year old) and formal certificate.
- F. Coordination Drawings: Refer to paragraph, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.
  1. One wall-mounted stick file with complete set of prints. Mount stick file in the chiller plant or control room along with control diagram stick file.
  2. One complete set of reproducible drawings.
  3. One complete set of drawings in electronic AutoCAD and pdf format.
- H. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
  1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- I. Completed System Readiness Checklist 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 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- J. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

### **1.5 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one-year old.
- C. All couplings, fittings, valves, and specialties shall be the products of a single manufacturer.
  - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:

1. As-built drawings are to be provided, with a copy of them on AutoCAD provided on CD or DVD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **1.7 SPARE PARTS**

- A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

- A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

### **2.2 PIPE AND TUBING**

- A. Heating Hot Water, and Glycol-Water, and Vent Piping:
  1. Steel: ASTM A53/A53M Grade B, seamless or ERW, Schedule 40.
  2. Copper water tube option: ASTM B88, Type K or L, hard drawn.
- B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.

C. Cooling Coil Condensate Drain Piping:

1. From air handling units: Copper water tube, ASTM B88, Type M, or Schedule 40 PVC plastic piping.

D. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

## 2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded joints.

1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
2. Forged steel, socket welding or threaded: ASME B16.11.
3. Screwed: 150-pound malleable iron, ASME B16.3. 125-pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: ASME B16.39.
5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.

B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.

1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
2. Welding flanges and bolting: ASME B16.5:
  - a. Water service: Weld neck or slip-on, plain face, with 3.2 mm (1/8 inch) thick full-face neoprene gasket suitable for 104 degrees C (220 degrees F).
    - 1) Contractor's option: Convuluted, cold formed 150-pound steel flanges, with Teflon gaskets, may be used for water service.
  - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gauge connections.



## **2.4 FITTINGS FOR COPPER TUBING**

### **A. Joints:**

1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
2. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall ensure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

### **B. Bronze Flanges and Flanged Fittings: ASME B16.24.**

### **C. Fittings: ASME B16.18 cast copper or ASME B16.22 solder wrought copper.**

## **2.5 DIELECTRIC FITTINGS**

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- C. 65 mm (2-1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42. Dielectric gasket material shall be compatible with hydronic medium.
- D. Temperature Rating, 99 degrees C (210 degrees F).
- E. Contractor's option: On pipe sizes 50 mm (2 inch) and smaller, screwed end brass ball valves or dielectric nipples may be used in lieu of dielectric unions.

## **2.6 SCREWED JOINTS**

- A. Pipe Thread: ASME B1.20.1.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

## **2.7 VALVES**

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.
- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2.4 m (8 feet) or more above the floor or operating platform.

D. Shut-Off Valves:

1. Ball Valves (Pipe sizes 50 mm (2 inch) and smaller): MSS SP-110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2758 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
2. Butterfly Valves (Pipe Sizes 65 mm (2-1/2 inch) and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS SP-67, flange lug type rated 1200 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Butterfly valves are prohibited for direct buried pipe applications.
  - a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47/A47M electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
  - b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
  - c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
    - 1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
    - 2) Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.
- 3) Gate Valves:
  - a) 50 mm (2 inches) and smaller: MSS SP-80, Bronze, 1035 kPa (150 psig), wedge disc, rising stem, union bonnet.

- b) 65 mm (2-1/2 inches) and larger: Flanged, outside screw and yoke. MSS SP-70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves:

1. Globe Valves:

- a. 50 mm (2 inches) and smaller: MSS SP-80, bronze, 1035 kPa (150 psig) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2-1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-85 for globe valves.

2. Angle Valves:

- a. 50 mm (2 inches) and smaller: MSS SP-80, bronze, 1035 kPa (150 psig) Angle valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2-1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-85 for angle.

F. Check Valves:

1. Swing Check Valves:

- a. 50 mm (2 inches) and smaller: MSS SP-80, bronze, 1035 kPa (150 psig), 45-degree swing disc.
- b. 65 mm (2-1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-71 for check valves.

2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.

- a. Body: MSS SP-125 cast iron, ASTM A126, Class B, or steel, ASTM A216/A216M, Class WCB, or ductile iron, ASTM 536, flanged or wafer type.
- b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

G. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.

1. Ball style valve.
  2. A dual-purpose flow balancing valve and adjustable flow meter, with bronze or cast-iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
  3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of 27 to 393 kPa (4 to 57 psig). Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:
1. Gray iron ASTM A126 or brass body rated 1200 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
  2. Brass or ferrous body designed for 2070 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
  3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
  4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

## **2.8 STRAINERS**

- A. Y Type.
1. Screens: Bronze, Monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (1/8 inch) diameter perforations.
- B. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

## **2.9 FLEXIBLE CONNECTORS FOR WATER SERVICE**

### **A. Flanged Spool Connector:**

1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
2. Working pressures and temperatures shall be as follows:
  - a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165 psig) at 121 degrees C (250 degrees F).
  - b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
3. Provide ductile iron retaining rings and control units.

## **2.10 HYDRONIC SYSTEM COMPONENTS**

### **A. Plate and Frame Heat Exchanger:**

1. Fixed frame with bolted removable corrugated channel plate assembly, ASME code stamped for 1035 kPa (150 psig) working pressure.
2. Corrugated channel plates shall be type 316 or 304 stainless steel.
3. Channel plate ports to be double gasketed to prevent mixing or cross-contamination of hot side and cold side fluids. Gaskets to be EPPM.
4. Channel plate carrying bars to be carbon steel with zinc yellow chromate finish.
5. Fixed frame plates and moveable pressure plates to be corrosion resistant epoxy painted carbon steel.
6. Piping connections 50 mm (2 inch) and smaller to be carbon steel NPT tappings. Piping connections 100 mm (4 inch) and larger to be stubbed port design to accept ANSI flange connections. Connection ports to be integral to the frame or pressure plate.
7. Finished units to be provided with OSHA required, formed aluminum splash guards to enclose exterior channel plate and gasket surfaces.

8. Provide two sets of replacement gaskets and provide one set of wrenches for disassembly of plate type heat exchangers.
9. Performance: As scheduled on drawings.
- B. Air Purger: Cast iron or fabricated steel, 861 kPa (125 psig) water working pressure, for in-line installation.
- C. Tangential Air Separator: ASME BPVC Section VIII construction for 861 kPa (125 psig) working pressure, flanged tangential inlet and outlet connection, internal perforated stainless-steel air collector tube designed to direct released air into expansion tank, bottom blowdown connection. Provide Form No. U-1. If scheduled on the drawings, provide a removable stainless-steel strainer element having 5 mm (3/16 inch) perforations and free area of not less than five times the cross-sectional area of connecting piping.
- D. Diaphragm Type Pre-Pressurized Expansion Tank: ASME BPVC Section VIII construction for 861 kPa (125 psig) working pressure, welded steel shell, rustproof coated, with a flexible elastomeric diaphragm suitable for a maximum operating temperature of 115 degrees C (240 degrees F). Provide Form No. U-1. Tank shall be equipped with system connection, drain connection, standard air fill valve and be factory pre-charged to a minimum of 83 kPa (12 psig).
- E. Pressure Relief Valve: Bronze or iron body and bronze or stainless-steel trim, with testing lever. Comply with ASME BPVC Section VIII and bear ASME stamp.
- F. Automatic Air Vent Valves (where shown on drawings): Cast iron or semi-steel body, 1035 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

## **2.11 GAUGES, PRESSURE AND COMPOUND**

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 59 mm (2-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white

dial with black or blue graduations and pointer, clear glass or acrylic plastic window, glycerin filled as manufactured by TIF or approved equal.

- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gauges in water service.
- C. Range of Gauges: Provide range equal to at least 130 percent of normal operating range.
  - 1. For condenser water suction (compound): 101 kPa (30 inches Hg) to 690 kPa (100 psig).

## **2.12 PRESSURE/TEMPERATURE TEST PROVISIONS**

- A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, norel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gauge test connections shown on the drawings.
- B. Provide one each of the following test items to the COR:
  - 1. 6 mm (1/4 inch) FPT by 3.2 mm (1/8 inch) diameter stainless steel pressure gauge adapter probe for extra-long test plug.
  - 2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gauge, 101 kPa (30 inches Hg) to 690 kPa (100 psig) range.
  - 3. 0 to 104 degrees C (32 to 220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (1 inch) dial, 125 mm (5 inch) long stainless-steel stem, plastic case.

## **2.13 THERMOMETERS**

- A. Bimetal 125 mm (5 inch) diameter thermometer with adjustable angle connection. Wika T1.52 or approved equal.
- B. Case: Stainless steel.
- C. Scale: Not less than 225 mm (9 inches), range as described below, two-degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges:
  - 1. Chilled Water and Glycol-Water: 0 to 38 degrees C (32 to 100 degrees F).
  - 2. Hot Water and Glycol-Water: 38 to 93 degrees C (100 to 200 degrees F).

## 2.14 FIRESTOPPING MATERIAL

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

## 2.15 PRE-ENGINEERED, FACTORY-FABRICATED, DIRECT-BUIRED, DRAINABLE-DRYABLE-TESTABLE (DDT) SYSTEMS

- A. Complete factory-fabricated heating water piping system with carrier pipes, carrier pipe insulation with jackets and banding, air space, 6 mm (1/4 inch) thick steel casing, fusion-bonded epoxy casing coatings, cathodic protection, accessories.
- B. All components of system shall be suitable for carrier pipe pressures and temperatures as follows:
1. Hydronic System: 345 kPa (50 psig); 154 degrees C (310 degrees F).
- C. Heating Wwater Carrier Pipes: No piping joints are allowed in factory-fabricated straight sections of pre-engineered direct-buried systems.
- D. Carrier Pipe Insulation:
1. Conform to minimum thickness and type of insulation listed in Tables 1 and 2 below as required for service temperature in carrier pipe as listed below.

<b>TABLE 1</b> <b>Minimum Pipe Insulation Thickness mm (inches)</b> <b>For Heating Hydronic Pipe</b>		
<b>Nominal Pipe Diameter mm (inches)</b>	<b>Pre-Formed Mineral Wool</b>	<b>Calcium Silicate</b>
25 (1)	50 (2)	75 (3)
40 (1-1/2)	50 (2)	75 (3)
50 (2)	50 (2)	75 (3)
65 (2-1/2)	50 (2)	75 (3)
75 (3)	65 (2-1/2)	90 (3-1/2)
100 (4)	65 (2-1/2)	90 (3-1/2)
125 (5)	65 (2-1/2)	90 (3-1/2)
150 (6)	75 (3)	115 (4-1/2)

Notes:



1. Submittals shall include manufacturer's certification that all insulation have passed the 96-hour boiling water test which indicates that satisfactory performance in underground service can be expected.
  2. Pipes smaller than 25 mm (1 inch) shall have the same insulation thickness as required for 25 mm (1 inch) pipe.
- E. Insulation Banding and Jacket: 304 stainless steel bands and clips, at least 13 mm (1/2 inches) wide, maximum spacing 457 mm (18 inches). A minimum of two bands is required for each 1200 mm (4 foot) section of insulation.
- F. Vinyl-coated Fiberglass Scrim Jacket: Fed. Spec. L-S-125, Type II, Class 2, with 18 x 16 mesh (number of filaments per inch) and made of 0.335 mm (0.013 inch) diameter vinyl-coated fibrous glass yarn. Install bands over the jacket to secure the insulation to the carrier pipe.
- G. Casing: ASTM A139/A139M, smooth-wall steel, electric resistance welded. Plastic casings are prohibited. Use eccentric connectors as necessary between casing sections to provide continuous gravity drainage in bottom of casing.

Casing Diameter mm (inches)	Minimum Thickness mm (inches)
150 - 1170 (6 – 46)	6.35 (0.250)

- H. Casing End Seal Plates with Vents and Drains: ASTM A36/A36M, steel, minimum thickness 10 mm (3/8 inch) for casings up through 300 mm (12 inches) diameter and 13 mm (1/2 inch) for casings over 300 mm (12 inches) diameter. Provide 25 mm (1 inch) drain at the bottom and vent at the top. Construct with threaded steel half couplings. Install threaded brass plugs in drains.
- I. Provide continuous 25 mm (1 inch) minimum air space between carrier pipe insulation and casing.
- J. Casing coating shall be dual layers of fusion-bonded epoxy, inner green-colored layer minimum thickness 0.5 mm (0.020 inch), outer black-colored layer minimum thickness 0.25 mm (0.010 inch). Rated by coating manufacturer for continuous service for at least 25 years at minimum temperature of 110 degrees C (230 degrees F) and having a

coefficient of expansion similar to that of steel. Coating shall be applied in accordance to recommendations of coating manufacturer including surface preparation. Factory-inspect for holidays and make repairs as necessary.

- K. Carrier pipe guides and supports shall be maximum spacing 3000 mm (10 feet) on centers, no greater than 1500 mm (5 feet) from pipe ends, minimum of three guides per elbow section. Designed to permit thermal expansion without damage, provide proper pipe guiding and support, and to allow horizontal movement in two directions as necessary at expansion loops and bends. Design of guides and supports must permit continuous drainage of water in bottom of casing. Pipe insulation shall extend through the pipe guides and supports and be protected by steel sleeves. Design of guides and supports shall be such that no metal-to-metal contact exists between the casing and the carrier pipe. Insulation or non-metallic material used to ensure no metal to metal contact shall be designed to not be compressed by the weight of the carrier pipe when full of water.
- L. Field connection of casing sections shall be steel section conforming to casing specification, welded to casing sections, coated on all surfaces with system manufacturer's coating field repair compound, and covered with a 1.3 mm (0.05 inch) minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 80 degrees C (176 degrees F).
- M. Building wall penetrations shall provide steel leak plates welded to wall sleeves or to casings. Where a wall sleeve is utilized, allow sufficient annular space between the sleeve and the casing and install a watertight seal, rated for 121 degrees C (250 degrees F) minimum. Building walls cannot be used as anchor points.
- N. Provide sacrificial anode type cathodic protection system with dielectric isolation devices and test stations for all systems. Design system for 25 years of service, assume two percent bare metal. System shall comply with NACE SP0169.
- O. Provide embossed brass or stainless-steel tag hung by a brass or stainless-steel chain at each end of each casing or insulated piping in the building. The tag shall identify system

manufacturer's name, date of installation, government contract, and manufacturer's project number.

- P. Ensure the DDT manufacturer is responsible for the complete design of the DDT system, including, but not limited to, the product to be supplied, fabrication, installation, supervision, and testing of the system within the design parameters established by the contract documents, and in compliance with the detailed design. The complete design of the system shall be sealed by a Professional Engineer in the employ of the DDT manufacturer.
- Q. Furnish thermal expansion calculations for the piping using the design characteristics indicated in this section and installation temperature no higher than the ambient temperature at the site: 37.7 degrees C (100 degrees F).
- R. DDT manufacturer shall submit a complete description of the design and assembly of the system, materials of construction and field installation instructions. Include sufficient system details to show that the specified minimum insulation thickness has been met. A detailed design layout of the system (plan and elevation views) showing size, type, elevations and location of each component to be used in the system, the design and location of anchors, pipe guides, pipe supports, expansion loops, Z-bends, L-bends, end seals, leak plates, joint locations, pipe and insulation thickness and sizes, types, and movements, connection to manhole and building wall penetrations, and including, if applicable, details of transition point to aboveground or other type systems. Detailed design layout drawings shall be stamped by a registered Professional Engineer.
- S. Expansion Loops and Bends: Pipe-stress and system-expansion calculations for each expansion compensation elbow using a finite element computer generated 3-dimensional analysis (FEA). Demonstrate with calculations that pipe stresses from temperature changes are within the allowable requirements in ASME B31.1 and that the anchors and the guides will withstand the resultant forces. Detailed design layout drawings shall include all analysis node points. As a minimum, computer analysis results shall include node stresses, forces, moments and displacements. Calculations shall be stamped by a registered Professional Engineer in the employ of the DDT manufacturer.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost or time to the Government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- C. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- D. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (1 inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- F. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally, locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

- G. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- H. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- I. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.
- J. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
  - 1. Water treatment pot feeders and condenser water treatment systems.
  - 2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- K. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- L. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- M. Where copper piping is connected to steel piping, provide dielectric connections.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.9 and AWS B2.1/B2.1M. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Screwed: Threads shall conform to ASME B1.20.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

- D. Solvent Welded Joints: As recommended by the manufacturer.

### **3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)**

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding.

### **3.4 SEISMIC BRACING ABOVEGROUND PIPING**

- A. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.5 LEAK TESTING ABOVEGROUND PIPING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the COR. Tests may be either of those below, or a combination, as approved by the COR.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems, the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

### 3.6 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
- B. Initial Flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/s (5.9 f/s), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the COR.
- C. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/s (5.9 f/s). Circulate each section for not less than 4 hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
- D. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean

equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

### **3.7 WATER TREATMENT**

- A. Install water treatment equipment and provide water treatment system piping.
- B. Close and fill system as soon as possible after final flushing to minimize corrosion.
- C. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
- D. Utilize this activity, by arrangement with the COR, for instructing VA operating personnel.

### **3.8 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.
- D. Adjust red set hand on pressure gauges to normal working pressure.

### **3.9 DIRECT-BURIED SYSTEM INSTALLATION**

- A. The Contractor shall deliver, store, install and test the system as per manufacturer's recommendations. All work shall be in strict accordance with the requirements specified by the manufacturer. Printed instructions must be available on site prior to delivery of system components. Any changes required to the design and layout of the system due to site conditions must be approved in writing by the manufacturer and submitted for review by the COR
- B. Excavation, Trenching, and Backfilling: Perform all excavation, trenching, and backfilling as required by the system manufacturer's design. Beach sand or any sand with large



amounts of chlorides is prohibited. Install per manufacturers recommendations based on soil conditions. Foundation for system must be firm and stable. Foundation and backfill must be free from rocks. Concrete anchor and thrust blocks must be installed in undisturbed earth. Backfilling must not commence until elevations have been surveyed and accepted and system has been satisfactorily pressure tested and cleaned, including hydrostatic testing of carrier pipes and air testing of casings.

- C. Maintain constant slope of carrier pipes as specified. Prior to backfilling over the top of the casing, but after removal of temporary supports, Contractor shall measure and record elevations of top of casing in the trench. Elevations shall be taken at every field joint, 1/3 points along each pipe section, and at tops of elbows. These measurements shall be checked against contract drawings and shall confirm that the casing system has been installed to the elevations shown on the contract drawings unless approved by the COR. Slope shall be uniform within 0.1 percent. Measurements shall be recorded by the Contractor, accompanied with photo documentation of each piping with the elevation instrument reading visible, included in the direct-buried system manufacturer representative's daily report, and given to the COR prior to covering the top of the casing with backfill.
- D. Provide cathodic protection for all steel casing systems and all buried exposed metal. Provide dielectric pipe flanges and unions and isolation devices at all points necessary. Provide test stations at grade on each section of the piping system. Isolation flanges and unions shall be rated for the carrier pipe service temperature and pressure.
- E. Completely remove all dirt, scale, oil, coatings, and other foreign matter from inside the piping by use of a pipe swab, pipe "pig", brush, scrapers, or chemical cleaning before connecting pipe sections, valves, or fittings.
- F. Sections of system that have been fully or partially submerged in water must be replaced. Moisture content of insulation during installation shall not exceed five percent by weight.
- G. Provide reports to the COR that include:

1. Daily Written Report: Prepared daily and signed by the Contractor. Submit the original report to the COR two days after it is prepared. Provide one set of field pictures of work daily. Format shall be in digital PDF files and hardcopy printout. Digital files can be submitted through email, FTP, USB stick or CD.
2. Report Contents: State whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the manufacturer's recommendations, changes to drawings and specifications, any corrective action that was taken of the system, identify any conditions that could result in an unsatisfactory installation.
3. Report Certification: Daily reports are to be reviewed, signed and sealed by the Professional Engineer responsible for the system installation.
4. Report Submittals and Stop Order: Daily reports shall be submitted with the payment requests. All work must stop if daily reports are not furnished and requests for payments shall be denied if the daily reports are not furnished.
5. Certification of Compliance: Upon completion of the work and 30 days prior to final acceptance, deliver to COR a notarized Certificate of Compliance signed by principal officers of Contractor, stating that the installation is satisfactory and in accordance with plans, specifications, and manufacturer's instructions.
6. The Contractor shall retain copies of all the daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.

### **3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.11 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hour to instruct each VA personnel responsible in operation and maintenance of the system.

- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

--- E N D ---

**SECTION 23 21 23**  
**HYDRONIC PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Capacity: Liters per second (L/s) (Gallons per minute (gpm)) of the fluid pumped.  
Hydronic pumps for Heating, Ventilating and Air Conditioning.
- B. Definitions:
  - 1. Capacity: Liters per second (L/s) (Gallons per minute (gpm)) of the fluid pumped.
  - 2. Head: Total dynamic head in kPa (feet) of the fluid pumped.
  - 3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.
- C. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- H. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- I. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- J. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- K. Section 23 21 13, HYDRONIC PIPING.
- L. Section 26 29 11, MOTOR CONTROLLERS.

### 1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced.

The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.

- B. American Society of Mechanical Engineers (ASME):

B16.1-2015 ..... Cast Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

- C. American Society for Testing and Materials (ASTM):

A48/48M-2003(R2016)..... Standard Specification for Gray Iron Castings

B62-2017 ..... Standard Specification for Composition Bronze or Ounce Metal Castings

### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 21 23, HYDRONIC PUMPS", with applicable paragraph identification.

- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

1. Pumps and accessories.
2. Motors and drives.
3. Variable speed motor controllers.

- D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

- E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:

1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- F. Completed System Readiness Checklist 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 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

### **1.5 QUALITY ASSURANCE**

- A. Design Criteria:
1. Pumps design and manufacturer shall conform to Hydraulic Institute Standards.
  2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
  3. Head-capacity curves shall slope up to maximum head at shut-off. Curves shall be relatively flat for closed systems. Select pumps near the midrange of the curve, so the design capacity falls to the left of the best efficiency point, to allow a cushion for the usual drift to the right in operation, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
  4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
  5. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.

6. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in gpm and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
  7. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
  8. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.
- B. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:

1. As-built drawings are to be provided, with a copy of them on AutoCAD provided on CD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **1.7 SPARE MATERIALS**

- A. Furnish one spare seal and casing gasket for each pump to the COR.

## **PART 2 - PRODUCTS**

### **2.1 CENTRIFUGAL PUMPS, BRONZE FITTED**

- A. General:
  1. Provide pumps that will operate continuously without overheating bearings or motors at every condition of operation on the pump curve, or produce noise audible outside the room or space in which installed.
  2. Provide pumps of size, type and capacity as indicated, complete with electric motor and drive assembly, unless otherwise indicated. Design pump casings for the indicated working pressure and factory test at 1-1/2 times the designed pressure.



3. Provide pumps of the same type, the product of a single manufacturer, with pump parts of the same size and type interchangeable.
4. General Construction Requirements
  - a. Balance: Rotating parts, statically and dynamically.
  - b. Construction: To permit servicing without breaking piping or motor connections.
  - c. Pump Motors: Provide high efficiency motors, inverter duty for variable speed service. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT. Motors shall be TEFC and operate at 1750 RPM unless noted otherwise.
  - d. Heating pumps shall be suitable for handling water to 107 degrees C (225 degrees F).
  - e. Provide coupling guards that meet OSHA requirements.
  - f. Pump Connections: Flanged.
  - g. Pump shall be factory tested.
  - h. Performance: As scheduled on the Contract Drawings.
5. Variable Speed Pumps:
  - a. The pumps shall be the type shown on the drawings and specified herein flex coupled to a TEFC motor.
  - b. Variable Speed Motor Controllers: Refer to Section 26 29 11, MOTOR CONTROLLERS and to Section 23 05 11, COMMON WORK RESULTS FOR HVAC, VARIABLE SPEED MOTOR CONTROLLERS. Furnish controllers with pumps and motors.
  - c. Pump operation and speed control shall be as shown on the drawings.
  - d. Direct drive pumps with integrated variable frequency drive (VFD) utilizing the design pump curve programmed on board the built-in controller (also known as sensor-less, or self-sensing). Pump to comply with paragraphs in this section. VFD and motor to comply with Section 26 29 11, MOTOR CONTROLLERS and Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.

B. In-Line Type, Base Mounted End Suction or Double Suction Type:

1. Casing and Bearing Housing: Close-grained cast iron, ASTM A48/A48M.
2. Casing Wear Rings: Bronze.
3. Suction and Discharge: Plain face flange, 861 kPa (125 psig), ASME B16.1.
4. Casing Vent: Manual brass cock at high point.
5. Casing Drain and Gauge Taps: 15 mm (1/2 inch) plugged connections minimum size.
6. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft.
7. Shaft: Steel, Type 1045 or stainless steel.
8. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped.
9. Shaft Sleeve: Bronze or stainless steel.
10. Motor: Furnish with pump. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
11. Base Mounted Pumps:
  - a. Designed for disassembling for service or repair without disturbing the piping or removing the motor.
  - b. Impeller Wear Rings: Bronze.
  - c. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, bolted to the baseplate.
  - d. Bearings (Double-Suction pumps): Regreaseable ball or roller type.
  - e. Provide lip seal and slinger outboard of each bearing.
  - f. Base: Cast iron or fabricated steel for common mounting to a concrete base.
12. Provide line sized shut-off valve and suction strainer, maintain manufacturer recommended straight pipe length on pump suction (with blow down valve).

Contractor option: Provide suction diffuser as follows:

  - a. Body: Cast iron with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 5 mm (3/16 inch) diameter openings for pump protection. Provide taps for strainer blowdown and gauge connections.
  - b. Provide adjustable foot support for suction piping.

- c. Strainer free area: Not less than five times the suction piping.
- d. Provide disposable startup strainer.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Follow manufacturer's written instructions for pump mounting and startup.  
Access/Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.
- C. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.
- D. Coordinate location of thermometer and pressure gauges as per Section 23 21 13, HYDRONIC PIPING.

#### **3.2 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.
- D. Verify that the piping system has been flushed, cleaned and filled.
- E. Lubricate pumps before startup.
- F. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.

- G. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.
- H. Field modifications to the bearings and or impeller (including trimming) are prohibited. If the pump does not meet the specified vibration tolerance send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.
- I. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.
- J. After several days of operation, replace the disposable startup strainer with a regular strainer in the suction diffuser.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hour to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

--- E N D ---

**SECTION 23 25 00**  
**HVAC WATER TREATMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.
  - 1. Cleaning compounds.
  - 2. Chemical treatment for closed loop heat transfer systems.
  - 3. Glycol-water heat transfer systems.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- E. Section 23 21 13, HYDRONIC PIPING.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than 6 service calls and written status reports. Emergency calls are not included. Minimum service during construction/start-up shall be 6 hours.
- C. Chemicals: Chemicals shall be non-toxic approved by local authorities and meeting applicable EPA requirements.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data including:

1. Cleaning compounds and recommended procedures for their use.
  2. Chemical treatment for closed systems, including installation and operating instructions.
  - 3.
  4. Glycol-water system materials, equipment, and installation.
- C. Water analysis verification.
- D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.
- E. Maintenance and operating instructions in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

### **1.5 APPLICABLE PUBLICATIONS**

- A. The publication listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):  
70-2017 ..... National Electric Code (NEC)
- C. American Society for Testing and Materials (ASTM):  
F441/F441M-02-2018 ..... Standard Specification for Chlorinated Poly (Vinyl Chloride)  
(CPVC) Plastic Pipe, Schedules 40 and 80

## **PART 2 - PRODUCTS**

### **2.1 CLEANING COMPOUNDS**

- A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.
- B. All chemicals to be acceptable for discharge to sanitary sewer.
- C. Refer to Section 23 21 13, HYDRONIC PIPING, PART 3, for flushing and cleaning procedures.

## **2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS**

- A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.
- B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.
- C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

## **2.4 GLYCOL-WATER SYSTEM**

- A. Propylene glycol shall be inhibited with 1.75 percent dipotassium phosphate. Do not use automotive anti-freeze because the inhibitors used are not needed and can cause sludge precipitate that interferes with heat transfer.
- B. Provide required amount of glycol to obtain the percent by volume for glycol-water systems as follows and to provide one-half tank reserve supply: 40 percent for air handler hydronic system.
- C. Glycol-Water Make-up System:
  - 1. Glycol-Water storage tank: Self supporting polyethylene, minimum 90 mil thickness, with removable cover or black steel with 90 mil polyethylene insert. Capacity shall be 213 L (55 gallons), with approximate diameter of 584 mm (23 inches) and height of 914 mm (36 inches). Reinforced threaded pipe connections shall be provided for all connections. Provide identification for tank showing name of the contents.

2. Glycol-Water make-up pump: Bronze fitted, self-priming, high head type suitable for pumping a 33 percent to 50 percent glycol-water solution in intermittent service.  
The pump shall be provided with a mechanical shaft seal and be flange connected to a 1750 rpm NEMA type C motor. The pump capacity shall be 11 L/m (3 gpm) , 345 kPa (50 psig) discharge pressure with a suction lift capability of 127 mm (5 inches) of mercury, with a 2.5 kW (1/3 horsepower) drip-proof motor. The pump may be a "gear-within-a-gear" positive displacement type with built-in relief valve set for 296 kPa (43 psig), or the pump may be a regenerative turbine type providing self-priming with built-in or external relief valve set for design head of the pump.
3. Back pressure regulating valve: Spring loaded, diaphragm actuated type with bronze or steel body, stainless steel trim with capacity to relieve 100 percent of pump flow with an allowable rise in the regulated pressure of 69 kPa (10 psig) above the set point. Set point shall be 103 kPa (15 psig) above system PRV setting.
4. Low water level control: Steel or plastic float housing, stainless steel or plastic float, positive snap-acting SPST switch mechanism, rated 10 amps-120 volt AC, in General Purpose (NEMA 1) enclosure. The control shall be rated for pressures to 1034 kPa (150 psig) and make alarm circuit on low water level. The alarm circuit shall be wired to an alarm light on the nearest local Temperature Control panel (LTCP). Provide remote output relay to indicate alarm condition at the Building Control System specified under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

## **2.5 EQUIPMENT AND MATERIALS IDENTIFICATION**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.
- B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.



- C. Refer to Section 23 21 13 HYDRONIC PIPING for chemical treatment piping, installed as follows:
1. Provide a by-pass line around water meters and bleed off piping assembly. Provide ball valves to allow for bypassing, isolation, and servicing of components.
  2. Bleed off water piping with bleed off piping assembly shall be piped from pressure side of circulating water piping to a convenient drain. Bleed off connection to main circulating water piping shall be upstream of chemical injection nozzles.
  3. Provide piping for the flow assembly piping to the main control panel and accessories.
    - a. The inlet piping shall connect to the discharge side of the circulating water pump.
    - b. The outlet piping shall connect to the water piping serving the cooling tower downstream of the heat source.
    - c. Provide inlet Y-strainer and ball valves to isolate and service main control panel and accessories.
  4. Install injection nozzles with corporation stops in the water piping serving the cooling tower downstream of the heat source.
  5. Provide piping for corrosion monitor rack per manufacturer's installation instructions. Provide ball valves to isolate and service rack.
  6. Provide installation supervision, start-up and operating instruction by manufacturer's technical representative.
- D. Before adding cleaning chemical to the closed system, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils.
- E. Do not valve in or operate system pumps until after system has been cleaned.
- F. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.
- G. Perform tests and report results in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

- H. After cleaning is complete, and water PH is acceptable to manufacturer of water treatment chemical, add manufacturer-recommended amount of chemicals to systems.
- I. Instruct VA personnel in system maintenance and operation in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

--- E N D ---

**SECTION 23 31 00**  
**HVAC DUCTS AND CASINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Ductwork and accessories for HVAC including the following:
  - 1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
- B. Definitions:
  - 1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
  - 2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
  - 3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
  - 4. Exposed Duct: Exposed to view in a finished room, exposed to weather.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 07 84 00, FIRESTOPPING: Fire Stopping Material.
- C. Section 08 90 00, LOUVERS and VENTS: Outdoor and Exhaust Louvers.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Reinforcing.
- H. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General Mechanical Requirements.
- I. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Noise Level Requirements.
- J. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Testing and Balancing of Air Flows.
- K. Section 23 07 11, HVAC, and BOILER PLANT INSULATION: Duct Insulation.

- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Duct Mounted Instrumentation.
- M. Section 23 34 00, HVAC FANS: Return Air and Exhaust Air Fans.
- N. Section 23 36 00, AIR TERMINAL UNITS: Air Flow Control Valves and Terminal Units.
- P. Section 23 40 00, HVAC AIR CLEANING DEVICES: Air Filters and Filters' Efficiencies.
- T. Section 28 31 00, FIRE DETECTION and ALARM: Smoke Detectors.

### **1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Fire Safety Code: Comply with NFPA 90A.
- C. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
- D. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
- E. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Rectangular ducts:
    - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
    - b. Sealants and gaskets.
    - c. Access doors.
  - 2. Round and flat oval duct construction details:
    - a. Manufacturer's details for duct fittings.

- b. Sealants and gaskets.
    - c. Access sections.
    - d. Installation instructions.
  - 3. Volume dampers, back draft dampers.
  - 4. Upper hanger attachments.
  - 5. Fire dampers, fire doors, and smoke dampers with installation instructions.
  - 6. Sound attenuators, including pressure drop and acoustic performance.
  - 7. Flexible ducts and clamps, with manufacturer's installation instructions.
  - 8. Flexible connections.
  - 9. Instrument test fittings.
  - 10 Details and design analysis of alternate or optional duct systems.
  - 11 COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11-COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Civil Engineers (ASCE):
- ASCE7-2017 ..... Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
- A167-2009 ..... Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- A653-2019 ..... Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
- A1011-2018 ..... Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength

B209-2014 ..... Standard Specification for Aluminum and Aluminum-Alloy  
Sheet and Plate

C1071-2019 ..... Standard Specification for Fibrous Glass Duct Lining  
Insulation (Thermal and Sound Absorbing Material)

E84-2014 ..... Standard Test Method for Surface Burning Characteristics  
of Building Materials

D. National Fire Protection Association (NFPA):

90A-2018 ..... Standard for the Installation of Air Conditioning and  
Ventilating Systems

96-2018 ..... Standard for Ventilation Control and Fire Protection of  
Commercial Cooking Operations

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

3rd Edition –2006 ..... HVAC Duct Construction Standards, Metal and Flexible

2nd Edition -2012 ..... HVAC Air Duct Leakage Test Manual

6th Edition –2016 ..... Fibrous Glass Duct Construction Standards

F. Underwriters Laboratories, Inc. (UL):

181-2013 ..... Factory-Made Air Ducts and Air Connectors

555-2006 ..... Standard for Fire Dampers

555S-2014 ..... Standard for Smoke Dampers

## **PART 2 - PRODUCTS**

### **2.1 DUCT MATERIALS AND SEALANTS**

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards.

1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread, and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally, provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
3. Gaskets in Flanged Joints: Soft neoprene.

D. Approved factory-made joints may be used.

## **2.2 DUCT CONSTRUCTION AND INSTALLATION**

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
  - 0 to 50 mm (2 inch)
  - > 50 mm to 75 mm (2 inch to 3 inch)
  - > 75 mm to 100 mm (3 inch to 4 inch)Show pressure classifications on the floor plans.
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
  1. Elbows: Diameters 80 through 200 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.

2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
  3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
    - a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
    - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
  4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Resident Engineer.
- E. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches) wide by 1200 - 1350 mm (48 - 54 inches) high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.
- F. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.
- G. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

### **2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS**

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
1. Each duct mounted coil and humidifier.



2. Each fire damper (for link service), smoke damper and automatic control damper.
  3. Each duct mounted smoke detector.
  4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
  2. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

## **2.4 FIRE DAMPERS**

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2-hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless-steel construction, all others may be galvanized steel.
- C. Minimum requirements for fire dampers:
1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.
  2. Submit manufacturer's installation instructions conforming to UL rating test.

## **2.5 FLEXIBLE AIR DUCT**

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct

length shall not exceed 1.5 m (5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.

- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 200 mm (8 inches) in diameter shall be Class 1. Ducts 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm (foot) of straight duct, at 500 Hz, based on 150 mm (6 inch) duct, of 750 m/min (2500 fpm).
- D. Application Criteria:
  - 1. Temperature range: -18 to 93 degrees C (0 to 200 degrees F) internal.
  - 2. Maximum working velocity: 1200 m/min (4000 feet per minute).
  - 3. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.
- E. Duct Clamps: 100 percent nylon strap, 80 kg (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless-steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

## **2.6 FLEXIBLE DUCT CONNECTIONS**

- A. Where duct connections are made to fans, air terminal units, and air handling units, install a non-combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50

mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to ensure that no vibration is transmitted.

## **2.7 PREFABRICATED ROOF CURBS**

- A. Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

## **2.8 FIRESTOPPING MATERIAL**

- A. Refer to Section 07 84 00, FIRESTOPPING.

## **2.9 SEISMIC RESTRAINT FOR DUCTWORK**

- A. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

## **2.10 DUCT MOUNTED THERMOMETER (AIR)**

- A. Stem Type Thermometers: ASTM E1, 7-inch scale, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, brass stem, 2 percent of scale accuracy to ASTM E77 scale calibrated in degrees Fahrenheit.
- B. Thermometer Supports:
  - 1. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
  - 2. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

## **2.11 DUCT MOUNTED TEMPERATURE SENSOR (AIR)**

- A. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

## **2.12 INSTRUMENT TEST FITTINGS**

- A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.
- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC, particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
  - 1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
  - 2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
  - 3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.

4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- C. Install duct hangers and supports in accordance with SMACNA Standards.
- D. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Resident Engineer.
- E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- F. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 1.5 m (5 feet) long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hours. Support ducts SMACNA Standards.
- G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- H. Control Damper Installation:
  1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.

2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
  3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
  4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- I. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- J. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- K. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

### **3.2 DUCT LEAKAGE TESTS AND REPAIR**

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Resident Engineer on ductwork constructed to the 500 Pa (2" WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 500 Pa (2" WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.

- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual.  
The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Resident Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

### **3.4 TESTING, ADJUSTING AND BALANCING (TAB)**

- A. Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

### **3.5 OPERATING AND PERFORMANCE TESTS**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

--- E N D ---

**SECTION 23 34 00**  
**HVAC FANS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Fans for heating, ventilating and air conditioning.
- B. Product Definitions: AMCA Publication 99, Standard I-66.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- F. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- G. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- I. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.
- J. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Fans and power ventilators shall be listed in the current edition of AMCA 26I, and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
  - 1. Testing and Rating: AMCA 210.
  - 2. Sound Rating: AMCA 300.



- E. Vibration Tolerance for Fans and Power Ventilators: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Performance Criteria:
  - 1. The fan schedule shall show the design air volume and static pressure. Select the fan motor HP by increasing the fan BHP by 10 percent to account for the drive losses and field conditions.
  - 2. Select the fan operating point as follows:
    - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point
    - b. Air Foil, Backward Inclined, or Tubular: At or near the peak static efficiency
- G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.
- H. Corrosion Protection:
  - 1. Except for fans in fume hood exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.
  - 2. Fans for general purpose fume hoods, or chemical hoods, and radioisotope hoods shall be constructed of materials compatible with the chemicals being transported in the air through the fan.
- I. Spark resistant construction: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), the fan construction shall be as recommended by AMCA's Classification for Spark Resistant Construction. Drive set shall be comprised of non-static belts for use in an explosive.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturers Literature and Data:
  - 1. Fan sections, motors and drives.

2. Centrifugal fans, motors, drives, accessories and coatings.
  - a. In-line centrifugal fans.
- C. Certified Sound power levels for each fan.
- D. Motor ratings types, electrical characteristics and accessories.
- E. Belt guards.
- F. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- G. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.

### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Movement and Control Association International, Inc. (AMCA):
  - 99-2016 ..... Standards Handbook
  - 210-2016 ..... Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
  - 261-2017 ..... Directory of Products Licensed to bear the AMCA Certified Ratings Seal - Published Annually
  - 300-2014 ..... Reverberant Room Method for Sound Testing of Fans
- C. American Society for Testing and Materials (ASTM):
  - B117-2018 ..... Standard Practice for Operating Salt Spray (Fog) Apparatus
  - D1735-2008 ..... Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
  - D3359-2017 ..... Standard Test Methods for Measuring Adhesion by Tape Test
  - G152-2013 ..... Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
  - G153-2013 ..... Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials

D. National Fire Protection Association (NFPA):

NFPA 96-2018.....Standard for Ventilation Control and Fire Protection of  
Commercial Cooking Operations

E. National Sanitation Foundation (NSF):

37-2017 .....Air Curtains for Entrance Ways in Food and Food Service  
Establishments

F. Underwriters Laboratories, Inc. (UL):

181-2013 ..... Factory Made Air Ducts and Air Connectors

**1.6 EXTRA MATERIALS**

- A. Provide one additional set of belts for all belt-driven fans.

**PART 2 - PRODUCTS**

**2.1 FAN SECTION (CABINET FAN)**

- A. Refer to specification Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING  
UNITS.

**2.2 CENTRIFUGAL FANS**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record  
factory vibration test results on the fan or furnish to the Contractor.
- B. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA  
standards.
1. Housing: Low carbon steel, arc welded throughout, braced and supported by  
structural channel or angle iron to prevent vibration or pulsation, flanged outlet,  
inlet fully streamlined. Provide lifting clips, and casing drain. Provide manufacturer's  
standard access door. Provide 12.5 mm (1/2 inches) wire mesh screens for fan inlets  
without duct connections.
  2. Wheel: Steel plate with die formed blades welded or riveted in place, factory  
balanced statically and dynamically.
  3. Shaft: Designed to operate at no more than 70 percent of the first critical speed at  
the top of the speed range of the fans class.

4. Bearings: Heavy duty ball or roller type sized to produce a B10 life of not less than 50,000 hours, and an average fatigue life of 200,000 hours. Extend filled lubrication tubes for interior bearings or ducted units to outside of housing.
  5. Belts: Oil resistant, non-sparking and non-static.
  6. Belt Drives: Factory installed with final alignment belt adjustment made after installation.
  7. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15HP, fixed pitch for use with motors larger than 15HP. Select pulleys so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
  8. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for specifications. Provide protective sheet metal enclosure for fans located outdoors.
  9. Furnish variable speed fan motor controllers where shown on the drawings. Refer to Section 26 29 11, MOTOR STARTERS. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for controller/motor combination requirements.
- C. In-line Centrifugal Fans: In addition to the requirements of paragraphs A and 2.2.C3 thru 2.2.C9, provide minimum 18 Gauge galvanized steel housing with inlet and outlet flanges, backward inclined aluminum centrifugal fan wheel, bolted access door and supports as required. Motors shall be factory pre-wired to an external junction box. Provide factory wired disconnect switch.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install fan, motor and drive in accordance with manufacturer's instructions.
- B. Align fan and motor sheaves to allow belts to run true and straight.
- C. Bolt equipment to curbs with galvanized lag bolts.
- D. Install vibration control devices as shown on drawings and specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

### **3.2 PRE-OPERATION MAINTENANCE**

- A. Lubricate bearings, pulleys, belts and other moving parts with manufacturer recommended lubricants.
- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.
- C. Clean fan interiors to remove foreign material and construction dirt and dust.

### **3.3 START-UP AND INSTRUCTIONS**

- A. Verify operation of motor, drive system and fan wheel according to the drawings and specifications.
- B. Check vibration and correct as necessary for air balance work.
- C. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

--- E N D ---

**SECTION 23 36 00**  
**AIR TERMINAL UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air terminal units, air flow control valves.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- E. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- G. Section 23 31 00, HVAC DUCTS and CASINGS.
- H. Section 23 82 16, AIR COILS.

**1.3 QUALITY ASSURANCE**

- A. Refer to Article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Air Terminal Units: Submit test data.
  - 2. Air flow control valves.
- C. Certificates:
  - 1. Compliance with Article, QUALITY ASSURANCE.
  - 2. Compliance with specified standards.
- D. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.

## 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced.

The publications are referenced in the text by the basic designation only.

- B. Air Conditioning and Refrigeration Institute (AHRI)/(ARI):

880-2017 ..... Performance Rating of Air Terminals

- C. National Fire Protection Association (NFPA):

90A-2021 ..... Standard for the Installation of Air Conditioning and

Ventilating Systems

- D. Underwriters Laboratories, Inc. (UL):

181-2013 ..... Standard for Factory-Made Air Ducts and Air Connectors

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

C 665-2017 ..... Standard Specification for Mineral-Fiber Blanket Thermal

Insulation for Light Frame Construction and Manufactured

Housing

## 1.6 GUARANTY

- A. In accordance with the GENERAL CONDITIONS

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Coils:

2. All Air-Handling Units: Provide aluminum fins and copper coils for all hot water reheat coils.

3. Water Heating Coils:

a. ARI certified, continuous plate or spiral fin type, leak tested at 2070 kPa (300 PSI).

b. Capacity: As indicated, based on scheduled entering water temperature.

c. Headers: Copper or Brass.

d. Fins: Aluminum, maximum 315 fins per meter (8 fins per inch).

e. Tubes: Copper, arrange for counter-flow of heating water.

f. Water Flow Rate: Minimum 0.032 Liters/second (0.5 GPM).

- g. Provide vent and drain connection at high and low point, respectively of each coil.
  - h. Coils shall be guaranteed to drain.
- B. Labeling: Control box shall be clearly marked with an identification label that lists such information as nominal CFM, maximum and minimum factory-set airflow limits, coil type and coil connection orientation, where applicable.
- C. Factory calibrate air terminal units to air flow rate indicated. All settings including maximum and minimum air flow shall be field adjustable.
- D. Dampers with internal air volume control: See section 23 31 00 HVAC DUCTS and CASINGS.
- E. Terminal Sound Attenuators: See Section 23 31 00 HVAC DUCTS and CASINGS.

## **2.2 AIR TERMINAL UNITS (BOXES)**

- A. General: Factory built, pressure independent units, factory set-field adjustable air flow rate, suitable for single duct applications. Use of dual-duct air terminal units is not permitted. Clearly show on each unit the unit number and factory set air volumes corresponding to the contract drawings. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC work assumes factory set air volumes. Coordinate flow controller sequence and damper operation details with the drawings and Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. All air terminal units shall be brand new products of the same manufacturer.
- B. Capacity and Performance: The Maximum Capacity of a single terminal unit shall not exceed 566 Liters/second (2,200 CFM) with the exception of operating rooms and Cystoscopy rooms, which shall be served by a single air terminal unit at a maximum of 1,250 Liters/second (3,000 CFM).
- C. Sound Power Levels:
  - 1. Acoustic performance of the air terminal units shall be based on the design noise levels for the spaces stipulated in Section 23 05 41 (Noise and Vibration Control for HVAC Piping and Equipment). Equipment schedule (Single Duct Reheat Terminal



Unit) shall show the discharge and radiated NC levels. Terminal sound attenuators shall be provided, as required, to meet the intent of the design.

D. Casing: Unit casing shall be constructed of galvanized steel no lighter than 0.85 mm (22 Gauge). Air terminal units serving the operating rooms and Cystoscopy rooms shall be fabricated without lining. Provide hanger brackets for attachment of supports.

1. Lining material: Suitable to provide required acoustic performance, thermal insulation and prevent sweating. Meet the requirements of NFPA 90A and comply with UL 181 for erosion as well as ASTM C 665 antimicrobial requirements.

Insulation shall consist of 13 mm (1/2 IN) thick non-porous foil faced rigid fiberglass insulation of 4-lb/cu.ft, secured by full length galvanized steel z-strips which enclose and seal all edges. Tape and adhesives shall not be used. Materials shall be non-friable and with surfaces, including all edges, fully encapsulated and faced with perforated metal or coated so that the air stream will not detach material. No lining material is permitted in the boxes serving operating rooms and Cystoscopy rooms.

2. Access panels (or doors): Provide panels large enough for inspection, adjustment and maintenance without disconnecting ducts, and for cleaning heating coils attached to unit, even if there are no moving parts. Panels shall be insulated to same standards as the rest of the casing and shall be secured and gasketed airtight. It shall require no tool other than a screwdriver to remove.
3. Total leakage from casing: Not to exceed 2 percent of the nominal capacity of the unit when subjected to a static pressure of 750 Pa (3 inch WG), with all outlets sealed shut and inlets fully open.
4. Octopus connector: Factory installed, lined air distribution terminal. Provide where flexible duct connections are shown on the drawings connected directly to terminals. Provide butterfly-balancing damper, with locking means in connectors with more than one outlet. Octopus connectors and flexible connectors are not permitted in the Surgical Suite.

E. Construct dampers and other internal devices of corrosion resisting materials which do not require lubrication or other periodic maintenance.

1. Damper Leakage: Not greater than 2 percent of maximum rated capacity, when closed against inlet static pressure of 1 kPa (4 inch WG).
- F. Provide multi-point velocity pressure sensors with external pressure taps.
  1. Provide direct reading air flow rate table pasted to box.
- G. Provide static pressure tubes.
- H. Externally powered DDC variable air volume controller and damper actuator to be furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for factory mounting on air terminal units. The DDC controller shall be electrically actuated.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- B. Handle and install units in accordance with manufacturer's written instructions.
- C. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.
- D. Locate air terminal units to provide a straight section of inlet duct for proper functioning of volume controls. See VA Standard Detail.

#### **3.2 OPERATIONAL TEST**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

--- E N D ---

**SECTION 23 37 00**  
**AIR OUTLETS AND INLETS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- E. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

**1.3 QUALITY ASSURANCE**

- A. Refer to Article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Fire Safety Code: Comply with NFPA 90A.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Air intake/exhaust hoods.
  - 2. Diffusers, registers, grilles and accessories.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Diffusion Council Test Code:
  - 1062 GRD-2015 ..... Certification, Rating, and Test Manual 4<sup>th</sup> Edition

C. American Society of Civil Engineers (ASCE):

ASCE7-2017 ..... Minimum Design Loads for Buildings and Other Structures

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

A167-99 2009 ..... Standard Specification for Stainless and Heat-Resisting  
Chromium-Nickel Steel Plate, Sheet and Strip

B209- 2014 ..... Standard Specification for Aluminum and Aluminum-Alloy  
Sheet and Plate

E. National Fire Protection Association (NFPA):

90A-2018..... Standard for the Installation of Air Conditioning and  
Ventilating Systems

F. Underwriters Laboratories, Inc. (UL):

181-2013 ..... UL Standard for Safety Factory-Made Air Ducts and  
Connectors

## **PART 2 - PRODUCTS**

### **2.1 AIR OUTLETS AND INLETS**

A. Materials:

1. Steel or aluminum. Provide manufacturer's standard gasket.
2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.

B. Performance Test Data: In accordance with Air Diffusion Council Code 1062GRD. Refer to Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT for NC criteria.

C. Air Supply Outlets:

1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, off-white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.

- a. Square, louver, fully adjustable pattern: Round neck, surface mounting unless shown otherwise on the drawings. Provide equalizing or control grid and volume control damper.
- b. Louver face type: Square or rectangular, removable core for 1, 2, 3, or 4 way directional pattern. Provide equalizing or control grid and opposed blade damper.
- c. Perforated face type: Manual adjustment for one-, two-, three-, or four-way horizontal air distribution pattern without change of air volume or pressure. Provide equalizing or control grid and opposed blade over overlapping blade damper. Perforated face diffusers for VAV systems shall have the pattern controller on the inner face, rather than in the neck and designed to discharge air horizontally at the ceiling maintaining a Coanda effect.
- d. Slot diffuser/plenum:
  - 1) Diffuser: Frame and support bars shall be constructed of heavy gauge extruded aluminum. Form slots or use adjustable pattern controllers, to provide stable, horizontal air flow pattern over a wide range of operating conditions.
  - 2) Galvanized steel boot lined with 13 mm (1/2 inch) thick fiberglass conforming to NFPA 90A and complying with UL 181 for erosion. The internal lining shall be factory-fabricated, anti-microbial, and non-friable.
  - 3) Provide inlet connection diameter equal to duct diameter shown on drawings or provide transition coupling if necessary. Inlet duct and plenum size shall be as recommended by the manufacturer.
  - 4) Maximum pressure drop at design flow rate: 37 Pa  
(0.15 inch W.G.)
- 4. Supply Registers: Double deflection type with horizontal face bars and opposed blade damper with removable key operator.
  - a. Margin: Flat, 30 mm (1-1/4 inches) wide.
  - b. Bar spacing: 20 mm (3/4 inch) maximum.

- c. Finish: Off white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded with manufacturer's standard finish.
- 5. Supply Grilles: Same as registers but without the opposed blade damper.
- D. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.
  - 1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish.
  - 2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin.
  - 3. Perforated Face Type: To match supply units.
  - 4. Grid Core Type: 13 mm by 13 mm (1/2 inch by 1/2 inch) core with 30 mm (1-1/4 inch) margin.
  - 5. Linear Type: To match supply units.
  - 6. Door Grilles: Are furnished with the doors.
  - 7. Egg Crate Grilles: Aluminum or Painted Steel 1/2 by 1/2 by 1/2 inch grid providing 90% free area.
    - a. Heavy extruded aluminum frame shall have countersunk screw mounting.  
Unless otherwise indicated, register blades and frame shall have factory applied white finish.
    - b. Grille shall be suitable for duct or surface mounting as indicated on drawings. All necessary appurtenances shall be provided to allow for mounting.
- E. Supply Registers in Psychiatric Rooms: Supply air registers shall be security type, steel with perforated faceplate, flat surface margin, extension sleeve, opposed blade damper and back mounting flanges. Faceplate shall be 5 mm (3/16 inch) (minimum) with 5x5 mm holes on 7 mm (3/16 by 3/16 inch holes on 9/32 inch) spacing and a minimum free area of 45 percent. Wall sleeve shall be 5 mm (3/16 inch) thick (minimum).

- F. Air Inlet Registers in Psychiatric Rooms: Return, exhaust, transfer and relief air registers shall be security type, steel with perforated faceplate, flat surface margin, wall sleeve, opposed blade damper and back mounting flanges. Faceplate shall be 5 mm (3/16 inch) (minimum) with 5x5 mm holes on 7 mm (3/16 by 3/16 inch holes on 9/32 inch) spacing and a minimum free area of 45 percent. Wall sleeve shall be 5 mm (3/16 inch) thick (minimum).
- G. Acoustic Transfer Grille: Aluminum, suitable for partition or wall mounting.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Protection and Cleaning: Protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

#### **3.3 TESTING, ADJUSTING AND BALANCING (TAB)**

Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

#### **3.4 OPERATING AND PERFORMANCE TESTS**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

--- E N D ---

**SECTION 23 74 13**  
**PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Roof top air handling units including integral components specified herein.
- B. Definitions: Roof Top Air Handling Unit(Roof Top Units, RTU): A factory fabricated assembly consisting of fan, coils, filters, and other necessary equipment to perform one or more of the following functions of circulating, cleaning, heating, cooling, and mixing of air. Design capacities of units shall be as scheduled on the drawings.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- F. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- G. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- H. Section 23 07 11, HVAC and BOILER PLANT INSULATION.
- I. Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- K. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.
- L. Section 23 31 00, HVAC DUCTS and CASINGS.
- M. Section 23 34 00, HVAC FANS.
- N. Section 23 40 00, HVAC AIR CLEANING DEVICES.
- O. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.



### **1.3 QUALITY ASSURANCE**

- A. Refer to Article, Quality Assurance, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Air Handling Units Certification
  - 1. Air Handling Units with Housed Centrifugal Fans: The air handling units shall be certified in accordance with AHRI 430 and tested/rated in accordance with AHRI 260.
  - 2. Air Handling Units with Plenum Fans:
    - a. Air Handling Units with a single Plenum Fan shall be certified in accordance with AHRI 430 and tested/rated in accordance with AHRI 260.
    - b. Air handling Units with Multiple Fans in an Array shall be tested and rated in accordance with AHRI 430 and AHRI 260.
- C. Heating, Cooling, and Air Handling Capacity and Performance Standards: AHRI 410, AHRI 430, ASHRAE 51, and AMCA 210.
- D. Performance Criteria:
  - 1. The fan BHP shall include all system effects for all fans and v-belt drive losses for housed centrifugal fans.
  - 2. The fan motor shall be selected within the rated nameplate capacity, without relying upon NEMA Standard Service Factor.
  - 3. Select the fan operating point as follows:
    - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point.
    - b. Air Foil, Backward Inclined, or Tubular Fans Including Plenum Fans: At or near the peak static efficiency but at an appropriate distance from the stall line.
  - 4. Operating Limits: AMCA 99 and Manufacturer's Recommendations.
- E. Units shall be factory-fabricated, assembled, and tested by a manufacturer, in business of manufacturing similar air-handling units for at least five (5) years.

### **1.4 SUBMITTALS:**

- A. The contractor shall, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish a complete submission for all roof top units covered in the

project. The submission shall include all information listed below. Partial and incomplete submissions shall be rejected without reviews.

B. Manufacturer's Literature and Data:

1. Submittals for RTUs shall include fans, drives, motors, coils, mixing box with outside/return air dampers, filter housings, and all other related accessories. The contractor shall provide custom drawings showing total air handling unit assembly including dimensions, operating weight, access sections, , flexible connections, door swings, controls penetrations, electrical disconnect, lights, duplex receptacles, switches, wiring, utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc) and rigging points.
2. Submittal drawings of section or component only, will not be acceptable. Contractor shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details; if the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements. This data shall be submitted in hard copies and in electronic version compatible to AutoCAD version used by the VA at the time of submission.
3. Submit sound power levels in each octave band for fan and at entrance and discharge of RTUs at scheduled conditions. Include sound attenuator capacities and itemized internal component attenuation. Internal lining of supply air ductwork with sound absorbing material is not permitted. In absence of sound power ratings refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
4. Provide fan curves showing Liters/Second (cubic feet per minute), static pressure, efficiency, and horsepower for design point of operation and at maximum design Liters/Second (cubic feet per minute) and 110 percent of design static pressure.

5. Submit total fan static pressure, external static pressure, for RTU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air handling unit schedule on drawings.
- C. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS. Include instructions for lubrication, filter replacement, motor and drive replacement, spare part lists, and wiring diagrams.
- D. Submit written test procedures two weeks prior to factory testing. Submit written results of factory tests for approval prior to shipping.
- E. 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.
- F. Submit shipping information that clearly indicates how the units will be shipped in compliance with the descriptions below.
  1. Units shall be shipped in one (1) piece where possible and in shrink wrapping to protect the unit from dirt, moisture and/or road salt.
  2. If not shipped in one (1) piece, provide manufacturer approved shipping splits where required for installation or to meet shipping and/or job site rigging requirements in modular sections. Indicate clearly that the shipping splits shown in the submittals have been verified to accommodate the construction constraints for rigging as required to complete installation and removal of any section for replacement through available access without adversely affecting other sections.
  3. If shipping splits are provided, each component shall be individually shrink wrapped to protect the unit and all necessary hardware (e.g. bolts, gaskets etc.) will be included to assemble unit on site (see section 2.1.A4).
  4. Lifting lugs will be provided to facilitate rigging on shipping splits and joining of segments. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements.

## 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced.

The publications are referenced in the text by the basic designation only.

- B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

260-2017 ..... Sound Rating of Ducted Air Moving and Conditioning  
Equipment

410-2001 ..... Standard for Forced-Circulation Air-Heating and Air-  
Cooling Coils

430-2020 ..... Standard for Central Station Air Handling Units

DCAACP2008 ..... Directory of Certified Applied Air Conditioning Products

- C. Air Moving and Conditioning Association (AMCA):

210-2016 ..... Laboratory Methods of Testing Fans for Rating

- D. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):

9-2015 ..... Load Ratings and Fatigue life for Ball Bearings

- E. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):

51-2016 ..... Laboratory Methods of Testing Fans for Rating

- F. American Society for Testing and Materials (ASTM):

A653/653M-2020 ..... Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-  
Coated (Galvannealed) by the Hot-Dip Process

B117-2019 ..... Salt Spray (Fog) Testing

C1071-2019 ..... Standard Specification for Fibrous Glass Duct Lining  
Insulation (Thermal and Sound Absorbing Material)

D1654-2016 ..... Standard Method for Evaluation of Painted or Coated  
Specimens Subjected to Corrosive Environments

D1735-2014 ..... Water Resistance of Coatings Using Water Fog Apparatus

D3359-2017 ..... Standard Test Methods for Measuring Adhesion by Tape  
Test

E84-2014 ..... Standard Test Method for Surface Burning Characteristics  
of Building Materials

G. Military Specifications (Mil. Spec.):

DOD-P-21035A-2014 ..... Paint, High Zinc Dust Content, Galvanizing Repair

H. National Fire Protection Association (NFPA):

90A-2018 ..... Standard for Installation of Air Conditioning and  
Ventilating Systems, 2009

I. Energy Policy Act of 2005 (P.L.109-58)

**PART 2 - PRODUCTS**

**2.1 ROOF TOP AIR HANDLING UNITS**

A. General:

1. Roof top units (RTU) shall be fabricated from insulated, solid double-wall galvanized steel without any perforations in draw-through configuration. Casing is specified in paragraph 2.1.C. Galvanizing shall be hot dipped conforming to ASTM A525 and shall provide a minimum of 0.275 kg of zinc per square meter (0.90 oz. of zinc per square foot) (G90). Aluminum constructed units may be provided subject to VA approval and documentation that structural rigidity is equal or greater than the galvanized steel specified.
2. The contractor and the RTU manufacturer shall be responsible for insuring that the unit will not exceed the allocated space shown on the drawings, including required clearances for service and future overhaul or removal of unit components. All structural, piping, wiring, and ductwork alterations of units, which are dimensionally different than those specified, shall be the responsibility of the contractor at no additional cost to the government.
3. RTUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown on the drawings. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to

- accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit.
4. The RTU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements noted on the drawings. Provide documentation that this representative has provided this service on similar jobs to the Contracting Officer. If a local representative cannot be provided, the manufacturer shall provide a factory representative.
  5. Gaskets: All door and casing and panel gaskets and gaskets between air handling unit components, if joined in the field, shall be high quality which seal air tight and retain their structural integrity and sealing capability after repeated assembly and disassembly of bolted panels and opening and closing of hinged components. Bolted sections may use a more permanent gasketing method provided they are not disassembled.
  6. Structural Rigidity: Provide structural reinforcement when required by span or loading so that the deflection of the assembled structure shall not exceed 1/200 of the span based on a differential static pressure of 1991 Pa (8 inches water gage) or higher.
- B. Base:
1. Provide a heavy duty steel base for supporting all major RTU components. Bases shall be constructed of wide-flange steel I-beams, channels, or minimum 125 mm (5 inch) high 3.5 mm (10 Gauge) steel base rails. Welded or bolted cross members shall be provided as required for lateral stability.
  2. RTUs shall be completely self supporting for installation on roof curb.
  3. The RTU bases not constructed of galvanized material shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.

C. Casing (including wall, floor and roof):

1. General: RTU casing shall be entirely double wall insulated panels, integral of or attached to a structural frame. Construction shall be such that removal of any panel shall not affect the structural integrity of the unit. Casing finished shall meet salt-spray test as specified in paragraph 2.1.C.10. All casing and panel sections shall be tightly butted and gasketed. No gaps of double wall construction will be allowed where panels bolt to air handling unit structural member. Structural members, not covered by the double wall panels, shall have equivalent insulated double wall construction.
2. Double wall galvanized steel panels, minimum 51 mm (2 inches) thick, constructed to limit wall, roof and floor deflection to not exceed an  $L/240$  ratio when the unit casing is pressurized to  $(\pm 1245 \text{ Pa } (\pm 5 \text{ in. w.g.}))$ . Deflection shall be measured at the midpoint of the panel height. Total housing leakage shall not exceed 1% of rated cfm when the unit casing is pressurized to  $\pm 5 \text{ in. w.g. } (\pm 1245 \text{ Pa})$ . The outer (skin) and inner panels shall be solid.
3. Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.
4. Insulation: Insulation shall be injected CFC free foam encased in double-wall casing between exterior and interior panels such that no insulation can erode to the air stream. Insulation shall be 50 mm (2 inch) thick, and  $48 \text{ kg/m}^3$  ( $3.0 \text{ lb/ft}^3$ ) density with a total thermal resistance (R-value) of approximately  $2.3 \text{ m.K/W}$  ( $13.0 \text{ hr-ft}^2 \text{ } ^\circ\text{F/BTU}$ ). Units with less than 50 mm (2 inch) of insulation in any part of the walls, floor, roof or drain pan shall not be acceptable. The insulation shall comply with NFPA 90-A for the flame and smoke generation requirements. Also, refer to specification Section 23 07 11, HVAC and BOILER PLANT INSULATION.

Table 2.1.C.4

Outer Panel	0.8 mm (22 Gage) Minimum
Inner Panel	0.8 mm (22 Gage) Minimum

Insulation	Foam
Thickness	50 mm (2 inch) Minimum
Density	48 kg/m <sup>3</sup> (3.0 lb/ft <sup>3</sup> ) Minimum
Total R Value	2.3 m <sup>2</sup> .K/W (13.0 ft <sup>2</sup> .°F.hr/Btu) Minimum

5. The thickness of insulation, mode of application, and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU.
6. Casing panels shall be secured to the support structure with stainless steel or zinc-chromate plated screws and gaskets installed around the panel perimeter. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are not acceptable.
7. Access Doors: Provide in each access section and where shown on drawings. Show single-sided and double-sided access doors with door swings on the floor plans. Doors shall be a minimum of 50 mm (2 inches) thick with same double wall construction as the unit casing. Doors shall be a minimum of 600 mm (24 inches) wide, unless shown of different size on drawings, and shall be the full casing height up to a maximum of 1850 mm (6 feet). Doors shall be gasketed, hinged, and latched to provide an airtight seal. The access doors for fan section, mixing box, coil section shall include a minimum 150 mm x 150 mm (6 inch x 6 inch) double thickness, with air space between glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.
  - a. Hinges: Manufacturers standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 pound) weight hung on latch side of door.
  - b. Latches: Non-corrosive alloy construction, with operating levers for positive cam action, operable from either inside or outside. Doors that do not open against unit operating pressure shall allow the door to ajar and then require



- approximately 0.785 radian (45 degrees) further movement of the handle for complete opening. Latch shall be capable of restraining explosive opening of door with a force not less than 1991 Pa (8 inches water gage).
- c. Gaskets: Neoprene, continuous around door, positioned for direct compression with no sliding action between the door and gasket. Secure with high quality mastic to eliminate possibility of gasket slipping or coming loose.
8. Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring and pneumatic tubing. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights, switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting may be provided in the factory or in the field. All field penetrations shall be performed neatly by drilling or saw cutting. No cutting by torches will be allowed. Neatly seal all openings airtight.
9. Roof of the unit shall be sloped to have a minimum pitch of 1/4 inch per foot. The roof shall overhang the side panels by a minimum of three inches to prevent precipitation drainage from streaming down the unit side panels.
10. Casing finished shall meet ASTM B117, 500-hour salt spray test, using 20 percent sodium chloride solution. Immediately after completion of the test, the coating shall show no sign of blistering, wrinkling, or cracking, no loss of adhesion, and the specimen shall show no sign of rust creepage beyond 1/8-inch on either side of scratch mark.
- D. Unit floor shall be level without offset space or gap and designed to support a minimum of 488 kg/square meter (100 pounds per square foot) distributed load without permanent deformation or crushing of internal insulation. Provide adequate structural base members beneath floor in service access sections to support typical service foot traffic and to prevent damage to unit floor or internal insulation. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.

- E. Condensate Drain Pan: Drain pan shall be designed to extend entire length of cooling coils including headers and return bends. Depth of drain pan shall be at least 43 mm (1.7 inches) and shall handle all condensate without overflowing. Drain pan shall be double wall construction, Type 304 stainless steel and have a minimum of 50 mm (2 inch) insulation, and shall be sloped to drain. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
1. An intermediate condensate drip pan shall be provided on stacked cooling coils and shall be constructed of type 304 stainless steel with copper downspouts factory piped to main condensate pan. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
  2. Drain pan shall be piped to the exterior of the unit. Drain pan shall be readily cleanable.
  3. Installation, including frame, shall be designed and sealed to prevent blow-by.
- F. Plenum Fans –Multiple Fans in an Array
1. General: Fans shall be Class II (minimum) construction with single inlet, aluminum wheel and stamped air-foil aluminum bladed. The fan wheel shall be mounted on the directly-driven motor shaft in AMCA Arrangement 4. Fans shall be dynamically balanced and internally isolated to minimize the vibrations. Provide a steel inlet cone for each wheel to match with the fan inlet. Locate fan in the air stream to assure proper flow. The fan performance shall be rated in accordance with AMCA 210 or ASHRAE 51.
  2. Allowable vibration tolerances for fan shall not exceed a self-excited vibration maximum velocity of 0.005 m/s (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions. After field installation, compliance to this requirement shall be

- demonstrated with field test in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT and Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC. The fan wheel shall meet or exceed guidelines in AMCA 801-92 for dynamic balancing requirements. The complete fan assembly balance shall be tested using an electronic balance analyzer with a tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 axial).
3. The plenum fans shall be driven by variable speed drives with at least one back-up drive as shown in the design documents. Use of a drive with bypass is not permitted.
  4. Multiple fans shall be installed in a pre-engineered structural frame to facilitate fan stacking. All fans shall modulate in unison, above or below the synchronous speed within the limits specified by the manufacturer, by a common control sequence. Staging of the fans is not permitted. Redundancy requirement shall be met by all operating fans in an array and without the provision of an idle standby fan.
  5. Fan Accessories
    - a. Fan Isolation: Provide an automatic back draft damper to isolate the fan not in operation due to failure.
    - b. Fan Airflow Measurement: Provide an airflow measuring device integral to the fan to measure air volume within +/- 5 percent accuracy. The probing device shall not be placed in the airflow path to stay clear of turbulence and avoid loss of performance.
  6. Fan Motor, Drive and Mounting Assembly: Fan Motors shall be premium energy efficient type, as mandated by the Energy Policy Act of 2005, with efficiencies as shown in the Specifications Section 23 05 12 GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMNT, on drawings and suitable for use in variable frequency drive applications. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC, for additional motor and drive specifications. Refer to Specification Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS

- G. Mixing Boxes: Mixing box shall consist of casing and outdoor air and return air dampers in opposed blade arrangement with damper linkage for automatic operation.
- Coordinate damper operator with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Dampers shall be of ultra-low leak design with metal compressible bronze jamb seals and extruded vinyl edge seals on all blades. Blades shall rotate on stainless steel sleeve bearings or bronze bushings. Leakage rate shall not exceed 1.6 cubic meters/min/square meter (5 cfm per square foot) at 250 Pa (1 inch water gage) and 2.8 cubic meters/min/square meter (9 cfm per square foot) at 995 Pa (4 inches water gage) Electronic damper operators shall be furnished and mounted in an accessible and easily serviceable location by the air handling unit manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- H. Filter Section: Refer to Section 23 40 00, HVAC AIR CLEANING DEVICES, for filter requirements.
1. Filters including one complete set for temporary use at site shall be provided independent of the RTU. The RTU manufacturer shall install filter housings and racks in filter section compatible with filters furnished. The RTU manufacturer shall be responsible for furnishing temporary filters (pre-filters and after-filters, as shown on drawings) required for RTU testing.
  2. Factory-fabricated filter section shall be of the same construction and finish as the RTU casing including filter racks and hinged double wall access doors. Filter housings shall be constructed in accordance with side service or holding frame housing requirements in Section 23 40 00, HVAC AIR CLEANING DEVICES.
- I. Coils: Coils shall be mounted on hot dipped galvanized steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing adjacent coil. Cooling coils shall be designed and installed to insure no condensate carry over. Provide factory installed extended supply, return,

drain, and vent piping connections. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements.

1. Water Coils, Including Glycol-Water.

J. Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.

1. Vapor-proof lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, mixing box, and any section over 300mm (12 inch) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective compartment access door. Wiring between switches and lights shall be factory installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt - one phase connection at junction box.
2. Install compatible 100 watt bulb in each light fixture.
3. Provide a convenience duplex weatherproof receptacle next to the light switch.
4. Disconnect switch and power wiring: Provide factory or field mounted disconnect switch. Coordinate with Division 26, ELECTRICAL.

K Low-voltage VARIABLE SPEED MOTOR CONTROLLERS (VSMC)

1. VSMC shall be electronic, with adjustable frequency and voltage, three phase output, capable of driving standard NEMA B three-phase induction motors at full rated speed. The control technique shall be pulse width modulation (PWM), where the VSMC utilizes a full wave bridge design incorporating diode rectifier circuitry. Silicon controlled rectifiers or other control techniques are not acceptable.
2. VSMC shall be suitable for variable torque loads, and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.
3. VSMC shall be capable of operating within voltage parameters of plus 10 to minus 15 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.

4. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
5. The displacement power factor of the VSMC shall not be less than 95 percent under any speed or load condition.
6. VSMC current and voltage harmonic distortion shall not exceed the values allowed by IEEE 519.
7. Operating and Design Conditions:
  - a. Elevation: 2710 feet Above Mean Sea Level (AMSL)
  - b. Temperatures: Maximum +90°F Minimum -10°F
  - c. Relative Humidity: 95%
  - d. VSMC Location: Air conditioned space
8. VSMC shall have the following features:
  - a. Isolated power for control circuits.
  - b. Manually resettable overload protection for each phase.
  - c. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
  - d. independent acceleration and deceleration time adjustment, manually adjustable from 2 to 2000 seconds. Set timers to the equipment manufacturer's recommended time in the above range.
  - e. Control input circuitry that will accept 4 to 20 mA current or 0-10 VDC voltage control signals from an external source.
  - f. Automatic frequency adjustment from 1 Hz to 300 Hz.
  - g. Circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The VSMC shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The VSMC shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
    - (1. Incorrect phase sequence.
    - (2. Single phasing.

- (3 Overvoltage in excess of 10 percent.
- (4 Undervoltage in excess of 15 percent.
- (5 Running overcurrent above 110 percent (VSMC shall not automatically reset for this condition.)
- (6 Instantaneous overcurrent above 150 percent (VSMC shall not automatically reset for this condition).
- (7 Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
- h. Automatic Reset/Restart: Attempt three restarts after VSMC fault or on return of power after an interruption and before shutting down for manual reset or fault correction, with adjustable delay time between restart attempts.
- i. Bidirectional Autospeed Search: Capable of starting VSMC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to VSMC, motor, or load.
- 9. VSMC shall include an input circuit breaker which will disconnect all input power, interlocked with the door so that the door cannot be opened with the circuit breaker in the closed position.
- 10. VSMC shall include a 5% line reactor and a RFI/EMI filter.
- 11. Surge Suppression: Provide three-phase protection against damage from supply voltage surges in accordance with UL 1449.
- 12. VSMC shall include front-accessible operator station, with sealed keypad and digital display, which allows complete programming, operating, monitoring, and diagnostic capabilities.
  - a. Typical control functions shall include but not be limited to:
    - (1. HAND-OFF-AUTOMATIC-RESET, with manual speed control in HAND mode.
    - (2. NORMAL-BYPASS.
    - (3. NORMAL-TEST, which allows testing and adjusting of the VSMC while in bypass mode.
  - b. Typical monitoring functions shall include but not be limited to:

- (1. Output frequency (Hz).
  - (2. Motor speed and status (run, stop, fault).
  - (3. Output voltage and current.
- c. Typical fault and alarm functions shall include but not be limited to:
  - (1. Loss of input signal, under- and over-voltage, inverter overcurrent, motor overload, critical frequency rejection with selectable and adjustable deadbands, instantaneous line-to-line and line-to-ground overcurrent, loss-of-phase, reverse-phase, and short circuit.
  - (2. System protection indicators indicating that the system has shutdown and will not automatically restart.
13. VSMC shall include two N.O. and two N.C. dry contacts rated 120 Volts, 10 amperes, 60 Hz.
14. Hardware, software, network interfaces, gateways, and programming to control and monitor the VSMC by control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
15. Network communications ports: As required for connectivity to control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
16. Communications protocols: As required for communications with control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
17. Bypass controller: Provide contactor-style bypass, arranged to bypass the inverter.
  - a. Inverter Output Contactor and Bypass Contactor: Load-break NEMA-rated contactor.
  - b. Motor overload relays.
  - c. HAND-OFF-AUTOMATIC bypass control.
18. Bypass operation: Transfers motor between inverter output and bypass circuit, manually, automatically, or both. VSMC shall be capable of stable operation (starting, stopping, and running), and control by fire alarm and detection systems,



with motor completely disconnected from the inverter output. Transfer between inverter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

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

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Install roof top unit in conformance with ARI 435.
- B. Assemble roof top unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint in accordance with Military Spec. DOD-P-21035A. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air-handling units clean prior to operation.
- C. Install seismic restraints for roof top units. Refer to specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Leakage and test requirements for roof top units shall be the same as specified for ductwork in Specification Section 23 31 00, HVAC DUCTS AND CASINGS except leakage shall not exceed Leakage Class (C<sub>L</sub>) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.
- E. Perform field mechanical (vibration) balancing in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Seal and/or fill all openings between the casing and RTU components and utility connections to prevent air leakage or bypass.

### **3.2 STARTUP SERVICES**

- A. The air handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.
- B. After the air handling unit is installed and tested, provide startup and operating instructions to VA personnel.
- C. An authorized factory representative should start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

--- E N D ---

**SECTION 23 81 23**  
**COMPUTER-ROOM AIR-CONDITIONERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies process cooling split systems air conditioning unit.
- B. Definitions:
  - 1. Energy Efficiency Ratio (EER): A ratio calculated by dividing the cooling capacity in Btu/h by the power input in watts at any given set of rating conditions, expressed in Watts (Btu/h) per watt.
  - 2. Coefficient of Performance (COP): A ratio calculated by dividing the change in heating or cooling capacity (Btu/h) to the energy consumed by the system (kW), expressed in Btu/kWh.
  - 3. Unitary (AHRI): Consists of one or more factory-made assemblies, which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function.
  - 4. CRAC Units: Computer Room Air Conditioning Units.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- F. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- G. Section 23 05 93: TESTING, ADJUSTING, and BALANCING FOR HVAC.
- H. Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.
- I. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

### **1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

### **1.4 SUBMITTALS**

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data rated capacities (at design indoor and outdoor conditions), EER/COP, operating characteristics, required specialties and accessories. Submit published catalog selection data showing equipment ratings and compliance with required sensible ratio.
  - 1. Indoor Air Conditioning Unit
  - 2. Air Cooled Condensing Unit
- C. Submit detailed equipment assemblies with dimensions, operating weights, required clearances.
- D. Submit wiring diagrams for power, alarm and controls.
- E. Certification: Submit, simultaneously with shop drawings, a proof of certification:
- F. 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

### **1.5 GUARANTEE**

- A. The unit shall be guaranteed against all mechanical defects in material, parts or workmanship and shall be repaired or replaced at the Contractor's expense within the period of one year from final acceptance. Contractor shall adhere to a four-hour service response time to troubles during the guarantee period.

### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed Spec):

- 00-A-374C-1999 ..... Air-Conditioners with Remote Condensing Units or Remote  
Air-cooled and Water-Cooled Condenser Units, Unitary
- TT-C-490D-1993 ..... Cleaning Methods for Ferrous Surfaces and Pretreatments  
for Organic Coatings
- C. Air-Conditioning, Heating and Refrigeration Institute (AHRI) Standards:
- 210/240-2017 ..... Performance Rating of Unitary Air-Conditioning and Air-  
Source Heat Pump Equipment
- 340/360-2015 ..... Performance Rating of Commercial and Industrial Unitary  
Air Conditioning and Heat Pump Equipment
- 410-2001 ..... Forced-Circulation Air-Cooling and Air-Heating Coils
- 460-2005 ..... Performance Rating of Remote Mechanical-Draft Air-  
Cooled Refrigerant Condensers
- 520-2004 ..... Performance Rating of Positive Displacement Condensing  
Units
- DCPP -2008 ..... Directory of Certified Product Performance - Applied  
Directory of Certified Products
- D. Air Movement and Control Association (AMCA):
- 210-2016 ..... Laboratory Methods of Testing Fans for Certified  
Aerodynamic Performance Rating (ANSI)
- 410-1996 ..... Recommended Safety Practices for Users and Installers of  
Industrial and Commercial Fans
- E. American Society of Heating, Refrigerating, and Air-Conditioning Engineers Inc.  
(ASHRAE):
- 15-2019 ..... Safety Standard for Refrigeration Systems (ANSI)
- Handbook 2019 HVAC Systems and Equipment
- Handbook 2018 Refrigeration
- 52.1-1992 ..... Gravimetric and Dust-Spot Procedures for Testing Air-  
Cleaning Devices used in General Ventilation for Removing  
Particulate Matter

62-1-2016 ..... Ventilation for Acceptable Indoor Air Quality (ANSI)

90.1-2016 ..... Energy Standard for Buildings except Low-Rise Residential  
Buildings (ANSI Approved; IESNA Co-sponsored)

F. American Society of Testing and Materials (ASTM):

B117-2017 ..... Standard Practice for Operating Salt Spray (Fog) Apparatus

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

MG 1-2019 ..... Motors and Generators (ANSI)

H. National Fire Protection Association (NFPA) Publications:

70-2017 ..... National Electrical Code

90A-2018 ..... Standard for the Installation of Air-Conditioning and  
Ventilating Systems

## **PART 2 - PRODUCTS**

### **2.1 CONSOLE UNITS**

- A. Description: Split system consisting of evaporator section for floor or wall mounting and remote condensing section.
- B. Evaporator Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans and two-speed motor.
- C. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.
- D. Condenser Cabinet: Steel with baked-enamel finish and containing compressor and condenser.
- E. Compressor: Hermetic scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
- F. Refrigeration Circuit: Filter/dryer, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
- G. Refrigerant: R-410A unless otherwise indicated.
- H. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.

1. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
- I. Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with propeller fan, direct driven.
- J. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- K. Filter: Cleanable 25-mm (1-inch) thick.
  1. Initial Resistance: .05 Pa (inches wg) >.
  2. Recommended Final Resistance: 0.75 Pa (inches wg) >.
  3. Arrestance: 90 percent according to ASHRAE 52.1.
  4. MERV Rating: 7 according to ASHRAE 52.2.
- L. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- M. Control System: Unit-mounted panel with contactors, control transformer with circuit breaker, and solid-state temperature control modules. Wall-mounted control panel shall be solid-state, with start-stop switch and adjustable temperature set point.
- N. DDC or BAS Interface: Provide connection to the DDC or the BAS system.

## **2.2 FAN MOTORS**

- A. Default motor characteristics are specified in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- B. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- C. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- D. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

## **2.3 SPECIAL TOOLS**

- A. If any part of equipment furnished under these specifications requires a special tool for assembly, adjustment, setting, or maintenance and the tool is not readily available from the commercial tool market, furnish the necessary tools with equipment as a standard accessory

## **2.4 CORROSION CONTROL**

A. Remote Outdoor Condenser Coils:

1. Epoxy Immersion Coating – Electrically Deposited: The multi-stage corrosion-resistant coating application comprises of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. The coating thickness shall be maintained between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, they are treated to permeate immersion rinse and spray. Where the coils are subject to UV exposure, UV protection spray treatment comprising of UV-resistant urethane mastic topcoat shall be applied. Provide complete coating process traceability for each coil and minimum five years of limited warranty. The coating process shall be such that uniform coating thickness is maintained at the fin edges. The quality control shall be maintained by ensuring compliance to the applicable ASTM Standards for the following:
  - a. Salt Spray Resistance (Minimum 6,000 Hours)
  - b. Humidity Resistance (Minimum 1,000 Hours)
  - c. Water Immersion (Minimum 260 Hours)
  - d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)
  - e. Impact Resistance (Up to 160 Inch/Pound)

B. Exposed Outdoor Cabinet

1. Casing Surfaces (Exterior and Interior): All exposed and accessible metal surfaces shall be protected with a water-reducible acrylic with stainless steel pigment spray-applied over the manufacturer's standard finish. The spray coating thickness shall



be 2-4 mils and provide minimum salt-spray resistance of 1,000 hours (ASTM B117)  
AND 500 hours UV resistance (ASTM D4587).

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Handle and install refrigeration units and accessories in accordance with the instructions and recommendations of the manufacturer.
- B. Coordinate installation of Computer room Air Conditioning Units with Computer room access flooring installer.
- C. Field Refrigerant Piping: As specified in specification Section 23 23 00, REFRIGERANT PIPING.
- D. Field Piping: Glycol Piping, Hot water Piping, Steam and Condensate Piping, as specified in specification Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.
- E. Electrical System Connections and Equipment Ground: As specified in Division 26 Sections.

#### **3.2 CONNECTIONS**

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
- B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to machine to allow service and maintenance.
- D. Water and Drainage Connections: Comply with applicable requirements in Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING and Section 22 11 00, FACILITY WATER DISTRIBUTION. Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- E. Retain first paragraph below for units with hot-water coils.

#### **3.3 FIELD QUALITY CONTROL**

- A. Tests and Inspections:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. After startup service and performance test, change filters and flush humidifier.

### **3.4 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.
- B. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of computer room air conditioning equipment.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.6 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

--- E N D ---

**SECTION 23 82 00**  
**CONVECTION HEATING AND COOLING UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies unit heaters,

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 09 00, GENERAL COMMISSIONING REQUIREMENTS
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- D. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for equipment.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- F. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Noise requirements.
- G. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Flow rates adjusting and balancing.
- H. Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- I. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.
- J. Section 23 21 13, HYDRONIC PIPING: Heating hot water and chilled water piping.
- K. Section 23 82 16, AIR COILS: Additional coil requirements.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide guarantee in accordance with FAR clause 52.246-21

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:

1. Unit heaters.

C. Certificates:

1. Compliance with Article, QUALITY ASSURANCE.
2. Compliance with specified standards.

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

E. 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

## 1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute / Air Conditioning, Heating and Refrigeration Institute (ANSI/AHRI):

440-2019 ..... Performance Rating of Room Fan Coils

445-2013 ..... Standard for Air-Induction Units

C. National Fire Protection Association (NFPA):

90A-2018 ..... Standard for the Installation of Air Conditioning and Ventilating Systems

70-2017 ..... National Electrical Code

D. Underwriters Laboratories, Inc. (UL):

181-2013 ..... Standard for Factory-Made Air Ducts and Air Connectors

1995-2015 ..... Heating and Cooling Equipment

## PART 2 - PRODUCTS

### 2.1 UNIT HEATERS

- A. General: Horizontal or vertical discharge type for hot water or electric heating medium, as indicated.

- B. Casing: Steel sheet, phosphatized to resist rust and finished in baked enamel. Provide hanger supports.
- C. Fan: Propeller type, direct driven by manufacturer's standard electric motor. Provide resilient mounting. Provide fan guard for horizontal discharge units.
- D. Discharge Air Control:
  - 1. Horizontal discharge: Horizontal, adjustable louvers.
- E. Hot Water Coil: Aluminum fins bonded to seamless copper tubing by mechanical expansion of the tubing, designed for 517 kPa (75 psig) steam working pressure.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- B. Handle and install units in accordance with manufacturer's written instructions.
- C. Support units rigidly so they always remain stationary. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.
- D. Install fiberglass blanket insulation with a minimum R value of 8 above hydronic radiant panels.

#### **3.2 OPERATIONAL TEST**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

#### **3.3 STARTUP AND TESTING**

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

#### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

--- E N D ---

**SECTION 23 82 16**  
**AIR COILS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Heating and cooling coils for air handling unit and duct applications

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- B. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC
- D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS
- E. Section 23 09 23, DDC SYSTEMS for HVAC
- F. Section 23 31 00, HVAC DUCTS AND CASINGS
- G. Section 23 36 00, AIR TERMINAL UNITS: Reheat coils for VAV/CV terminals.
- H. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Unless specifically exempted by these specifications, heating and cooling coils shall be tested, rated, and certified in accordance with AHRI Standard 410 and shall bear the AHRI certification label.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data for Heating and Cooling Coils: Submit type, size, arrangements and performance details. Present application ratings in the form of tables, charts or curves.
- C. Provide installation, operating and maintenance instructions.
- D. Certification Compliance: Evidence of listing in current ARI Directory of Certified Applied Air Conditioning Products.

- E. Coils may be submitted with Section 23 36 00, AIR TERMINAL UNITS, Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS, Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS, or Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.
- F. 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning and Refrigeration Institute (AHRI):  
Directory of Certified Applied Air Conditioning Products  
AHRI 410-2001 ..... Forced-Circulation Air-Cooling and Air-Heating Coils
- C. American Society for Testing and Materials (ASTM):  
B75/75M-2019 ..... Standard Specifications for Seamless Copper Tube
- D. National Fire Protection Association (NFPA):  
70-2017 ..... National Electric Code
- E. National Electric Manufacturers Association (NEMA):  
250-2014 ..... Enclosures for Electrical Equipment (1,000 Volts  
Maximum)
- F. Underwriters Laboratories, Inc. (UL):  
1996-2014 ..... Electric Duct Heaters

## PART 2 - PRODUCTS

### 2.1 HEATING AND COOLING COILS

- A. Conform to ASTM B75 and AHRI 410.
- B. Surgical Suites – All Locations: All coils installed in the air handling units serving surgical suites, duct-mounted reheat coils, and air terminal unit-mounted reheat coils shall be equipped with copper fins.



- C. Tubes: Minimum 16 mm (0.625 inch) tube diameter; Seamless copper tubing.
- D. Fins: 0.1397 mm (0.0055 inch) aluminum or 0.1143 mm (0.0045 inch) copper mechanically bonded or soldered or helically wound around tubing.
- E. Headers: Copper, welded steel or cast iron. Provide seamless copper tubing or resistance welded steel tube for volatile refrigerant coils.
- F. "U" Bends, Where Used: Machine die-formed, silver brazed to tube ends.
- G. Coil Casing: 1.6 mm (16 gage) galvanized steel with tube supports at 1200 mm (48 inch) maximum spacing. Construct casing to eliminate air bypass and moisture carry-over. Provide duct connection flanges.
- H. Pressures kPa (PSIG):

Pressure	Water Coil	Steam Coil	Refrigerant Coil
Test	2070 (300)	1725 (250)	2070 (300)
Working	1380 (200)	520 (75)	1725 (250)

- I. Protection: Unless protected by the coil casing, provide cardboard, plywood, or plastic material at the factory to protect tube and finned surfaces during shipping and construction activities.
- J. Vents and Drain: Coils that are not vented or drainable by the piping system shall have capped vent/drain connections extended through coil casing.
- K. Cooling Coil Condensate Drain Pan: Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.

## 2.2 WATER COILS, INCLUDING GLYCOL-WATER

- A. Use the same coil material as listed in Paragraphs 2.1.
- B. Drainable Type (Self Draining, Self Venting); Manufacturer standard:
  - 1. Cooling, all types.
  - 2. Heating or preheat.
  - 3. Runaround energy recovery. ARI certification of capacity adjustment is waived. See Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT.
- C. Cleanable Tube Type; manufacturer standard:

1. Well water applications.
2. Waste water applications.

### **2.3 VOLATILE REFRIGERANT COILS**

- A. Continuous circuit, straight tubes, dry expansion type equipped with multi-port distribution header, less expansion valve.
- B. Minimum 16 mm (5/8-inch) tube diameter.
- C. Designed for R22 or other EPA approved refrigerants.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Follow coil manufacturer's instructions for handling, cleaning, installation and piping connections.
- B. Comb fins, if damaged. Eliminate air bypass or leakage at coil sections.

### **3.2 STARTUP AND TESTING**

- A. 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.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and as required by Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.

- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

--- E N D ---

**SECTION 25 10 10**  
**ADVANCED UTILITY METERING SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section includes the following for the advanced metering of the systems of the facility. The metered systems include the electrical power, heating water, domestic water. The metering systems in each facility are part of a Corporate-Wide utility metering system, rendering the VA accurate and automated metering of its facilities' energy and water flows. Metering systems are comprised of:
1. PC-based workstation(s) or server(s) and software.
  2. Communication network and interface modules for RS-232, RS-485, Modbus TCP/IP, IEEE 802.3 data transmission protocols.
  3. Electric meters.
  4. Volumetric flowmeters, temperature sensors and pressure transducers.
  5. Mass flowmeters.

**1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of nonstructural components.
- B. Section 22 05 19 METERS AND GAGES FOR PLUMBING PIPING: meters and gages.
- E. Section 22 35 00 DOMESTIC WATER HEATER EXCHANGERS: references meters.
- F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements, common to more than one section in mechanical.
- H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Flowmeters and communications
- I. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- J. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage cable.

- K. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- L. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- M. Section 26 11 16, SECONDARY UNIT SUBSTATIONS: Unit secondary substation.
- N. Section 26 13 00, MEDIUM-VOLTAGE SWITCHGEAR: High voltage switchgear.
- O. Section 26 18 41, MEDIUM-VOLTAGE SWITCHES: High voltage switches.
- p. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Secondary distribution switchgear.
- Q. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Secondary distribution switchboards.
- R. Section 26 24 19, MOTOR-CONTROL CENTERS: Motor control assemblies.
- S. Section 32 84 00 PLANTING IRRIGATION: references meters.

### **1.3 DEFINITIONS**

- A. AMR: Automatic meter reading is the technology of automatically collecting consumption, diagnostic, and status data from water and energy metering devices (water, gas, electric, steam) and transferring that data to a central database for billing, troubleshooting, and analyzing.
- B. AUMS: Advanced Utility Metering System: the system described by this Section.
- C. BACnet: BACnet is a Data Communications Protocol for Building Automation and Control Networks. It is defined by ASHRAE/ANSI Standard 135 (ISO 16484-5) standard protocol.
- D. Data Over Cable Service Interface Specification (DOCSIS): an international standard defining communications and operation support interface requirements for a data over cable system, by the Cable Television Laboratories, Inc. consortium
- E. Data Head (on meters): converts analog and pulse signals to digital signals for transmission to the Site Data Aggregation Device. Also provides for limited storage of the digital signals.
- F. Device Accuracy: accuracy in this section is based on actual flow, not full scale or full range. Device accuracy measures the conversion of flow information to analog or pulse signals.
- G. Ethernet: Local area network, based on IEEE 802.3 standards.

- H. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- I. Gateway: Bi-directional protocol translator connecting control systems that use different communication protocols.
- J. GB: gigabyte. When used to describe data storage, "GB" represents 1024 megabytes.
- K. HTML: Hypertext markup language.
- L. I/O: Input/output.
- M. KB: Short for kilobyte. When used to describe data storage, "KB" represents 1024 bytes.
- N. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
- O. LAN: Local area network. Sometimes plural as "LANs."
- P. LCD: Liquid crystal display.
- Q. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- R. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- S. LonWorks: Network technology developed by the Echelon Corporation.
- T. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- U. MB: megabyte. When used to describe data storage, "MB" represents 1024 kilobytes.
- V. Mbps: Megabytes per second, equal to 8 megabits per second
- W. Modbus TCP/IP: An open protocol for exchange of process data.
- X. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

- Y. OTDR: Optical Time Domain Reflectometer. A test instrument that analyzes the light loss in an optical fiber. Used to find faults, splices and bends in the line, it works by sending out a light pulse and measuring its reflection. Such devices can measure fiber lines that are longer than 150 miles
- Z. PC: Personal computer
- AA.PICS, Protocol Implementation Conformance Statement: A written document that identifies the particular options specified by BACnet that are implemented in a device.
- BB.REO: Resident Engineer Office: the VA office administering the construction contract.
- CC.Reporting Accuracy: this is the root-mean-square sum of all of the metering devices' inaccuracies: measurement inaccuracy, mechanical inaccuracy, analog-to-digital or pulse integration inaccuracy, etc., up to the meter's data head.
- DD.rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- EE.Router: A device that connects two or more networks at the network layer.
- FF.RS-232: A Telecommunications Industry Association standard for asynchronous serial data communications between terminal devices.
- GG.RS-485: A Telecommunications Industry Association standard for multipoint communications using two twisted-pairs.
- HH.TB: terrabyte. When used to describe data storage, "TB" represents 1024 gigabytes.
- II.TCP/IP: Transport control protocol/internet protocol.
- JJ.Turn-down: the maximum flow divided by the minimum flow through a meter; used along with accuracy requirements. For example, a meter shall be accurate to within 2% of actual flow with throughout a 20:1 turndown
- KK.THD: Total harmonic distortion.
- LL.UPS: Uninterruptible power supply; used both in singular and plural context.
- MM.UTP: Unshielded twisted pair cabling, used to limit crosstalk and electromagnetic interference from the environment
- NN.WAN: Wide area network.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced at least three years in manufacturing and installing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency, and marked for intended use.
- D. System Modifications: Make recommendations for system modification in writing to the VA. No system modifications shall be made without prior written approval of the VA. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected. Provide to the VA software updates for all software furnished under this specification during this contract's construction and verification periods and for the first two years after government acceptance. All updated software shall be verified as part of this contract.

#### **1.5 PERFORMANCE**

- A. The advanced utility metering system shall conform to the following:
  - 1. Site Data Aggregation Device Graphic Display: The system shall display up to 4 graphics on a single screen with a minimum of (20) dynamic points per graphic. All current data shall be displayed within (10) seconds of the request.
  - 2. Site Data Aggregation Device Graphic Refresh: The system shall update all dynamic points with current data within ten seconds. Data refresh shall be automatic, without operator intervention.
  - 3. Meter Scan: All changes of metered values shall be transmitted over the high-speed network such that any data used or displayed at a controller or Site Data Aggregation Device will be current, within the prior ten seconds.
  - 4. Alarm Response Time: The maximum time from when meter goes into alarm to when it is annunciated at the workstation shall not exceed ten seconds.



5. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values within the below minimum turn-down envelope reported by the meters:

Measured Variable	Units Measured	Minimum Turn-Down of Meter	Reporting Accuracy (Note 1)
Electricity	V, A, W, etc.	n/a	±0.5% of measured value
Domestic Water flow	l/s (GPH)	20:1	±2%
Heating Water	kW (MBH)	20:1	±2%
Outside Air Temperature	°C (°F)	n/a	±2%
Outside Air Relative Humidity	% rh	n/a	±2.5%

**Table 1.5: Meter Performance Criteria**

Table Notes:

1. This table shows reporting accuracy, not merely the meter's accuracy. Reporting accuracy includes meter accuracy and data conversion accuracy. See Article 1.3 in this Section for definition. Accuracy is shown against the measured value, not against the full range of the meter.
2. l/s: liter per second  
CFH: cubic feet per hour  
kW: kilowatt  
MBH: 1000's British Thermal Units per hour  
GPH: gallons per hour

## **1.6 WARRANTY**

- A. Labor and materials for advanced utility metering systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.
- B. Advance utility metering system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and metering devices.

## **1.7 SUBMITTALS**

- A. Product Data: for each type of product indicated, Attach copies of approved Product Data submittals for products (such as flowmeters, temperature sensors and pressure transmitters, switchboards and switchgear) that describe advance utility metering

features to illustrate coordination among related equipment and utility metering and control.

- B. Shop Drawings: include plans, elevations, sections, details, and attachments to other work.
  - 1. Outline Drawings: Indicate arrangement of meters, components and clearance and access requirements. Clearly identify system components, internal connections, and all field connections.
  - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
  - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Wiring Diagrams: Power, signal, and communications wiring. Coordinate nomenclature and presentation with a block diagram. Show all communications network components and include a communications single-line diagram indicating device interconnection and addressing information for all system devices. Identify terminal blocks used for interconnections and wire type to be used.
  - 5. UPS sizing calculations for workstation.
- C. Software and Firmware Operational Documentation:
  - 1. Self-study guide describing the process for setting equipment's network address; setting Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
  - 2. Software operating and upgrade manuals.
  - 3. Software Backup: On a compact disc, complete with Owner-selected options.
  - 4. Device address list and the set point of each device and operator option, as set in applications software.

5. Graphic file and printout of graphic screens and related icons, with legend.
  6. "Quick-Start" guide to describe a simple, three-step commissioning process for setting the equipment's Ethernet address, and ensuring trouble-free data access from any PC on the network, using a standard web browser.
- D. Software Upgrade Kit: For Owner to use in modifying software to suit future utility metering system revisions.
- E. Firmware Upgrade Kit: For Owner to use in modifying firmware to suit future power system revisions or advanced utility metering system revisions. Firmware updates, and necessary software tools for firmware updates, shall be downloadable from the internet. VA shall be able to update firmware, in equipment, without removing device from the equipment. VA shall be capable of updating firmware over the utility metering communication network or through local communication ports on the device.
- F. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.
- G. Qualification Data: For installer and manufacturer
- H. Other Informational Submittals:
1. System installation and setup guides, with data forms to plan and record options and setup decisions.
- I. Revise and update the Contract Drawings to include details of the system design. Drawings shall be on 17 by 11 inches sheets. Details to be shown on the Design Drawing include:
1. Details on logical structure of the network. This includes logical location of all network hardware.
  2. Manufacturer and model number for each piece of computer and network hardware.
  3. Physical location for each piece of network or computer hardware.
  4. Physical routing of LAN cabling.
  5. Physical and qualitative descriptions of connectivities.

## **1.8 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For advanced utility metering system components and meters, to include in emergency, operation, and maintenance manuals. Include the following:
1. Operating and applications software documentation.
  2. Software licenses.
  3. Software service agreement.
  4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot compact disks, and drivers for all installed hardware. Provide separately for each PC.
  5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
  6. In addition to the copies required by 01 00 00, provide 5 bound paper copies of the Operation and Maintenance Data and two compact disks (CD), with all Instructions as Acrobat PDF files. The pdf files shall identical to the paper copies and shall Acrobat navigation tools including Bookmarks for each Chapter.
  7. The advanced utility metering system Operation and Maintenance Instructions shall include:
    - a. Procedures for the AUMS system start-up, operation and shut-down.
    - b. Final As-Built drawings, including actual LAN cabling routing shown on architectural backgrounds.
      - 1) IP address(es) as applicable for each piece of network hardware.
      - 2) IP address for each computer server, workstation and networked printer.
      - 3) Network identifier (name) for each printer, computer server and computer workstation.
      - 4) CEA-709.1B address (domain, subnet, node address) for each CEA-709.1B TP/FT-10 to IP Router.

- c. Routine maintenance checklist, rendered in a Microsoft Excel format. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall list each device's node identifier/address, the third column shall describe each device's physical location, the fourth column shall state the maintenance activity or state no maintenance required, the fifth column shall state the frequency of the maintenance activity, frequency of calibration and the sixth column for additional comments or reference.
  - d. Qualified service organization list.
  - e. In addition to the requirements in Section 01 33 23, the submittal shall include manufacturer Installation Requirements.
  - f. Include complete instructions for calibration of each meter type and model.
  - g. Start-Up and Start-Up Testing Report.
  - h. Performance verification test procedures and reports.
  - i. Preventive Maintenance Work Plan.
  - j. In addition to factory-trained manufacturers' representatives requirements in 01 00 00, provide signed letter by factory-trained manufacturers' representatives stating that the system and components are installed in strict accordance with the manufacturers' recommendations.
- B. Field quality-control test reports.

## **1.9 LICENSING AGREEMENT**

- A. Licenses procured as part of this work become the property of the government upon acceptance of the work. Licenses shall have no expiration.
- B. Technical Support: Beginning with Government Acceptance, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Government Acceptance. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

#### **1.10 MAINTENANCE AND SERVICE**

- A. Preventive Maintenance Requirements: provide a preventative maintenance plan with attached procedures indicated by meter and component manufacturers. Perform maintenance procedures for a period of 1 year after government acceptance, at frequencies and using procedures required by the meter and component manufacturers. At a minimum and if the manufacturer is silent on its preventative maintenance requirements, frequencies, deliverables and activities shall comply with the following:
  1. Preventive Maintenance Work Plan: prepare a Preventive Maintenance Work Plan to schedule all required preventive maintenance. VA approval of the Work Plan shall be obtained. Adhere to the approved work plan to facilitate VA verification of work. If the Contractor finds it necessary to reschedule maintenance, a written request shall be made to the VA detailing the reasons for the proposed change at least five days prior to the originally scheduled date. Scheduled dates shall be changed only with the prior written approval of the REO.
  2. Semiannual Maintenance: perform the following Semiannual Maintenance as specified:
    - a. Perform data backups on all Server Hardware.
    - b. Run system diagnostics and correct diagnosed problems.
    - c. Perform fan checks and filter changes for AUMS hardware.
    - d. Perform all necessary adjustments on printers.
    - e. Resolve all outstanding problems.
    - f. Install new ribbons, ink cartridges and toner cartridges into printers, and ensure that there is at least one spare ribbon or cartridge located at each printer.
  3. Maintenance Procedures
    - a. Maintenance Coordination: Any scheduled maintenance event by Contractor that will result in component downtime shall be coordinated with the VA as

follows. Time periods shall be measured as actual elapsed time from beginning of equipment off-line period, including working and non-working hours.

- 1) For non-redundant computer server hardware, provide 14 days notice, components shall be off-line for no more than 8 hours.
  - 2) For redundant computer server hardware, provide 7 days notice, components shall be off-line for no more than 36 hours.
  - 3) For active (powered) network hardware, provide 14 days notice, components shall be off-line for no more than 6 hours.
  - 4) For cabling and other passive network hardware, provide 21 days notice, components shall be off-line for no more than 12 hours.
- b. Software/Firmware: Software/firmware maintenance shall include operating systems, application programs, and files required for the proper operation of the advanced utility metering system regardless of storage medium. User- (project site-) developed software is not covered by this contract, except that the advanced utility metering system software/firmware shall be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. Perform diagnostics and corrective reprogramming as required to maintain total advanced utility metering system operations as specified. Back up software before performing any computer hardware and software maintenance. Do not modify any parameters without approval from the VA. Any approved changes and additions shall be properly documented, and the appropriate manuals shall be updated.
- c. Network: Network maintenance shall include testing transmission media and equipment to verify signal levels, system data rates, errors and overall system performance.

B. Service Call Reception

1. A VA representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time

- notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the VA.
2. The Contractor shall have procedures for receiving and responding to service calls during regular working hours. A single telephone number shall be provided for receipt of service calls during regular working hours. Service calls shall be considered received by the Contractor at the time and date the telephone call is placed by the VA.
  3. Separately record each service call request, as received on the Service Call Work Authorization form. Complete the Service Call Work Authorization form for each service call. The completed form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.
  4. Respond to each service call request within two working hours. The status of any item of work must be provided within four hours of the inquiry during regular working hours, and within sixteen hours after regular working hours or as needed to repair equipment.

#### **1.11 SPARE PARTS**

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Addressable Relays: One for every ten installed. Furnish at least one of each type.
  2. Data Line Surge Suppressors: One for every ten of each type installed. Furnish at least one of each type.
- B. Furnish spare parts shall not be used for any warranty-required remediation.



## 1.12 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced, unless otherwise noted. Publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
- B16.1-1998 .....Cast Iron Pipe Flanges and Flanged Fittings
  - B31.1-2007 .....Power Piping
  - B31.8-2007 .....Gas Transmission and Distribution Piping Systems
  - B31.9-2008 .....Building Services Piping
  - B40.100-1998 .....Pressure Gauges and Gauge Attachments
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers
- ASHRAE 135-2008 .....A Data Communication Protocol for Building Automation and Control Networks (ANSI)
- D. American Society for Testing and Materials (ASTM)
- A53-2006 .....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  - A106-2006 .....Seamless Carbon Steel Pipe for High Temperature Service
- E. Consumer Electronics Association (CEA)
- 709.1B-2002 .....Control Network Protocol Specification
  - 709.3-1999 .....Free-Topology Twisted-Pair Channel Specification
  - 852-A-2004 .....Tunneling Component Network Protocols Over Internet Protocol Channels
- F. Federal Communications Commission (FCC)
- EMC-2002 .....FCC Electromagnetic Compliance Requirements
- G. 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
  - 100-2000 .....The Authoritative Dictionary of IEEE Standards Terms

- 802.1D-2004.....Media Access Control Bridges
- 802.2-2003 .....Standards for Local Area Networks: Logical Link Control
- 802.3-2005 .....Information Technology - Telecommunications and  
Information Exchange between Systems. Local and  
Metropolitan Area Networks - Specific Requirements - Part  
3: Carrier Sense Multiple Access with Collision Detection  
(CSMA/CD) Access Method and Physical Layer  
Specifications (ANSI)
- 1100-2005 .....Recommended Practice for Powering and Grounding  
Electronic Equipment (ANSI)
- C37.90.1-2002 .....Surge Withstand Capability (SWC) Tests for Relays and  
Relay Systems Associated with Electric Power Apparatus
- C57.13-2008 .....Standard Requirements for Instrument Transformers
- C62.41.1-2002 .....Guide on the Surges Environment in Low-Voltage(1000 V  
and Less) AC Power Circuits
- C62.41.2-2002 .....Recommended Practice on Characterization of Surges in  
Low-Voltage (1000 V and Less) AC Power Circuits
- H. International Electrotechnical Commission (IEC)
- IEC 61000-2005 .....Electromagnetic Compatibility (EMC)- Part 4-5: Testing and  
Measurement Techniques; Surge Immunity Test
- I. National Electrical Contractors Association
- NECA 1-2006 .....Good Workmanship in Electrical Construction
- J. National Electrical Manufacturers Association (NEMA)
- 250-2008 .....Enclosures for Electrical Equipment (1000 Volts Maximum)
- C12.1-2008 .....Electric Meters; Code for Electricity Metering
- C12.20-2002 .....Electricity Meter - 0.2 and 0.5 Accuracy Classes
- C62.61-1993 .....Gas Tube Surge Arresters on Wire Line Telephone Circuits
- ICS 1-2008 .....Standard for Industrial Control and Systems General  
Requirements

K. National Institute of Standards and Technology (NIST)

800, Part 39-2008.....[DRAFT] Managing Risk from Information Systems: An  
Organizational Perspective

800, Part 46-2009.....Guide to Enterprise Telework and Remote Access Security

800, Part 52-2009.....Recommended Security Controls for Federal Information  
Systems and Organizations

(FIPS) 200-2006 .....Minimum Security Requirements for Federal Information  
and Information Systems

L. National Fire Protection Association (NFPA)

30-08 .....Flammable and Combustible Liquids Code

70-2008 .....National Electrical Code (NEC)

54-06 .....National Fuel Gas Code

85-07 .....Boiler and Combustion Systems Hazard Code

101-06 .....Life Safety Code

262-2007 .....Test for Flame Travel and Smoke of Wires and Cables for  
Use in Air-Handling Spaces

M. NSF International

14-03 .....Plastics Piping Components and Related Materials

61-02 .....Drinking Water System Components-Health Effects  
(Sections 1-9)

N. Telecommunications Industry Association, (TIA/EIA)

H-088C3.....Pathway Design Handbook

232-F-2002 .....Interface Between Data Terminal Equipment and Data  
Circuit-Terminating Equipment Employing Serial Binary  
Data Interchange

485-A-2003.....Electrical Characteristics of Generators and Receivers for  
Use in Balanced Digital Multipoint System

568-C.1-2009.....Commercial Building Telecommunications Cabling  
Standard

606-A-2002.....Administration Standard for the Telecommunications  
Infrastructure

607-A-2002.....Commercial Building Grounding (Earthing) and Bonding  
Requirements for Telecommunications

O. Underwriters Laboratories, Inc. (UL):

916-2007 .....Energy Management Equipment

5085-3-2007 .....UL Standard for Safety Standard Low Voltage

1244-2000 .....Electrical and Electronic Measuring and Testing Equipment

1581-2006 .....Electrical Wires, Cables, and Flexible Cords

## **PART 2 - PRODUCTS**

### **2.1 ADVANCED UTILITY METERING SYSTEM**

A. Functional Description

1. Meter and record load profiles. Chart energy and water consumption patterns.

a. Calculate and record the following:

- 1) Load factor.
- 2) Peak demand periods.
- 3) Consumption correlated with facility activities.

b. Measure and record metering data for the following:

- 1) Electricity.
- 3) Domestic water.
- 9) Heating water

c. Software: calculate allocation of utility costs.

- 1) Automatically import energy and water usage records to allocate energy and water costs for the following:

c) At least 1 buildings.

- 2) Verify utility bills and analyze alternate energy rates.

d. Electric Power Quality Monitoring: Identify power system anomalies and measure, display, capture waveforms, and record trends and alarms of the following power quality parameters:

- 1) Voltage regulation and unbalance.
  - 2) Continuous three-phase rms voltage.
  - 3) Periodic max./min./avg. samples.
  - 4) Harmonics.
  - 5) Voltage excursions.
  - e. Emergency Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:
    - 1) Determine system topology.
    - 2) Evaluate remaining loads and sources.
    - 3) Shed loads in less than 100 ms.
  - f. Demand Management:
    - 1) Peaking or co-generator control.
    - 2) Load interlocking.
    - 3) Load shedding.
    - 4) Load trimming.
  - g. System: Report equipment status and power system control.
- B. Communications Components and Networks
1. Site Data Aggregation Device and its networked meters shall communicate using BACnet protocol. Backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2008, BACnet Annex J.
    - a. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2008, BACnet.
    - b. Each controller shall have a communication port for connection to an operator interface.
  2. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard LAN and WAN and Internetworked LAN.

3. Communication protocol; LANs complying with RS-485 or RS-485 accessed through Ethernet, 100 Base-TX Ethernet, and Modbus TCP/IP.
4. Network Hardware
  - a. Building Point of Connection Hardware
    - 1) Active equipment and communication interfaces.
    - 2) Switches, hubs, bridges, routers and servers.
  - b. IP Network Hardware
    - 1) Wire and Cables, copper connectivity devices.
    - 2) Fiber Optic Patch Panel.
    - 3) Fiber Optic Media Converter
    - 4) Ethernet Switch
    - 5) IP Router
5. Communication Security
  - a. Remote teleworking and remote access of the network shall be through a firewall, at the Site Data Aggregation Device, complying with the requirements associated with Level 1 security in the Federal Information Processing Standard 140-2 (2002), Security Requirements for Cryptographic Modules.
  - b. Direct access to network shall be restricted as described in

## **2.2 DATA COLLECTION HARDWARE AND SOFTWARE**

- A. Metering data shall be collected and archived by the local campus building management control system.
  1. DDC Control System approved for use must be able to tie into existing BVAMC WebCTRL DDC Management Server on the BVAMC Network. No new DDC Servers will be built. This includes:

Automated Logic WebCTRL by Clima-Tech Corporation
  2. Contractor wishing to provide ATC control system for this project shall submit system capabilities to the project Engineer. This is to allow for system demonstration for owner and design team.

## **2.3 CABLE SYSTEMS - TWISTED PAIR AND FIBER OPTIC**

### **A. General:**

1. All metallic cable sheaths, etc. (i.e.: risers, underground, station wiring, etc. shall be grounded.
2. Install temporary cable and wire pairs so as to not present a pedestrian safety hazard. Provide for all associated work for any temporary installation and for removal when no longer necessary. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and approved by the VA prior to installation.
3. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
4. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
5. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.
6. Label system's cables on each end. Test and certify cables in writing to the VA before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges specified. The cable tests shall demonstrate the operation of this cable at not less than 10 mega (m) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of  $10^{-6}$  at the maximum rate of speed. Make available all cable installation and test records at acceptance testing by the VA and shall thereafter be maintained in the Facility's Telephone Switch Room. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.

7. Coordinate with the Electrical Contractor to install the telephone entrance cable to the nearest point of entry into the Facility and as shown on the drawings.  
Coordinate with the VA and the Electrical Contractor to provide all cable pairs/circuits from the Facility point of entry to the Telephone Switch Room all telephone, FTS, DHCP, ATM, Frame Relay, data, pay stations, patient phones, and any low voltage circuits as described herein.
8. Provide all cable pairs/circuits from the Server Room and establish circuits throughout the Facility for all cabling as described herein.
9. Provide proper test equipment to demonstrate that cable pairs meet each OEM's standard transmission requirements, and guarantee the cable will carry data transmissions at the required speeds, frequencies, and fully loaded bandwidth.

B. LAN COPPER CABLES

1. Comply with Section 27 15 00 "Communications Horizontal Cabling."
2. RS-485 Cable:
  - a. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
3. Unshielded Twisted Pair Cables: Category 5e or 6 as specified for horizontal cable for data service in Section 27 15 00 "Communications Horizontal Cabling."
4. Cabling products shall be tested and certified for use at data speeds up to at least 100 Mbps. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media. Short lengths of media and transceivers may be used in these applications. Provide separately orderable media, taps and connectors.
5. Ethernet Switch shall be IEEE Std 802.3 bridges which shall function as the center of a distributed-star architecture and shall be "learning" bridges with spanning tree algorithms in accordance with IEEE Std 802.1D. The switch shall support the connected media types and shall have a minimum of 150% the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port.



6. Provide IP router network equipment. The routers shall be fully configurable for protocol types, security, and routing selection of sub-networks. The router shall meet all requirements of RFC 1812.

**D. LOW-VOLTAGE WIRING**

1. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
  - a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
  - b. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
  - c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

**2.4 GROUNDING**

- A. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with VA 27 05 26 Grounding and Bonding for Communications Systems and with VA 26 05 26 Grounding and Bonding for Electrical Systems.

**2.5 METER COMMUNICATION**

- A. Provide a BACnet network allowing communication from the meters' data heads to the Site Data Aggregation Device.
- B. Provide data heads at each meter, converting analog and pulsed information to digital information. Data heads shall allow for up to 24 hours of data storage (including time stamp, measured value, and scaling factor).
  1. Each data head shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol. Each data head shall have a communication port for connection to an operator interface.
  2. Environment: Data Head hardware shall be suitable for the conditions ranging from -29°C to 60°C (-20°F to 140°F). Data Heads used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at conditions ranging from -29°C to 60°C (-20°F to 140°F).

3. Provide a local keypad and display for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.
4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
5. Memory. The building controller shall maintain all BIOS and data in the event of a power loss for at least 72 hours.
6. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

## **2.6 ELECTRICAL POWER METERS AND SUB-METERS**

### **A. ELECTRICAL METER APPLICATIONS**

1. Energy meters in the advanced utility metering system shall have models available for amperage ranges of 100-2400 amperes.
  - a. The RS-485 communications shall provide communications links up to 10,000 feet long.
2. Power meters shall be installed as part of the advanced utility metering system.
  - a. All setup parameters required by the power meter shall be stored in nonvolatile memory and retained in the event of a control power interruption.
  - b. The power meter may be applied in three-phase, three- or four- wire systems.
  - c. The power meter shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.
  - d. The power meter shall provide for onboard data logging, able to log data, alarms, waveforms and events.

### **B. Physical and Common Requirements**

1. Electrical power meters shall be separately mounted, and enclosed in a NEMA 250, Type 1 enclosure. Environmental Conditions: System components shall be capable

of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

- a. Ambient conditions of 0 to 140 deg F dry bulb and 20 to 95 percent relative humidity, noncondensing.

C. Current and voltage ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Voltage inputs from standard instrument potential transformers with 120 volt secondary output. The power meter shall support PT primaries through 3.2 MV.
4. The power meter shall operate properly over a wide range of control power including 90-457 VAC or 100-300 VDC.

D. Electrical measurements and calculated values

1. Power meters shall include the following rms Real-Time Measurements:
  - a. Current: Each phase, neutral, average of three phases, percent unbalance.
  - b. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
  - c. Power: Per phase and three-phase total.
  - d. Reactive Power: Per phase and three-phase total.
  - e. Apparent Power: Per phase and three-phase total.
  - f. True Power Factor: Per phase and three-phase total.
  - g. Displacement Power Factor: Per phase and three-phase total.
  - h. Frequency.
  - i. THD: Current and voltage.
  - j. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

- k. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh  
(signed/absolute).
  - l. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh  
(signed/absolute).
- 2. Power meters shall perform the following demand current calculations, per phase,  
three-phase average and neutral:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Peak.
- 3. Power meters shall perform the following demand real power calculations, three-  
phase total:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.
- 4. Power meters shall perform the following demand reactive power calculations,  
three-phase total:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.

5. Power meters shall perform the following demand apparent power calculations, three-phase total:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.
6. Power meters shall perform the following average true power factor calculations, demand coincident, three-phase total:
  - a. Last completed interval.
  - b. Coincident with kW peak.
  - c. Coincident with kVAR peak.
  - d. Coincident with kVA peak.
7. Power Analysis Values:
  - a. THD, Voltage and Current: Per phase, three phase, and neutral.
  - b. Displacement Power Factor: Per phase, three phase.
  - c. Fundamental Voltage, Magnitude and Angle: Per phase.
  - d. Fundamental Currents, Magnitude and Angle: Per phase.
  - e. Fundamental Real Power: Per phase, three phase.
  - f. Fundamental Reactive Power: Per phase.
  - g. Harmonic Power: Per phase, three phase.
  - h. Phase rotation.
  - i. Unbalance: Current and voltage.
  - j. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st harmonic.

8. Power meters shall perform one of the following demand calculations, selectable by the User; meters shall be capable of performance of all of the following demand calculations.
  - a. Block interval with optional subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
    - 1) Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    - 2) Fixed block that calculates demand at end of the interval.
    - 3) Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
  - b. Demand calculations initiated by a Utility-furnished synchronization signal:
    - 1) Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
    - 2) Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
    - 3) Demand can be synchronized with clock in the power meter.
  - c. Minimum and maximum values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
    - 1) Line-to-line voltage.
    - 2) Line-to-neutral voltage.
    - 3) Current per phase.
    - 4) Line-to-line voltage unbalance.
    - 5) Line-to-neutral voltage unbalance.
    - 6) Power factor.
    - 7) Displacement power factor.
    - 8) Total power.
    - 9) Total reactive power.

10) Total apparent power.

11) THD voltage L-L.

12) THD voltage L-N.

13) THD current.

14) Frequency.

d. Harmonic calculation: display and record the following:

- 1) Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
- 2) Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by the VA.

E. Waveform Capture:

1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
2. Capture and store disturbance waveform captures of voltage and current channels, initiated automatically based on an alarm event. Each capture shall be fully configurable for duration with resolution of at least 128 data points per cycle, for all channels simultaneously. Waveform shall be configurable to capture pre-event cycles for analysis.
3. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

F. Meter accuracy:

1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
2. Accuracy from Light to Full Rating:
  - a. Power: Accurate to 0.5 percent of reading.
  - b. Voltage and Current: Accurate to 0.5 percent of reading.
  - c. Power Factor: Plus or minus 0.005, from 0.5 leading to 0.5 lagging.

- d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
- G. Meter input, sampling, display, output, recording and reading Capabilities
- 1. Input: One digital input signal.
    - a. Normal mode for on/off signal.
    - b. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
    - c. Conditional energy signal to control conditional energy accumulation.
    - d. GPS time synchronization.
  - 2. Sampling:
    - a. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
    - b. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
  - 3. Display Monitor:
    - a. Backlighted LCD to display metered data with touch-screen or touch-pad selecting device.
    - b. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
    - c. Display four values on one screen at same time.
      - 1) Coordinate list below with meter capabilities specified in subparagraphs above.
      - 2) Current, per phase rms, three-phase average //and neutral//.
      - 3) Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
      - 4) Real power, per phase and three-phase total.
      - 5) Reactive power, per phase and three-phase total.
      - 6) Apparent power, per phase and three-phase total.
      - 7) Power factor, per phase and three-phase total.
      - 8) Frequency.



- 9) Demand current, per phase and three-phase average.
- 10) Demand real power, three-phase total.
- 11) Demand apparent power, three-phase total.
- 12) Accumulated energy (MWh and MVARh).
- 13) THD, current and voltage, per phase.
- d. Reset: Allow reset of the following parameters at the display:
  - 1) Peak demand current.
  - 2) Peak demand power (kW) and peak demand apparent power (kVA).
  - 3) Energy (MWh) and reactive energy (MVARh).
- 4. Outputs:
  - a. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
  - b. Closed in either a momentary or latched mode as defined by user.
  - c. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
  - d. One digital KY pulse to a user-definable increment of energy measurement.  
Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
  - e. One relay output module, providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
  - f. Output Relay Control:
    - 1) Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
    - 2) Normally open and normally closed contacts, field configured to operate as follows:
      - a) Normal contact closure where contacts change state for as long as signal exists.
      - b) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.

- c) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
  - d) End of power demand interval when relay operates as synchronization pulse for other devices.
  - e) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
  - f) Output controlled by multiple alarms using Boolean-type logic.
- 5. Onboard Data Logging:
  - a. Store logged data, alarms, events, and waveforms in 2 MB of onboard nonvolatile memory.
  - b. Stored Data:
    - 1) Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 to 52 days of 15-minute interval data, depending on number of quantities selected.
    - 2) Custom Data Logs: three user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
      - a) Schedule interval.
      - b) Event definition.
      - c) Configured as "fill-and-hold" or "circular, first-in first-out."
    - 3) Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
    - 4) Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."
  - c. Default values for all logs shall be initially set at factory, with logging to begin on device power up.
- 6. Alarms.
  - a. User Options:

- 1) Define pickup, dropout, and delay.
  - 2) Assign one of four severity levels to make it easier for user to respond to the most important events first.
  - 3) Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.
- b. Alarm Events:
- 1) Over/undercurrent.
  - 2) Over/undervoltage.
  - 3) Current imbalance.
  - 4) Phase loss, current.
  - 5) Phase loss, voltage.
  - 6) Voltage imbalance.
  - 7) Over kW demand.
  - 8) Phase reversal.
  - 9) Digital input off/on.
  - 10) End of incremental energy interval.
  - 11) End of demand interval.

## **2.7 WATER, OIL, GAS METER DEVICES**

- A. Water, oil and gas meter applications:
5. Potable (Domestic) Water: provide a magnetic flowmeter in new installations; provide an ultrasonic or vortex-shedding flowmeter with pressure sensor in existing installations which service interruption is not allowed.
  9. HVAC Hydronic System Water Meters
    - b. Heating Water Systems: provide vortex-shedding flowmeters with pressure and temperature sensors to determine energy flow.
- B. Associated Devices (to provide outside air conditions as well as energy metering, not merely flow metering):
1. Temperature Sensors: Resistance Temperature Device (RTD) with an integral transmitter type.

- a. Immersion sensors shall be provided with a separable thermowell. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
  - b. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
  - c. Output Signal: 4-20 ma or digital.
2. Humidity Sensors: Bulk polymer sensing element type.
  - a. Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
  - b. Output Signal: 4-20 ma continuous output signal.
3. Pressure sensors.
  - a. Water Pressure Transmitters: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Thermowells.
  - a. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting. Stepped shank unless straight or tapered shank is indicated.  
ASME B40.200. Bore diameter required to match thermometer bulb or stem.  
Insertion length required to match thermometer bulb or stem. Provide a lagging extension on thermowells for insulated piping and tubing. Provide bushings.  
Use a mixture of graphite and glycerin for the thermowell's heat transfer medium.
    - 1) Material for Use with Copper Tubing: copper nickel (90-10).
    - 2) Material for Use with Steel Piping: stainless steel.
- D. Turbine flowmeters (water duty).
  1. Flowmeter shall be as specified in Section 23 09 23, in the "water flow sensors" paragraph. Provide data head on meter as specified in this section.
  2. Sensor shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly

- easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minus 0.05 inch; wetted parts shall be constructed of stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.
- a. Ambient conditions: -40 to 60 degrees C (-40 to 140 degrees F), 5 to 100 percent humidity
  - b. Operating conditions: 850 kPa (125 psig), 0 to 120 degrees C (30 to 250 degrees F), 0.15 to 12 m per second (0.5 to 40 feet per second) velocity.
3. Performance:
- a. Transmitted signal from flowmeter and its transmitter shall have a total (rms) accuracy plus or minus 1% of actual flow rate.
  - b. Flowmeter accuracy shall be no more than plus or minus 0.1% of actual flow rate. Flowmeter repeatability shall be no more than 0.3% of actual flow rate. Meter shall be designed to minimize vibration effect and to provide elimination of this effect.
  - c. Minimum turndown capability shall be 20:1.
  - d. Pressure drop shall be as scheduled, maximum 1% of line pressure in lines sized 4 inches and larger.
  - e. Ambient temperature effects, less than 0.005 percent calibrated span per degree C (degree F) temperature change.
  - f. RFI effect - flow meter shall not be affected by RFI.
  - g. Power supply effect less than 0.02 percent of actual flow rate for a variation of plus or minus 10 percent power supply.
4. Provide a data head on the meter.
- a. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet)..

5. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION REQUIREMENTS**

##### **A. Cabling**

1. Install Category 5e UTP, Category 6 UTP, and optical fiber cabling system as detailed in TIA-568-C.1, TIA/EIA-568-B.2, or TIA-568-C.3.
2. Screw terminals shall not be used except where specifically indicated on plans.
3. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations.
4. Do not untwist Category 5e, Category 6 UTP cables more than 12 mm (1/2 inch) from the point of termination to maintain cable geometry.
5. Provide service loop on each end of the cable, 3 m (10 feet) at the server rack and 304 mm (12 inches) at the meter.
6. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables.
7. Provide a device to monitor cable pull tensions. Do not exceed 110 N (25 pounds) pull tension for four pair copper cables.
8. Do not chafe or damage outer jacket materials.
9. Use only lubricants approved by cable manufacturer.
10. Do not over cinch cables, or crush cables with staples.
11. For UTP cable, bend radii shall not be less than four times the cable diameter.
12. Cables shall be terminated; no cable shall contain unterminated elements.
13. Cables shall not be spliced.
14. Label cabling in accordance with paragraph Labeling in this section.

##### **B. Labeling**

1. Labels: Provide labeling in accordance with TIA/EIA-606-A. Handwritten labeling is unacceptable. Stenciled lettering for all circuits shall be provided using laser printer.
2. Cables: Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA/EIA-606-A.

- C. Grounding: ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and grounding conductor of nonmetallic sheathed cables, as well as equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with VA 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS and with VA 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- D. Surge Protection
  - 1. Provide surge protective devices on all metallic cables entering and leaving an interior environment to an exterior environment or vice versa, i.e. surge protective device at each interior location of a penetration to the exterior environment.
- E. Network Hardware
  - 1. System components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable wired or wireless data transmission system shall be provided and shall be fully integrated with the configured network chosen for the project.
- F. Computer Hardware
  - 1. Provide the server(s) or personal computer workstation(s) where shown on the plans or indicated diagrammatically.
- G. Computer Software
  - 1. User friendly software shall be suitable for operation on computer workstations which serve as site data aggregation devices by monitoring the meters in the system, recording events, indicating alarm conditions, and logging and displaying system reports.
  - 2. The software shall be developed by the manufacturer of the monitoring devices, and shall be designed specifically for energy, power monitoring and control. Additional utilities, i.e. water, air gas, electric and steam shall also be easily integrated.

3. The software shall be configured, not programmed. All software shall be configured by the vendor and delivered ready to use. This configuration shall include preparation of all graphics, displays, and interactive one-line diagrams required as a part of this project.
  - a. Configuration shall be to the point that when monitoring devices are required to be added, the user shall only convey to the software the communications address and type of device.
4. The software shall be a standard product offering with no customization required and clients shall interface with the server or computer workstation via Internet Explorer browser.
  - a. The web-enabled interactive graphics client shall only reside on the server PC, client PC not required to host any application software other than Internet Explorer 6.0 SP1 or higher browser to become a fully functional system.

#### H. Electrical Meters

1. Power monitoring and control components shall all be factory installed, wired and tested prior to shipment to the job site.
2. All control power, CT, PT and data communications wire shall be factory wired and harnessed within the equipment enclosure.
3. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.
4. All wiring required to externally connect separate equipment lineups shall be furnished and installed at the site as part of the contractor's responsibility.
5. Contractor interconnection wiring requirements shall be clearly identified on the power monitoring and control system shop drawings.
6. Contractor shall provide and install all monitoring connection wiring to BACNET/IT system as required.

#### I. Water, Oil and Gas Meters

1. Thermowells



- a. Install thermowells with socket extending a minimum of 2 inches into fluid or one-third of pipe diameter and in vertical position in piping tees.
  - b. Install thermowells of sizes required to match temperature sensor connectors. Include bushings if required to match sizes.
  - c. Install thermowells with extension on insulated piping.
  - d. Fill thermowells with heat-transfer medium.
2. Provide a test plug beside each temperature sensor.
3. Flow meters, general
  - a. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
  - b. Connect flowmeter-system elements to meters, connect flowmeter transmitters to meters, and connect thermal-energy meter transmitters to meters.
  - c. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
  - d. Install flowmeter elements in accessible positions in piping systems.
  - e. Install flowmeter, with minimum 20 x pipe diameter straight lengths of pipe upstream and minimum 10 x pipe diameter straight lengths of pipe downstream from flowmeter unless otherwise indicated by manufacturer's written instructions.
  - f. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

### **3.2 ADJUSTING AND IDENTIFICATION**

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

### **3.3 FIELD QUALITY CONTROL**

- A. The power monitoring and control system vendor must be able to provide development, integration and installation services required to complete and turn over a fully functional system including:
  - 1. Project management to coordinate personnel, information and on-site supervision for the various levels and functions of suppliers required for completion of the project.
  - 2. All technical coordination, installation, integration, and testing of all components.
  - 3. Detailed system design and system drawings.
- B. Cabling, equipment and hardware manufacturers shall have a minimum of 5 years experience in the manufacturing, assembly, and factory testing of components which comply with EIA TIA/EIA-568-B.1, EIA TIA/EIA-568-B.2 and EIA TIA/EIA-568-B.3.
- C. The network cabling contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified network cabling systems and equipment. The contractor shall demonstrate experience in providing successful systems within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful network cabling system installations.
  - 1. Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

### **3.4 ACCEPTANCE TESTING**

- A. Develop testing procedures to address all specified functions and components of the Advanced Utility Metering System (AUMS). Testing shall demonstrate proper and anticipated responses to normal and abnormal operating conditions.
  - 1. Provide skilled technicians to start and operate equipment.
  - 2. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

3. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for issues identified in testing.
  4. Provide all tools to start, check-out and functionally test equipment and systems.
  5. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for issues identified in any testing
  6. Review test procedures, testing and results with Government.
- B. Testing checklists: Develop project-specific checklists to document the systems and all components are installed in accordance with the manufacturers recommendation and the Contract Documents.
- C. Before testing, the following prerequisite items must be completed.
1. All related equipment has been started and start-up reports and checklists submitted and approved as ready for testing:
  2. All associated system functions for all interlocking systems are programmed and operable per contract documents.
  3. All punchlist items for the AUMS and equipment are corrected.
  4. The test procedures reviewed and approved.
  5. Safeties and operating ranges reviewed.
- D. The following testing shall be included:
1. Demonstrate reporting of data and alarm conditions for each point and ensure that alarms are received at the assigned location, including Site Data Collection Device.
  2. Demonstrate ability of software program to function for the intended application.
  3. Demonstrate via graphed trends to show the reports are executed in correct manner.
  4. Demonstrate that the meter readings are accurate using portable NIST traceable portable devices and calibrated valves in the piping system
  5. Demonstrate that the systems perform during power loss and resumption of power.
- E. Copper cables: Contractor shall provide all necessary testing equipment to test all copper network circuit cables. Tests shall conform to EIA/TIA 568B Permanent Link

testing criteria. All testers are to be EIA/TIA 568B, Level IIe compliant. The primary field test parameters are:

1. Wire map: The wire map test is intended to verify pair to pin termination at each end and check for installation connectivity errors. For each of the conductors in the cable, the wire map indicates:
  - a. Continuity to the remote end
  - b. Shorts between any two or more conductors
  - c. Crossed pairs
  - d. Reversed pairs
  - e. Split pairs
  - f. Any other mis-wiring
2. Length requirements: The maximum physical length of the basic link shall be 94 meters (including test equipment cords).
3. Insertion Loss: Worst case insertion loss relative to the maximum insertion loss allowed shall be reported.
4. Near-end crosstalk (NEXT) loss: Field tests of NEXT shall be performed at both ends of the test configuration.
5. Power sum near-end crosstalk (PSNEXT) loss
6. Equal-level far-end crosstalk (ELFEXT): Field tests of ELFEXT shall be performed at both ends of the test configuration
7. Power sum equal-level far-end crosstalk (PSELFEXT): Must be determined from both ends of the cable. Power sum Near End Crosstalk is not a category 3 parameter. For all frequencies from 1 to 100 MHz, the category 5e PSELFEXT of the cabling shall be measured in accordance with annex E of ANSI/TIA/EIA-568-B.2 and shall meet the values determined using equations (12) and (13) for the permanent link. PSELFEXT is not a required category 3 measurement parameter.
8. Return loss: Includes all the components of the link. The limits are based on the category of components and cable lengths. Return loss must be tested at both ends

- of the cable. Cabling return loss is not a required measurement for category 3 cabling.
9. Propagation delay and delay skew: Propagation delay is the time it takes for a signal to propagate from one end to the other. Propagation delay shall be measured in accordance with annex D of ANSI/TIA/EIA-568 B.2. The maximum propagation delay for all category permanent link configurations shall not exceed 498 ns measured at 10 MHz. Delay skew is a measurement of the signaling delay difference from the fastest pair to the slowest. Delay skew shall be measured in accordance with annex D of ANSI/TIA/EIA-568-B.2. The maximum delay skew for all category permanent link configurations shall not exceed 44 ns.
- 10.Administration: In addition to Pass/Fail indications, measured values of test parameters should be recorded in the administration system. Any reconfiguration of link components after testing may change the performance of the link and thus invalidates previous test results. Such links shall require retesting to regain conformance.
- 11.Test equipment connectors and cords: Adapter cords that are qualified and determined by the test equipment manufacturer to be suitable for permanent link measurements shall be used to attach the field tester to the permanent link under consideration.
- 12.Test setup: The permanent link test configuration is to be used by installers and users of data telecommunications systems to verify the performance of permanently installed cabling. A schematic representation of the permanent link is illustrated in figure 1. The permanent link consists of up to 90 m (295 ft) of horizontal cabling and one connection at each end and may also include an optional transition/consolidation point connection. The permanent link excludes both the cable portion of the field test instrument cord and the connection to the field test instrument.
- 13.Replace or repair and cables, connectors, and/or terminations found to be defective.

14. Repair, replace, and/or re-work any or all defective components to achieve cabling tests which meet or exceed 568B permanent link requirements prior to acceptance of the installation or payment for services.

F. Optical Fiber cables: Contractor shall provide all necessary testing equipment to test all optical fiber cables.

1. Attenuation Testing:

- a. Singlemode testing shall conform to TIA/EIA 526-7 Method A.1 single jumper reference and TIA/EIA 568-B-1 requirements for link segment testing.
- b. Multimode testing shall conform to TIA/EIA 526-14-A Method B single jumper reference and TIA/EIA 568-B-1 requirements for link segment testing.
- c. Attenuation testing shall be performed in one direction at each operating wavelength.
- d. Testing of backbone fiber optic cabling shall be performed from main telecommunications room to each telecommunications room.
- e. Testing of horizontal fiber optic cabling shall be performed from telecommunications room to station outlet location.
- f. Tester shall be capable of recording and reporting test reading in an electronic format.

2. OTDR Testing:

- a. OTDR testing is required on all backbone fiber optic cables
- b. The test shall be performed as per the EIA/TIA 455-61.
- c. Multimode testing shall be performed with a minimum 80 meter launch cable.
- d. Singlemode testing shall be performed with a minimum of 500 meter launch cable.
- e. Tests shall be performed on each fiber in each direction at both operating wavelengths.

3. Test report data shall reference cables by cable labeling standards. Tests shall be submitted on a 1.5mb, 3.5" DOS formatted floppy disk. Contractor shall provide

- tests in the native file format of the tester. Contractor shall provide all software needed to view, print, and edit tests.
4. Replace or repair and defective cables, connectors, terminations, etc.
  5. Mated connector pairs shall have no more than 0.5dB loss. Fusion splices shall have no more than .15dB loss per splice. Cable attenuation shall be no more than 2% more than the attenuation of the cable on the reel as certified at the factory.
- Repair, replace, and/or rework any or all defective components to achieve specified test results prior to acceptance of the installation or payment for services.
- G. Wireless Modems: Test system by sending 100,000 commands. Frame error rate shall not be greater than 5 out 100,000 commands.

### **3.5 DEMONSTRATION AND INSTRUCTION**

- A. Furnish the services of a factory-trained engineer or technician for a total of two four-hour classes to instruct designated Facility Information Technologies personnel. Instruction shall include cross connection, corrective, and preventive maintenance of the wired network system and connectivity equipment.
- B. Before the System can be accepted by the VA, this training must be provided and executed. Training will be scheduled at the convenience of the Facilities Contracting Officer and Chief of Engineering Service.
- C. On-site start-up and training of the advanced utility metering system shall include a complete working demonstration of the system with simulation of possible operating conditions that may be encountered.
1. Include any documentation and hands-on exercises necessary to enable electrical and mechanical operations personnel to assume full operating responsibility for the advanced utility monitoring system after completion of the training period.
- D. Include 6 days on-site start-up assistance and 3 days on-site training in two sessions separated by minimum 1 month.
- E. Regularly schedule and make available factory training for VA staff training on all aspects of advanced utility metering system including:
1. Comprehensive software and hardware setup, configuration, and operation.

2. Advanced monitoring and data reporting.
  3. Advanced power quality and disturbance monitoring.
- F. Before the system is accepted by the VA, the contractor shall walk-through the installation with the VA's representative and the design engineer to verify proper installation. The contractor may be requested to open enclosures and terminal compartments to verify cable labeling and/or installation compliance.
- G. As-built drawings shall be provided noting the exact cable path and cable labeling information. Drawings in .DWG format will be available to the contractor. As-builts shall be submitted to the VA on disk saved as .DXF or .DWG files. Redline hardcopies shall be provided as well. CAD generated as-built information shall be shown on a new layer named AS\_BUILT.

----- END -----



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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.
- C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.
- D. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

**1.2 MINIMUM REQUIREMENTS**

- A. The latest International Building Code (IBC), Underwriters Laboratories, Inc. (UL), Institute of Electrical and Electronics Engineers (IEEE), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.
- B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

**1.3 TEST STANDARDS**

- A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which

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

**B. Definitions:**

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

**1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)**

- A. **Manufacturer's Qualifications:** The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified

for this project, and shall have manufactured the materials and equipment for at least three years.

B. Product Qualification:

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

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

**1.5 APPLICABLE PUBLICATIONS**

- A. Applicable publications listed in all Sections of Division 26 shall be the latest issue, unless otherwise noted.
- B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

**1.6 MANUFACTURED PRODUCTS**

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available. Materials and equipment furnished shall be new, and shall have superior quality and freshness.
- B. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
  1. Components of an assembled unit need not be products of the same manufacturer.
  2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Tests are specified, Factory Tests shall be performed in the factory by the equipment manufacturer, and witnessed by the contractor. In addition, the following requirements shall be complied with:
  1. The Government shall have the option of witnessing factory tests. The Contractor shall notify the Government through the COR a minimum of thirty (30) days prior to the manufacturer's performing of the factory tests.
  2. When factory tests are successful, contractor shall furnish four (4) copies of the equipment manufacturer's certified test reports to the COR fourteen (14) days prior to shipment of the equipment, and not more than ninety (90) days after completion of the factory tests.
  3. When factory tests are not successful, factory tests shall be repeated in the factory by the equipment manufacturer, and witnessed by the Contractor. The Contractor shall be liable for all additional expenses for the Government to witness factory re-testing.

#### **1.7 VARIATIONS FROM CONTRACT REQUIREMENTS**

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

#### **1.8 MATERIALS AND EQUIPMENT PROTECTION**

- A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
  1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.

2. During installation, equipment shall be protected against entry of foreign matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
3. Damaged equipment shall be repaired or replaced, as determined by the COR.
4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
5. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

### **1.9 WORK PERFORMANCE**

- A. All electrical work shall comply with requirements of the latest NFPA 70 (NEC), NFPA 70B, NFPA 70E, NFPA 99, NFPA 110, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, in addition to other references required by contract.
- B. Job site safety and worker safety is the responsibility of the Contractor.
- C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. However, energized electrical work may be performed only for the non-destructive and non-invasive diagnostic testing(s), or when scheduled outage poses an imminent hazard to patient care, safety, or physical security. In such case, all aspects of energized electrical work, such as the availability of appropriate/correct personal protective equipment (PPE) and the use of PPE, shall comply with the latest NFPA 70E, as well as the following requirements:
  1. Only Qualified Person(s) shall perform energized electrical work. Supervisor of Qualified Person(s) shall witness the work of its entirety to ensure compliance with safety requirements and approved work plan.
  2. At least two weeks before initiating any energized electrical work, the Contractor and the Qualified Person(s) who is designated to perform the work shall visually inspect, verify and confirm that the work area and electrical equipment can safely accommodate the work involved.

3. At least two weeks before initiating any energized electrical work, the Contractor shall develop and submit a job specific work plan, and energized electrical work request to the COR, and Medical Center's Chief Engineer or his/her designee. At the minimum, the work plan must include relevant information such as proposed work schedule, area of work, description of work, name(s) of Supervisor and Qualified Person(s) performing the work, equipment to be used, procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.
4. Energized electrical work shall begin only after the Contractor has obtained written approval of the work plan, and the energized electrical work request from the COR, and Medical Center's Chief Engineer or his/her designee. The Contractor shall make these approved documents present and available at the time and place of energized electrical work.
5. Energized electrical work shall begin only after the Contractor has invited and received acknowledgment from the COR, and Medical Center's Chief Engineer or his/her designee to witness the work.
- D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interference.

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

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working clearances shall not be less than specified in the NEC.
- C. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
- D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

#### **1.11 EQUIPMENT IDENTIFICATION**

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 12 mm (1/2 inch) high. Identification signs shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.
- C. Install adhesive arc flash warning labels on all equipment as required by the latest NFPA 70E. Label shall show specific and correct information for specific equipment based on its arc flash calculations. Label shall show the followings:

1. Nominal system voltage.
2. Equipment/bus name, date prepared, and manufacturer name and address.
3. Arc flash boundary.
4. Available arc flash incident energy and the corresponding working distance.
5. Minimum arc rating of clothing.
6. Site-specific level of PPE.

#### **1.12 SUBMITTALS**

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



2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion, etc.) associated with equipment or piping so that the proposed installation can be properly reviewed. Include sufficient fabrication information so that appropriate mounting and securing provisions may be designed and attached to the equipment.
  3. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  4. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.
- F. Maintenance and Operation Manuals:
1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
  2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the material or equipment.
  3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
  4. The manuals shall include:
    - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
    - b. A control sequence describing start-up, operation, and shutdown.
    - c. Description of the function of each principal item of equipment.

- d. Installation instructions.
  - e. Safety precautions for operation and maintenance.
  - f. Diagrams and illustrations.
  - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
  - h. Performance data.
  - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.
  - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
- G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.
- H. After approval and prior to installation, furnish the COR with one sample of each of the following:
- 1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
  - 2. Each type of conduit coupling, bushing, and termination fitting.
  - 3. Conduit hangers, clamps, and supports.
  - 4. Duct sealing compound.
  - 5. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

### **1.13 SINGULAR NUMBER**

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

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

- A. The Contractor shall furnish the instruments, materials, and labor for tests.
- B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Government.
- C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests for the equipment. Repair, replacement, and re-testing shall be accomplished at no additional cost to the Government.

#### **1.16 WARRANTY**

- A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer for the Government.

#### **1.17 INSTRUCTION**

- A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.
- B. Furnish the services of competent and factory-trained instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be factory-trained in operating theory as well as practical operation and maintenance procedures.
- C. A training schedule shall be developed and submitted by the Contractor and approved by the //Resident Engineer// //COR// at least 30 days prior to the planned training.

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

#### **PART 3 - EXECUTION (NOT USED)**

---END---

**SECTION 26 05 13**  
**MEDIUM-VOLTAGE CABLES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for medium-voltage cables.
- D. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Manholes and ducts for medium-voltage cables.
- E. Section 26 12 19, PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS: Medium-voltage cable terminations for use in pad-mounted, liquid-filled, medium-voltage transformers.

**1.3 QUALITY ASSURANCE**

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

**1.4 FACTORY TESTS**

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

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

### **1.5 SUBMITTALS**

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

1. Shop Drawings:
  - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
  - b. Submit the following data for approval:
    - 1) Complete electrical ratings.
    - 2) Installation instructions.
2. Samples:
  - a. After approval of submittal and prior to installation, Contractor shall furnish sample in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
3. Certifications:
  - a. Factory Test Reports: Submit certified factory production test reports for approval.
  - b. Field Test Reports: Submit field test reports for approval.
  - c. Compatibility: Submit a certificate from the cable manufacturer that the splices and terminations are approved for use with the cable.
  - d. Two weeks prior to final inspection, submit the following.
    - 1) Certification by the manufacturer that the cables, splices, and terminations conform to the requirements of the drawings and specifications.
    - 2) Certification by the Contractor that the cables, splices, and terminations have been properly installed and tested.

- 3) Certification by the Contractor that each splice and each termination were completely installed in a single continuous work period by a single qualified worker without any overnight interruption.
4. Qualified Worker Approval:
  - a. Qualified workers who install cables, splices, and terminations shall have a minimum of five years of experience splicing and terminating cables, including experience with the materials in the approved splices and terminations.  
Qualified workers who perform cable testing shall have a minimum of five year of experience performing electrical testing of medium-voltage cables, including the ability to understand, interpret test results and develop test report.
  - b. Furnish satisfactory proof of such experience for each qualified worker who splices or terminates the cables.

#### 1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Society for Testing and Materials (ASTM):  
B3-13 .....Standard Specification for Soft or Annealed Copper Wire
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):  
48-09 .....Test Procedures and Requirements for Alternating-Current  
Cable Terminations Used on Shielded Cables Having  
Laminated Insulation Rated 2.5 kV through 765 kV or  
Extruded Insulation Rated 2.5 kV through 500 kV  
386-06 .....Separable Insulated Connector Systems for Power  
Distribution Systems above 600 V  
400-12 .....Guide for Field Testing and Evaluation of the Insulation of  
Shielded Power Cable Systems  
400.2-13 .....Guide for Field Testing of Shielded Power Cable Systems  
Using Very Low Frequency (VLF)

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

D. National Electrical Manufacturers Association (NEMA):

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

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

E. National Fire Protection Association (NFPA):

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

F. Underwriters Laboratories (UL):

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

## 1.7 SHIPMENT AND STORAGE

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

## PART 2 - PRODUCTS

### 2.1 CABLE

- A. Cable shall be in accordance with ASTM, IEEE, NEC, NEMA and UL, and as shown on the drawings.
- B. Single conductor stranded copper conforming to ASTM B3.
- C. Voltage Rating:
  - 1. 15,000 V cable shall be used on all distribution systems with voltages ranging from 5,000 V to 15,000 V.
- D. Insulation:
  - 1. Insulation level shall be 133%.
  - 2. Types of insulation:

- a. Cable type abbreviation, EPR: Ethylene propylene rubber insulation shall be thermosetting, light and heat stabilized.
- b. Cable type abbreviation, XLP, XLPE, or TR-XLPE: cross-linked polyethylene insulation shall be thermosetting, light and heat stabilized, and chemically cross-linked.
- E. Insulation shield shall be semi-conducting. Conductor shield shall be semi-conducting.
- F. Insulation shall be wrapped with copper shielding tape, helically-applied over semi-conducting insulation shield.
- G. Heavy duty, overall protective polyvinyl chloride jacket shall enclose every cable. The manufacturer's name, cable type and size, and other pertinent information shall be marked or molded clearly on the overall protective jacket.
- H. Cable temperature ratings for continuous operation, emergency overload operation, and short circuit operation shall be not less than the NEC, NEMA WC 71, or NEMA WC 74 standard for the respective cable.

## **2.2 SPLICES AND TERMINATIONS**

- A. Materials shall be compatible with the cables being spliced and terminated, and shall be suitable for the prevailing environmental conditions.
- B. In locations where moisture might be present, the splices shall be watertight. In manholes and pullboxes, the splices shall be submersible.
- C. Splices:
  - 1. Shall comply with IEEE 404. Include all components required for complete splice, with detailed instructions.
- D. Terminations:
  - 1. Shall comply with IEEE 48. Include shield ground strap for shielded cable terminations.
  - 4. Class 3 terminations for outdoor use: Kit with stress cone and compression-type connector.



7. Ground metallic cable shields with a device designed for that purpose, consisting of a solderless connector enclosed in watertight rubber housing covering the entire assembly.
8. Provide insulated cable supports to relieve any strain imposed by cable weight or movement. Ground cable supports to the grounding system.

## **2.3 FIREPROOFING TAPE**

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

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

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

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

- A. Blowers shall be provided to force fresh air into manholes where free movement or circulation of air is obstructed. Waterproof protective coverings shall be available on the

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

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

- A. Cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winches, cable-feeding flexible tube guides, cable grips, pulling eyes, and lubricants. A sufficient number of qualified workers and equipment shall be employed to ensure the careful and proper installation of the cable.
- B. Cable reels shall be set up at the side of the manhole opening and above the duct or hatch level, allowing cables to enter through the opening without reverse bending. Flexible tube guides shall be installed through the opening in a manner that will prevent cables from rubbing on the edges of any structural member.
- C. Cable shall be unreeled from the top of the reel. Pay-out shall be carefully controlled. Cables to be pulled shall be attached through a swivel to the main pulling wire by means of a suitable cable grip and pulling eye.
- D. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.
- E. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.
- F. Cables shall be liberally coated with a suitable lubricant as they enter the tube guide or duct. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.
- G. Cables shall be pulled into ducts at a reasonable speed. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately at any indication of binding or obstruction, and shall not be resumed until the potential for

damage to the cable is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

- H. Splices in manholes shall be firmly supported on cable racks. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing.
- I. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture.

### **3.4 SPLICES AND TERMINATIONS**

- A. Install the materials as recommended by the manufacturer, including precautions pertaining to air temperature and humidity during installation.
- B. Installation shall be executed by qualified person trained to perform medium-voltage equipment installations. Tools shall be as recommended or provided by the manufacturer. Installation shall comply with manufacturer's instructions.
- C. Splices in manholes shall be located midway between cable racks on walls of manholes, and supported with cable arms at approximately the same elevation as the enclosing duct.
- D. Where the Government determines that unsatisfactory splices and terminations have been installed, the Contractor shall replace the unsatisfactory splices and terminations with approved material at no additional cost to the Government.

### **3.5 FIREPROOFING**

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

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

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

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

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

A. General:

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

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

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

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

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

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

<u>Voltage Class</u>	<u>Test Voltage</u>	<u>Min. Insulation Resistance</u>
5kV	2,500 VDC	1,000 megohms
15kV	2,500 VDC	5,000 megohms
25kV	5,000 VDC	20,000 megohms
35kV	15,000 VDC	100,000 megohms

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

D. Electrical Tests - Service-Aged Cables: Tests shall be performed for serviced-age cables before inter-connecting to new cables. Perform tests in order shown below:

1. Preparation Prior to Testing: Splices and terminations applied to cables shall be completed prior to testing. Ends of cables intended to be spliced to existing service-aged cables shall be prepared (cut back) to allow testing without flashover or tracking. Cables shall not be connected to other equipment while under test.
2. Perform Insulation-Resistance Test. Test all cables with respect to ground and adjacent cables. All adjacent cables shall be grounded during testing.
  - a. Apply test voltage for a period sufficient to stabilize output voltage and insulation resistance measurement.
  - b. Test data shall include megohm, applied test voltage, and leakage current readings.
  - c. Further testing shall not continue unless the insulation resistance test results meet or exceed the values listed below. Test voltages and minimum acceptable resistance values shall be:

<u>Voltage Class</u>	<u>Test Voltage</u>	<u>Min. Insulation Resistance</u>
5kV	2,500 VDC	1,000 megohms
15kV	2,500 VDC	5,000 megohms
25kV	5,000 VDC	20,000 megohms
35kV	15,000 VDC	100,000 megohms

3. Perform Tan Delta test. Review test readings with the COR prior to proceeding with the VLF Withstand test.
  4. Perform VLF Withstand test. Utilize test voltages in accordance with IEEE 400.2.
- E. Electrical Tests – Inter-connected New Cables and Service-Aged Cables: After successful Tan Delta and VLF Withstand testing of new cables, perform final splicing inter-connecting between new and service-aged cables. Once new and service-aged cables are completely inter-connected, conduct Tan Delta and VLF Withstand tests for the entire inter-connected cable. Utilize maintenance test voltage for VLF Withstand testing.
- F. Field Test Report: Submit a field test report to the COR that includes the following information:
1. Project Name, Location, Test Date.
  2. Name of Technician and Company performing the test.
  3. Ambient temperature and humidity at time of test.
  4. Name, Model Number and Description of Test Equipment used.
  5. Circuit identification, cable length, cable type and size, insulation type, cable manufacturer, service age (if any), voltage rating, description of splices or terminations.
  6. Visual field inspection notes, findings, and photographs.
  7. Insulation Resistance Test results:
    - a. Test voltage.
    - b. Measurement in Megohms.

- c. Leakage current.
- 8. Tan Delta results:
  - a. Test voltage.
  - b. Waveform (sinusoidal or cosine-rectangular).
  - c. Mean Tan Delta at  $V_0$ .
  - d. Stability measured by Standard Deviation at  $V_0$ .
  - e. Differential Tan Delta.
  - f. IEEE Condition Assessment Rating.
- 9. VLF Withstand results:
  - 1) Test voltage.
  - 2) Waveform (sinusoidal or cosine-rectangular).
  - 3) Pass/Fail Rating.
- 10. Conclusions. If any deficiency is discovered based on test results, provide recommendations for corrective action.
- G. Final Acceptance: Final acceptance shall depend upon the satisfactory performance of the cables under test. No cable shall be put into service until all tests are successfully passed, and field test reports have been approved by the COR.

---END---

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

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

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Submit the following data for approval:



- 1) Electrical ratings and insulation type for each conductor and cable.
  - 2) Splicing materials and pulling lubricant.
2. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.
- B. American Society of Testing Material (ASTM):
- D2301-10.....Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- D2304-10.....Test Method for Thermal Endurance of Rigid Electrical Insulating Materials
- D3005-10.....Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- C. National Electrical Manufacturers Association (NEMA):
- WC 70-09.....Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- D. National Fire Protection Association (NFPA):
- 70-17 .....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
- 44-14 .....Thermoset-Insulated Wires and Cables
- 83-14 .....Thermoplastic-Insulated Wires and Cables
- 467-13 .....Grounding and Bonding Equipment
- 486A-486B-13 .....Wire Connectors
- 486C-13 .....Splicing Wire Connectors

- 486D-15.....Sealed Wire Connector Systems
- 486E-15 .....Equipment Wiring Terminals for Use with Aluminum  
and/or Copper Conductors
- 493-07 .....Thermoplastic-Insulated Underground Feeder and Branch  
Circuit Cables
- 514B-12 .....Conduit, Tubing, and Cable Fittings

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

- A. Conductors and cables shall be in accordance with ASTM, NEMA, NFPA, UL, as specified herein, and as shown on the drawings.
- B. All conductors shall be copper.
- C. Single Conductor and Cable:
1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
  2. No. 12 AWG and larger: Stranded.
  4. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.
- E. Color Code:
1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
  2. No. 8 AWG and larger: Color-coded using one of the following methods:
    - a. Solid color insulation or solid color coating.
    - b. Stripes, bands, or hash marks of color specified.
    - c. Color using 19 mm (0.75 inches) wide tape.
  4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
  5. Conductors shall be color-coded as follows:

208/120 V	Phase	480/277 V
Black	A	Brown
Red	B	Orange

Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

6. Lighting circuit “switch legs”, and 3-way and 4-way switch “traveling wires,” shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate color coding in the field with the COR.
7. Color code for isolated power system wiring shall be in accordance with the NEC.

## 2.2 SPLICES

- A. Splices shall be in accordance with NEC and UL.
- B. Above Ground Splices for No. 10 AWG and Smaller:
  1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
  2. The integral insulator shall have a skirt to completely cover the stripped conductors.
  3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.
- C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:
  1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
  2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
  3. Splice and insulation shall be product of the same manufacturer.
  4. All bolts, nuts, and washers used with splices shall be zinc-plated.
- D. Above Ground Splices for 250 kcmil and Larger:
  1. Long barrel “butt-splice” or “sleeve” type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.

2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
  3. Splice and insulation shall be product of the same manufacturer.
- G. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

## **2.3 CONNECTORS AND TERMINATIONS**

- A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
- B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
- C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be zinc-plated.

## **2.4 CONTROL WIRING**

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

## **2.5 WIRE LUBRICATING COMPOUND**

- A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.
- B. Shall not be used on conductors for isolated power systems.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
  1. Provide a separate neutral for each 120 and 277 volt circuit. The use of "Edison Circuits", 1 neutral serving more than one circuit, is not permitted.

- B. Install all conductors in raceway systems.
- C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.
- D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.
- E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- F. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.
- G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.
- H. Use expanding foam or non-hardening duct-seal to seal conduits entering a building, after installation of conductors.
- I. Conductor and Cable Pulling:
  - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
  - 2. Use nonmetallic pull ropes.
  - 3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
  - 4. All conductors in a single conduit shall be pulled simultaneously.
  - 5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- J. No more than three branch circuits shall be installed in any one conduit.
- K. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

### **3.2 INSTALLATION IN MANHOLES**

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

B. Fireproofing:

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

**3.3 SPLICE AND TERMINATION INSTALLATION**

- A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Government.

**3.4 CONDUCTOR IDENTIFICATION**

- A. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.

**3.5 FEEDER CONDUCTOR IDENTIFICATION**

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

**3.6 EXISTING CONDUCTORS**

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

### **3.7 CONTROL WIRING INSTALLATION**

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

SPEC WRITER NOTE: Each separate system shall  
have a dedicated power supply circuit.

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

### **3.8 CONTROL WIRING IDENTIFICATION**

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

### **3.10 ACCEPTANCE CHECKS AND TESTS**

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests: Inspect physical condition.
  - 2. Electrical tests:
    - a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
    - b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
    - c. Perform phase rotation test on all three-phase circuits.

---END---

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- D. Section 26 12 19, PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS: pad-mounted, liquid-filled, medium-voltage transformers.
- E. Section 26 13 13, MEDIUM-VOLTAGE CIRCUIT BREAKER SWITCHGEAR: Medium-voltage circuit breaker switchgear.
- F. Section 26 23 13, GENERATOR PARALLELING CONTROLS: Generator paralleling controls.
- G. Section 26 13 16, MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHES: Medium-voltage fusible interrupter switches.
- H. Section 26 22 00, LOW-VOLTAGE TRANSFORMERS: Low-voltage transformers.
- I. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Low-voltage switchgear.
- J. Section 26 24 13, DISTRIBUTION SWITCHBOARDS: Low-voltage distribution switchboards.
- K. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.



- L. Section 26 24 19, MOTOR CONTROL CENTERS: Motor control centers.
- M. Section 26 32 13, ENGINE GENERATORS: Engine generators.
- N. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.
- O. Section 26 41 00, FACILITY LIGHTNING PROTECTION: Lightning protection.

### **1.3 QUALITY ASSURANCE**

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

### **1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.
  - 2. Test Reports:
    - a. Two weeks prior to the final inspection, submit ground resistance field test reports to the COTR.
  - 3. Certifications:
    - a. Certification by the Contractor that the grounding equipment has been properly installed and tested.

### **1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Society for Testing and Materials (ASTM):
  - B1-13 .....Standard Specification for Hard-Drawn Copper Wire
  - B3-13 .....Standard Specification for Soft or Annealed Copper Wire

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

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

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

D. National Fire Protection Association (NFPA):

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

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

99-15 .....Health Care Facilities

E. Underwriters Laboratories, Inc. (UL):

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

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

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

## **PART 2 - PRODUCTS**

### **2.1 GROUNDING AND BONDING CONDUCTORS**

- A. Equipment grounding conductors shall be insulated stranded copper for sizes 12 AWG and larger. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.
- B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.
- C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.
- D. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

SPEC WRITER NOTE: Specify stainless steel ground rods for corrosive soil conditions.

### **2.2 GROUND RODS**

- A. Copper clad steel, 19 mm (0.75 inch) diameter by 3 M (10 feet) long.

- B. Quantity of rods shall be as shown on the drawings, and as required to obtain the specified ground resistance.

### **2.3 CONCRETE ENCASED ELECTRODE**

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

### **2.4 GROUND CONNECTIONS**

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

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

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

### **2.6 GROUND TERMINAL BLOCKS**

- A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with

zinc-plated bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

## **2.7 GROUNDING BUS BAR**

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

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. System Grounding:
  - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
  - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
  - 3. A green insulated ground wire shall be installed in all raceways.
- C. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.
- D. For patient care area electrical power system grounding, conform to the latest NFPA 70 and 99.

### **3.2 INACCESSIBLE GROUNDING CONNECTIONS**

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

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

- A. Switchgear: Provide a bare grounding electrode conductor from the switchgear ground bus to the grounding electrode system.
- B. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing medium-voltage conductors, sized per NEC except that minimum size shall be No. 2 AWG. Bond the equipment grounding conductors to the switchgear ground bus, to all manhole grounding provisions and hardware, to the cable shield grounding provisions of medium-voltage cable splices and terminations, and to equipment enclosures.
- C. Pad-Mounted Transformers:
  - 1. Provide a driven ground rod and bond with a grounding electrode conductor to the transformer grounding pad.
  - 2. Ground the secondary neutral.
- D. Lightning Arresters: Connect lightning arresters to the equipment ground bus or ground rods as applicable.

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

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Structural Steel, and Supplemental Electrode(s):
  - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.
  - 2. Provide a supplemental ground electrode as shown on the drawings and bond to the grounding electrode system.
- C. Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control Centers, Engine-Generators, Automatic Transfer Switches, and other electrical equipment:
  - 1. Connect the equipment grounding conductors to the ground bus.

2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

D. Transformers:

1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment.

- E. Ground lighting fixtures to the green grounding conductor of the wiring system,

### **3.5 RACEWAY**

A. Conduit Systems:

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

- B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

C. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes

(except for special grounding systems for intensive care units and other critical units shown).

2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

D. Wireway Systems:

1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).
3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
4. Use insulated No. 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).

E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

F. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

H. Raised Floors: Provide bonding for all raised floor components as shown on the drawings.

I. Panelboard Bonding in Patient Care Areas: The equipment grounding terminal buses of the normal and essential branch circuit panel boards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than No. 10 AWG, installed in rigid metal conduit.

### **3.6 OUTDOOR METALLIC FENCES AROUND ELECTRICAL EQUIPMENT**

- B. Drive ground rods until the top is 300 mm (12 inches) below grade. Attach a No. 4 AWG copper conductor by exothermic weld to the ground rods, and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 300 mm (12 inches) of fence mesh and fasten by two approved bronze compression fittings, one to bond the wire to post and the other to bond the wire to fence. Each gate section shall be bonded to its gatepost by a 3 mm x 25 mm (0.375 inch x 1 inch) flexible, braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

### **3.7 CORROSION INHIBITORS**

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

### **3.8 CONDUCTIVE PIPING**

- A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In operating rooms and at intensive care and coronary care type beds, bond the medical gas piping and medical vacuum piping at the outlets directly to the patient ground bus.

### **3.9 LIGHTNING PROTECTION SYSTEM**

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

### **3.10 MAIN ELECTRICAL ROOM GROUNDING**

- A. Provide ground bus bar and mounting hardware at each main electrical room where incoming feeders are terminated, as shown on the drawings. Connect to pigtail extensions of the building grounding ring, as shown on the drawings.

### **3.11 EXTERIOR LIGHT POLES**

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



### **3.12 GROUND RESISTANCE**

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

### **3.13 GROUND ROD INSTALLATION**

- A. For outdoor installations, drive each rod vertically in the earth, until top of rod is 610 mm (24 inches) below final grade.
- B. For indoor installations, leave 100 mm (4 inches) of each rod exposed.
- C. Where buried or permanently concealed ground connections are required, make the connections by the exothermic process, to form solid metal joints. Make accessible ground connections with mechanical pressure-type ground connectors.
- D. Where rock or impenetrable soil prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified ground resistance.

### **3.14 ACCEPTANCE CHECKS AND TESTS**

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

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

---END---

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 06 10 00, ROUGH CARPENTRY: Mounting board for telephone closets.
- B. Section 07 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
- C. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- D. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- E. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Conduits bracing.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- H. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- I. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.
- J. Section 31 20 00, EARTHWORK: Bedding of conduits.

### 1.3 QUALITY ASSURANCE

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

### 1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Size and location of main feeders.
    - b. Size and location of panels and pull-boxes.
    - c. Layout of required conduit penetrations through structural elements.
    - d. Submit the following data for approval:
      - 1) Raceway types and sizes.
      - 2) Conduit bodies, connectors and fittings.
      - 3) Junction and pull boxes, types and sizes.
  - 2. Certifications: Two weeks prior to final inspection, submit the following:
    - a. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.
    - b. Certification by the Contractor that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have been properly installed.

### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Iron and Steel Institute (AISI):
  - S100-12 .....North American Specification for the Design of Cold-Formed Steel Structural Members
- C. National Electrical Manufacturers Association (NEMA):

- C80.1-15 .....Electrical Rigid Steel Conduit
- C80.3-15 .....Steel Electrical Metal Tubing
- C80.6-05 .....Electrical Intermediate Metal Conduit
- FB1-14 .....Fittings, Cast Metal Boxes and Conduit Bodies for Conduit,  
Electrical Metallic Tubing and Cable
- FB2.10-13 .....Selection and Installation Guidelines for Fittings for use  
with Non-Flexible Conduit or Tubing (Rigid Metal Conduit,  
Intermediate Metallic Conduit, and Electrical Metallic  
Tubing)
- FB2.20-14 .....Selection and Installation Guidelines for Fittings for use  
with Flexible Electrical Conduit and Cable
- TC-2-13 .....Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
- TC-3-13 .....PVC Fittings for Use with Rigid PVC Conduit and Tubing
- D. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  - 1-05 .....Flexible Metal Conduit
  - 5-16 .....Surface Metal Raceway and Fittings
  - 6-07 .....Electrical Rigid Metal Conduit - Steel
  - 50-15 .....Enclosures for Electrical Equipment
  - 360-13 .....Liquid-Tight Flexible Steel Conduit
  - 467-13 .....Grounding and Bonding Equipment
  - 514A-13 .....Metallic Outlet Boxes
  - 514B-12 .....Conduit, Tubing, and Cable Fittings
  - 514C-14 .....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
  - 651-11 .....Schedule 40 and 80 Rigid PVC Conduit and Fittings
  - 651A-11 .....Type EB and A Rigid PVC Conduit and HDPE Conduit
  - 797-07 .....Electrical Metallic Tubing
  - 1242-14 .....Electrical Intermediate Metal Conduit - Steel

## **PART 2 - PRODUCTS**

### **2.1 MATERIAL**

- A. Conduit Size: In accordance with the NEC, but not less than ¾-inch .
- B. Conduit:
  - 1. Size: In accordance with the NEC, but not less than ¾-inch.
  - 2. Rigid Steel Conduit (RMC): Shall conform to UL 6 and NEMA C80.1.
  - 4. Rigid Intermediate Steel Conduit (IMC): Shall conform to UL 1242 and NEMA C80.6.
  - 5. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and NEMA C80.3.  
Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.
  - 6. Flexible Metal Conduit: Shall conform to UL 1.
  - 7. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
  - 8. Direct Burial Plastic Conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).
  - 9. Surface Metal Raceway: Shall conform to UL 5.
- C. Conduit Fittings:
  - 1. Rigid Steel and Intermediate Metallic Conduit Fittings:
    - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
    - b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows:  
Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
    - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
    - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
    - e. Erickson (Union-Type) and Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and

cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

- f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
3. Electrical Metallic Tubing Fittings:
- a. Fittings and conduit bodies shall meet the requirements of UL 514B, NEMA C80.3, and NEMA FB1.
  - b. Only steel or malleable iron materials are acceptable.
  - c. Compression Couplings and Connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
  - d. Indent-type connectors or couplings are prohibited.
  - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
4. Flexible Metal Conduit Fittings:
- a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
  - b. Clamp-type, with insulated throat.
5. Liquid-tight Flexible Metal Conduit Fittings:
- a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
  - b. Only steel or malleable iron materials are acceptable.
  - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
6. Direct Burial Plastic Conduit Fittings: Fittings shall meet the requirements of UL 514C and NEMA TC3.
7. Surface Metal Raceway Fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end

- caps, conduit entry fittings, accessories, and other fittings as required for complete system.
8. Expansion and Deflection Couplings:
    - a. Conform to UL 467 and UL 514B.
    - b. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
    - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
    - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
  9. Conduit sizes 2" and smaller shall utilize compression type fittings. Conduit sizes 2" and larger are permitted to utilize set screw type fittings.

Conduit Supports:

    1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
    2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
    3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) diameter steel hanger rods.
    4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
  - E. Outlet, Junction, and Pull Boxes:
    1. Comply with UL-50 and UL-514A.
    2. Rustproof cast metal where required by the NEC or shown on drawings.
    3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.
  - F. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.



## **PART 3 - EXECUTION**

### **3.1 PENETRATIONS**

A. Cutting or Holes:

1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COR prior to drilling through structural elements.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except when permitted by the COR where working space is limited.

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

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

### **3.2 INSTALLATION, GENERAL**

- A. In accordance with NEC, NEMA, UL, as shown on drawings, and as specified herein.
- B. Raceway systems used for Essential Electrical Systems (EES) shall be entirely independent of other raceway systems.
- C. Install conduit as follows:
1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
  2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
  3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.

4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
  5. Cut conduits square, ream, remove burrs, and draw up tight.
  6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.
  7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
  8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
  9. Close ends of empty conduits with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
  10. Conduit installations under fume and vent hoods are prohibited.
  11. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
  12. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
  13. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
- D. Conduit Bends:
1. Make bends with standard conduit bending machines.
  2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
  3. Bending of conduits with a pipe tee or vise is prohibited.
- E. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.

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

### **3.3 CONCEALED WORK INSTALLATION**

#### **A. In Concrete:**

1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only:
  - 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 inches) thick is prohibited.
  - a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
  - b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
  - c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (0.75-inch) of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

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

1. Conduit for Conductors Above 600 V: Rigid steel. Mixing different types of conduits in the same system is prohibited.
2. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the same system is prohibited.

3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
5. Tightening set screws with pliers is prohibited.
6. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.

### **3.4 EXPOSED WORK INSTALLATION**

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

### **3.5 DIRECT BURIAL INSTALLATION**

Refer to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

### **3.6 HAZARDOUS LOCATIONS**

- A. Use rigid steel conduit only.
- B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

### **3.7 WET OR DAMP LOCATIONS**

- A. Use rigid steel or IMC conduits unless as shown on drawings.
- B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
- C. Use rigid steel or IMC conduit within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.
- D. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

### **3.8 MOTORS AND VIBRATING EQUIPMENT**

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

### 3.9 EXPANSION JOINTS

- A. Conduits 75 mm (3 inch) 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 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.
- C. Install expansion and deflection couplings where shown.
- D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper bonding jumper installed.

### 3.10 CONDUIT SUPPORTS

- A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
  - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
  - 2. Existing Construction:

- a. Steel expansion anchors not less than 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
  - b. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
  - c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

### **3.11 BOX INSTALLATION**

- A. Boxes for Concealed Conduits:
- 1. Flush-mounted.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.
- C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.
- D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

- E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.
- F. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.
- G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
- H. Label all covers of electrical boxes with the panel name and circuits contained in the box. For example, "L2S-15,17,19".
- I. On all branch circuit junction box covers, identify the circuits with black marker.
- J. For boxes installed in metal stud construction, use rigid support metal bar hangers or metal bar fasteners attached to (2) studs. Screwing boxes directly to joists or studs is not acceptable.

--- E N D ---



**SECTION 26 05 39**  
**UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of the underfloor raceways to form a complete, coordinated, grounded raceway system.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices installed as part of the underfloor raceway system.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Provide plan drawings, section drawings, and details.
    - c. Identify components and accessories such as expansion-joint assemblies, straight raceway lengths, inserts, junction boxes, and service fittings.

- d. Provide dimensions locating raceway components. Include spacing between preset inserts and between preset inserts and ends of raceway runs, walls, and columns.
  - e. Show connections between raceways and adjacent structural and architectural elements including slab reinforcement, floor finish work, permanent partitions, and pre-tensioning or post-tensioning components.
  - f. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab.
  - g. Indicate required floor slab thickness for encasement of raceways.
  - h. Show details of connections of underfloor raceways to conduits.
2. Manuals:
- a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and information for ordering replacement parts.
  - b. Manuals shall include information on locating and installing preset and afterset inserts.
  - c. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. As-built Drawings:
- a. Deliver drawings to the COTR showing the exact location of all underfloor ducts and junction boxes dimensioned from the centerline of building columns.
  - b. Show the location and circuiting of all power outlet fittings.
  - c. Show the location of all telecommunications fittings.
4. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the manufacturer that the underfloor raceways conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the underfloor raceways have been properly installed and adjusted.

## 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):  
70-17 .....National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):  
884-16 .....Underfloor Raceways and Fittings

## PART 2 - PRODUCTS

### 2.1 RACEWAYS

- A. Raceways shall comply with NFPA, UL, and as shown on the drawings.
- B. Raceways:
  - 1. The raceway shall have minimum outside dimensions of 79 mm x 32 mm (3-1/8 inches x 1-1/4 inches).
  - 2. Preset inserts shall be spaced 600 mm (24 inches) on centers and shall not be less than 58 mm (2-1/4 inches) in diameter.
  - 3. Raceways shall not be less than No. 16 gauge steel, continuously welded, with corrosion resistant coating, inside and outside.
  - 4. Raceway covers shall be minimum 6mm (1/4 inch) thick steel, with trim coordinated with finishes.
  - 5. Shall have rounded corners.
  - 6. Raceways shall have vertical 90 degree elbows as required.
  - 7. Raceways shall have horizontal 90 degree and 45 degree elbows and tees as required.
  - 8. Raceways shall have all fittings and accessories for a complete installation, such as adjustable supports, connectors, end closures, panel risers, covers, tile and carpet trims, etc.
  - 9. Power and telecommunications raceways shall be separate.

10. Raceways shall provide a 50 mm (2 inch) minimum bending radius for telecommunication cables.
- C. Junction Boxes:
  1. Shall be cast metal or formed steel, with corner conduit adapters.
  2. Each box shall have four screws for adjustment and leveling after installation.
  3. Boxes shall have adjustable covers.
  4. Coverplates shall be removable and the proper depth for and coordinated with the floor coverings and finishes.
- D. Service fittings:
  1. Shall be the low compact type, satin-finished aluminum.
  2. Power outlets shall have receptacles as indicated and as specified in Section 26 27 26, WIRING DEVICES.
  3. Telecommunications outlets shall have dimensions which are approximately the same as the power outlets. Data, telephone and other telecommunications jacks shall be as required by the applicable specifications.
  4. Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, manufacturers recommendations, and as shown on the drawings.
- B. Connect the raceways, boxes, and fittings so they are mechanically firm, electrically continuous, and watertight.
- C. Align, level, and make the raceways parallel to or at right angles with the building walls.
- D. Level raceways with floor slab, including height adjustments for floor finishes.
- E. Raceways shall be free from burrs, sharp edges, dents and other defects.
- F. Cap or plug unused openings with standard fittings.
- G. Fasten the junction boxes firmly in place to prevent their movement during pouring of the slabs.

- H. Raceway systems shall be supported at not more than 1500 mm (five feet) on centers.
- I. Specific methods of installing the raceways shall be demonstrated to and approved by the COTR prior to performing the installation.
- J. Branch circuit wiring shall be the same as that specified for wet locations in Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- K. Ground raceway system.
- L. Seal the raceway system, and prevent water, concrete, or other materials from entering the raceway system during floor construction.
- M. Protect underfloor raceway system from damage. Do not use the installed raceway system as working platforms or walkways. Do not allow equipment or heavy traffic over raceway during construction without first installing ramps over the raceway. Ramps shall be designed so that imposed loads are not transferred to the duct. Components of the system which are damaged during construction shall be replaced.
- N. Provide expansion fittings with suitable bonding jumper where raceway crosses building expansion joints.
- O. Install junction box tops flush and level with finished floor. Install blank closure plates or plugs to close unused junction box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of work.

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

- A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Inspect physical and electrical condition.
    - b. Vacuum-clean raceway interior.
    - c. Clean raceway exterior.

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

- A. Upon completion of acceptance checks, the Contractor shall show by demonstration in service that the raceway is in good operating condition and properly performing the intended functions.

---END---

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of underground ducts and raceways, and precast manholes and pullboxes to form a complete underground electrical raceway system.
- B. The terms “duct” and “conduit” are used interchangeably in this section.

**1.2 RELATED WORK**

- A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 31 20 00, EARTH MOVING: Trenching, backfill, and compaction.

**1.3 QUALITY ASSURANCE**

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Coordinate layout and installation of ducts, manholes, and pullboxes with final arrangement of other utilities, site grading, and surface features.

**1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Submit information on manholes, pullboxes, ducts, and hardware. Submit manhole plan and elevation drawings, showing openings, pulling irons, cable supports, cover, ladder, sump, and other accessories. Where equipment is mounted to manhole/vault. shop drawings shall clearly show equipment mounting details (ie: sectionalizer); all dimensions shall be shown.

- c. Proposed deviations from the drawings shall be clearly marked on the submittals. If it is necessary to locate manholes, pullboxes, or duct banks at locations other than shown on the drawings, show the proposed locations accurately on scaled site drawings, and submit to the COR for approval prior to construction.
2. Certifications: Two weeks prior to the final inspection, submit the following.
  - a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the materials have been properly installed, connected, and tested.

### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Concrete Institute (ACI):  
Building Code Requirements for Structural Concrete  
318-19/318M-19.....Building Code Requirements for Structural Concrete &  
Commentary  
MNL-66-20 .....ACI Detailing Manual
- C. American National Standards Institute (ANSI):  
77-17 .....Underground Enclosure Integrity
- D. American Society for Testing and Materials (ASTM):  
C478/C478M-20.....Standard Specification for Precast Reinforced Concrete Manhole  
Sections  
C858-19 .....Underground Precast Concrete Utility Structures  
C990/C990M-09 .....Joints for Concrete Pipe, Manholes and Precast Box Sections  
Using Preformed Flexible Joint Sealants.
- E. National Electrical Manufacturers Association (NEMA):  
TC 2-20 .....Electrical Polyvinyl Chloride (PVC) Conduit  
TC 3-21 .....Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit  
And Tubing  
TC 6 & 8-20.....Polyvinyl Chloride (PVC) Plastic Utilities Duct For Underground  
Installations



TC 9-20 ..... Fittings For Polyvinyl Chloride (PVC) Plastic Utilities Duct For  
Underground Installation

F. National Fire Protection Association (NFPA):

70-23 ..... National Electrical Code (NEC)

70E-21 ..... National Electrical Safety Code

G. Underwriters Laboratories, Inc. (UL):

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

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

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

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

## **PART 2 - PRODUCTS**

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

A. Structure: Factory-fabricated, reinforced-concrete, monolithically-poured walls and bottom.

Frame and cover shall form top of manhole. Pad-mounted equipment including, but not limited to, medium-voltage sectionalizers shall be mounted on manholes/vaults to provide adequate clearance for means of pulling cabling. Minimum interior dimensions shall be 6'H x 6'W x 10'L.

B. Cable Supports:

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

C. Ladder: Fiberglass with 400 mm (16 inches) rung spacing. Provide securely-mounted ladder for every manhole over 1.2 M (4 feet) deep.

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

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

## **2.2 PULLBOXES**

- A. General: Size as indicated on the drawings. Provide pullboxes with weatherproof, non-skid covers with recessed hook eyes, secured with corrosion- and tamper-resistant hardware. Cover material shall be identical to pullbox material. Covers shall have molded lettering, ELECTRIC or SIGNAL, as applicable. Pullboxes shall comply with the requirements of ANSI 77 Tier 5 loading. Provide pulling irons, 22 mm (0.875 inch) diameter galvanized steel bar with exposed triangular-shaped opening.
- B. Polymer Concrete Pullboxes: Shall be molded of sand, aggregate, and polymer resin, and reinforced with steel, fiberglass, or both. Pullbox shall have open bottom.

## **2.3 DUCTS**

- A. Number and sizes shall be as shown on the drawings.
- B. Ducts (concrete-encased):
  - 1. Plastic Duct:
    - a. UL 651 and 651A Schedule 40 PVC conduit.
    - b. Duct shall be suitable for use with 90° C (194° F) rated conductors.
  - 2. Conduit Spacers: Prefabricated plastic.
- C. Ducts (direct-burial):
  - 1. Plastic duct:
    - a. Schedule 40 PVC.
    - b. Duct shall be suitable for use with 75° C (167° F) rated conductors.
  - 2. Rigid metal conduit: UL 6 and NEMA RN1 galvanized rigid metal, half-lap wrapped with 10 mil PVC tape. Utilize RMC at all 90-deg or greater bends, elbows, or sweeps.

## **2.4 GROUNDING**

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

## **2.5 WARNING TAPE**

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

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

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

### **PART 3 - EXECUTION**

#### **3.1 MANHOLE AND PULLBOX INSTALLATION**

- A. Assembly and installation shall be per the requirements of the manufacturer.
  - 1. Install manholes and pullboxes level and plumb.
  - 2. Units shall be installed on a 300 mm (12 inches) thick level bed of 90% compacted granular fill, well-graded from the 25 mm (1 inch) sieve to the No. 4 sieve. Granular fill shall be compacted with a minimum of four passes with a plate compactor.
- B. Access: Ensure the top of frames and covers are flush with finished grade.
- C. Grounding in Manholes:
  - 1. Ground Rods in Manholes: Drive a ground rod into the earth, through the floor sleeve, after the manhole is set in place. Fill the sleeve with sealant to make a watertight seal. Rods shall protrude approximately 100 mm (4 inches) above the manhole floor.
  - 2. Install a No. 3/0 AWG bare copper ring grounding conductor around the inside perimeter of the manhole and anchor to the walls with metallic cable clips.
  - 3. Connect the ring grounding conductor to the ground rod by an exothermic welding process.
  - 4. Bond the ring grounding conductor to the duct bank equipment grounding conductors, the exposed non-current carrying metal parts of racks, sump covers, and like items in the manholes with a minimum No. 6 AWG bare copper jumper using an exothermic welding process.

#### **3.2 TRENCHING**

- A. Refer to Section 31 20 00, EARTH MOVING for trenching, backfilling, and compaction.
- B. Before performing trenching work at existing facilities, a Ground Penetrating Radar Survey shall be carefully performed by a certified technician to reveal all existing underground ducts, conduits, cables, and other utility systems.
- C. Work with extreme care near existing ducts, conduits, and other utilities to avoid damaging them.
- D. Cut the trenches neatly and uniformly.
- E. For Concrete-Encased Ducts:
  - 1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 1.2 M (4 feet) intervals to establish the grade and route of the duct bank.

2. Pitch the trenches uniformly toward manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts toward buildings wherever possible.
  3. The walls of the trench may be used to form the side walls of the duct bank, provided that the soil is self-supporting and that the concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.
  4. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth, and appropriate warning tape installed.
- F. Individual conduits to be installed under existing paved areas and roads that cannot be disturbed shall be jacked into place using rigid metal conduit, or bored using plastic utilities duct or PVC conduit, as approved by the COR.

### **3.3 DUCT INSTALLATION**

- A. General Requirements:
1. Ducts shall be in accordance with the NEC, as shown on the drawings, and as specified.
  2. Join and terminate ducts with fittings recommended by the manufacturer.
  3. Slope ducts to drain towards manholes and pullboxes, and away from building and equipment entrances. Pitch not less than 100 mm (4 inches) in 30 M (100 feet).
  4. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) outside the building foundation. Tops of conduits below building slab shall be minimum 610 mm (24 inches) below bottom of slab.
  5. Stub-ups and sweeps to equipment mounted on outdoor concrete slabs shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) away from the edge of slab.
  6. Install insulated grounding bushings on the conduit terminations.
  7. Radius for sweeps shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter.
  8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 75 mm (3 inches) above the bottom of the trench during the concrete pour. Spacer spacing shall not exceed 1.5 M (5 feet). Secure spacers to ducts and earth to prevent floating during concrete pour. Provide

- nonferrous tie wires to prevent displacement of the ducts during concrete pour. Tie wires shall not act as substitute for spacers.
9. Duct lines shall be installed no less than 300 mm (12 inches) from other utility systems, such as water, sewer, chilled water.
  10. Clearances between individual ducts:
    - a. For similar services, not less than 75 mm (3 inches).
    - b. For power and signal services, not less than 150 mm (6 inches).
  11. Duct lines shall terminate at window openings in manhole walls as shown on the drawings. All ducts shall be fitted with end bells.
  12. Couple the ducts with proper couplings. Stagger couplings in rows and layers to ensure maximum strength and rigidity of the duct bank.
  13. Keep ducts clean of earth, sand, or gravel, and seal with tapered plugs upon completion of each portion of the work.
  14. Spare Ducts: Where spare ducts are shown, they shall have a nylon pull rope installed. They shall be capped at each end and labeled as to location of the other end.
  15. Duct Identification: Place continuous strip of warning tape approximately 300 mm (12 inches) above ducts before backfilling trenches. Warning tape shall be preprinted with proper identification.
  16. Duct Sealing: Seal ducts, including spare ducts, at building entrances and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of foreign objects and material, moisture, and gases.
  17. Use plastic ties to secure cables to insulators on cable arms. Use minimum two ties per cable per insulator.
- B. Concrete-Encased Ducts:
1. Install concrete-encased ducts for medium-voltage systems, low-voltage systems, and signal systems, unless otherwise shown on the drawings.
  2. Duct banks shall be single or multiple duct assemblies encased in concrete. Ducts shall be uniform in size and material throughout the installation.
  3. Tops of concrete-encased ducts shall be:
    - a. Not less than 600 mm (24 inches) and not less than shown on the drawings, below finished grade.

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

- c. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.
- 3. Do not kink the ducts. Compaction shall not deform the ducts.
- D. Connections to Manholes: Ducts connecting to manholes shall be flared to have an enlarged cross-section to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 300 mm (12 inches) in each direction. Perimeter of the duct bank opening in the manhole shall be flared toward the inside or keyed to provide a positive interlock between the duct and the wall of the manhole. Use vibrators when this portion of the encasement is poured to ensure a seal between the envelope and the wall of the structure.
- E. Connections to Existing Manholes: For duct connections to existing manholes, break the structure wall out to the dimensions required and preserve the steel in the structure wall. Cut steel and extend into the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.
- F. Connections to Existing Ducts: Where connections to existing ducts are indicated, excavate around the ducts as necessary. Cut off the ducts and remove loose concrete from inside before installing new ducts. Provide a reinforced-concrete collar, poured monolithically with the new ducts, to take the shear at the joint of the duct banks.
- G. Partially-Completed Ducts: During construction, wherever a construction joint is necessary in a duct bank, prevent debris such as mud and dirt from entering ducts by providing suitable plugs. Fit concrete envelope of a partially completed ducts with reinforcing steel extending a minimum of 600 mm (2 feet) back into the envelope and a minimum of 600 mm (2 feet) beyond the end of the envelope. Provide one No. 4 bar in each corner, 75 mm (3 inches) from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 300 mm (12 inches) apart. Restrain reinforcing assembly from moving during pouring of concrete.

### **3.4 ACCEPTANCE CHECKS AND TESTS**

- A. Duct Testing and Cleaning:
  - 1. Upon completion of the duct installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the duct, and to test for out-of-round conditions.

2. The mandrel shall be not less than 300 mm (12 inches) long, and shall have a diameter not less than 13 mm (0.5 inch) less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.
3. If testing reveals obstructions or out-of-round conditions, the Contractor shall replace affected section(s) of duct and retest to the satisfaction of the COR.
4. Mandrel pulls shall be witnessed by the COR.

---END---



**SECTION 26 05 73**  
**OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the overcurrent protective device coordination study, related calculations and analysis, indicated as the study in this section.
- B. A short-circuit and selective coordination study, and arc flash calculations and analysis shall be prepared for the electrical overcurrent devices to be installed under this project.
- C. The study shall present a well-coordinated time-current analysis of each overcurrent protective device from the individual device up to the source of service..

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- E. Section 26 24 13, DISTRIBUTION SWITCHBOARDS: Low-voltage distribution switchboards.
- F. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.

**1.3 QUALITY ASSURANCE**

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. The study shall be prepared by the equipment manufacturer, and performed by the equipment manufacturer's licensed electrical engineer.

**1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Product data on the software program to be used for the study. Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.

2. Complete study as described in paragraph 1.6. Submittal of the study shall be well-coordinated with submittals of the shop drawings for equipment in related specification sections.
3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the Contractor that the overcurrent protective devices have been set in accordance with the approved study.

### **1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Institute of Electrical and Electronics Engineers (IEEE):
  - 241-90 .....Recommended Practice Electrical Systems in Commercial Buildings
  - 242-03 .....Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
  - 399-97 .....Recommended Practice for Industrial and Commercial Power Systems Analysis
  - 1584-02 .....Performing Arc-Flash Hazards Calculations
  - 1584A-04 .....Performing Arc-Flash Hazards Calculations – Amendment 1
  - 1584B-11 .....Performing Arc-Flash Hazards Calculations – Amendment 2
- C. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
  - 70E-18 .....Standard for Electrical Safety in the Workplace
  - 99-18 .....Health Care Facilities Code

### **1.6 STUDY REQUIREMENTS**

- A. The study shall be in accordance with IEEE and NFPA standards.
- B. The study shall include one line diagram, short-circuit and ground fault analysis, protective coordination plots for all overcurrent protective devices, and arc flash calculations and analysis.

C. One Line Diagram:

1. Show all electrical equipment and wiring to be protected by the overcurrent devices.
2. Show the following specific information:
  - a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.
  - b. Relay, circuit breaker, and fuse ratings.
  - c. Generator kW/kVA and transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
  - d. Voltage at each bus.
  - e. Identification of each bus, matching the identification on the drawings.
  - f. Conduit, conductor, and busway material, size, length, and X/R ratios.

D. Short-Circuit Study:

1. The study shall be performed using computer software designed for this purpose. Pertinent data and the rationale employed in developing the calculations shall be described in the introductory remarks of the study.
2. Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate applicable motor and/or generator contribution in determining the momentary and interrupting ratings of the overcurrent protective devices.
3. Present the results of the short-circuit study in a table. Include the following:
  - a. Device identification.
  - b. Operating voltage.
  - c. Overcurrent protective device type and rating.
  - d. Calculated short-circuit current.

E. Coordination Study:

1. Prepare the coordination curves to determine the required settings of overcurrent protective devices to demonstrate selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between devices, including the utility company upstream device if applicable. Plot the specific time-current

- characteristics of each overcurrent protective device in such a manner that all devices are clearly depicted.
2. The following specific information shall also be shown on the coordination curves:
    - a. Device identification.
    - b. Potential transformer and current transformer ratios.
    - c. Three-phase and single-phase ANSI damage points or curves for each cable, transformer, or generator.
    - d. Applicable circuit breaker or protective relay characteristic curves.
    - e. No-damage, melting, and clearing curves for fuses.
    - f. Transformer in-rush points.
  3. Develop a table to summarize the settings selected for the overcurrent protective devices. Include the following in the table:
    - a. Device identification.
    - b. Protective relay or circuit breaker potential and current transformer ratios, sensor rating, and available and suggested pickup and delay settings for each available trip characteristic.
    - c. Fuse rating and type.
- F. Arc Flash Calculations and Analysis:
1. Arc flash warning labels shall comply with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  2. Arc flash calculations shall be based on actual over-current protective device clearing time. Maximum clearing time shall be in accordance with IEEE 1584.
  3. Arc flash analysis shall be based on the lowest clearing time setting of the over-current protective device to minimize the incident energy level without compromising selective coordination.
  4. Arc flash boundary and available arc flash incident energy at the corresponding working distance shall be calculated for all electrical power distribution equipment specified in the project, and as shown on the drawings.

5. Required arc-rated clothing and other PPE shall be selected and specified in accordance with NFPA 70E.

#### **1.7 ANALYSIS**

- A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose solutions to effectively protect the underrated equipment.

#### **1.8 ADJUSTMENTS, SETTINGS, AND MODIFICATIONS**

- A. Final field settings and minor modifications of the overcurrent protective devices shall be made to conform with the study, without additional cost to the Government.

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

#### **PART 3 - EXECUTION (NOT USED)**

---END---

**SECTION 26 12 19**  
**PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of the pad-mounted, liquid-filled, medium-voltage transformers, indicated as transformers in this section.
- B. This specification specifies the furnishing, installation, connection, and testing of three-phase pad-mounted sectionalizers.

**1.2 RELATED WORK**

- A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete equipment pads.
- B. Section 09 06 00, SCHEDULE FOR FINISHES: Finishes for electrical equipment.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of non-structural components.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- E. Section 26 05 13, MEDIUM-VOLTAGE CABLES: Medium-voltage cables.
- F. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground currents.
- G. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Manholes, pull-boxes, and ducts for underground raceway systems.
- H. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.

**1.3 QUALITY ASSURANCE**

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

#### **1.4 FACTORY TESTS**

- A. Factory Tests shall be required.
- B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirement:
  - 1. Transformers shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted as per IEEE Standards. Factory tests shall be certified. The following tests shall be performed:
    - a. Perform insulation-resistance tests, winding-to-winding and each winding-to-ground.
    - b. Perform turns-ratio tests at all tap positions.
  - 2. Sectionalizers shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted as per IEEE Standards. Factory tests shall be certified. The following tests shall be performed:
    - a. Continuity test to assure correct internal connections.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Include electrical ratings, nameplate data, impedance, outline drawing with dimensions and front, top, and side views, weight, mounting details, decibel rating, termination information, temperature rise, no-load and full-load losses, regulation, overcurrent protection, connection diagrams, one-line diagram, base plan, schematics, mounting detail (reference specification 26 05 42 for additional information), and accessories.
    - c. Complete nameplate data, including manufacturer's name and catalog number.

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

2. Manuals:

- a. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
  - 1) Identify terminals on wiring diagrams to facilitate installation, maintenance, and operation.
  - 2) Indicate on wiring diagrams the internal wiring for each piece of equipment and interconnections between the pieces of equipment.
  - 3) Approvals will be based on complete submissions of manuals, together with shop drawings.
- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
  - 1) Update the manual to include any information necessitated by shop drawing approval.
  - 2) Show all terminal identification.
  - 3) Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
  - 4) Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.

B. Certifications:

- 1. Two weeks prior to the final inspection, submit the following certifications.
  - a. Certification by the manufacturer that the transformers conform to the requirements of the drawings and specifications.



- b. Certification by the Contractor that the transformers have been properly installed, connected, and tested.

## 1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Society for Testing and Materials (ASTM):  
D3487-16.....Standard Specification for Mineral Insulating Oil Used in  
Electrical Apparatus
- C. Institute of Electrical and Electronic Engineers (IEEE):  
48-09 .....Test Procedures and Requirements for Alternating-Current  
Cable Terminations Used on Shielded Cables Having  
Laminated Insulation Rated 2.5kV Through 765kV or  
Extruded Insulation Rated 2.5kV Through 500kV  
386-16 .....Separable Insulated Connector Systems for Power  
Distribution Systems Above 600 V  
592-07 .....Exposed Semiconducting Shields on High-Voltage Cable  
Joints and Separable Connectors  
C2-17 .....National Electrical Safety Code  
C37.47-11 .....Specification for High Voltage (>1000V) Distribution Class  
Current-Limiting Fuses and Fuse Disconnecting Switches  
C57.12.00-15 .....Liquid-Immersed Distribution, Power and Regulating  
Transformers  
C57.12.10-13 .....Liquid-Immersed Power Transformers  
C57.12.25-90 .....Pad-Mounted, Compartmental-Type, Self-Cooled, Single-  
Phase Distribution-Transformers with Separable Insulated  
High Voltage Connectors; High Voltage, 34500 Grd  
Y/19920 Volts and Below; Low-Voltage 240/120 Volts; 167  
kVA and Smaller Requirements

- C57.12.28-14 .....Pad-Mounted Equipment - Enclosure Integrity
- C57.12.29-14 .....Pad-Mounted Equipment – Enclosure Integrity for Coastal  
Environments
- C57.12.34-15 .....Pad-Mounted, Compartmental-Type, Self-Cooled, Three-  
Phase Distribution Transformers, 5 MVA and Smaller; High  
Voltage, 34.5 kV Nominal System Voltage and Below; Low  
Voltage, 15kV Nominal System Voltage and Below
- C57.12.90-15 .....Test Code for Liquid-Immersed Distribution, Power, and  
Regulating Transformers
- C62.11-12 .....Metal-Oxide Surge Arresters for AC Power Circuits
- C57.12.28-14 .....Pad-Mounted Equipment - Enclosure Integrity
- 386-06 .....Separable Insulated Connector Systems for Power  
Distribution Systems Above 600 V.
- D. International Code Council (ICC):
  - IBC-15 .....International Building Code
- E. National Electrical Manufacturers Association (NEMA):
  - TR 1-13 .....Transformers, Regulators, and Reactors
- F. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
- G. Underwriters Laboratories Inc. (UL):
  - 467-13 .....Grounding and Bonding Equipment
- H. United States Department of Energy (DOE):
  - 10 CFR Part 431 .....Energy Efficiency Program for Certain Commercial and  
Industrial Equipment

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

- A. Transformers and sectionalizers shall be in accordance with ASTM, IEEE, NFPA, UL, as shown on the drawings, and as specified herein. Each transformer and sectionalizer shall be assembled as an integral unit by a single manufacturer.

- B. Transformers shall be complete, outdoor type, continuous duty, integral assembly, grounded, tamper-resistant, and with liquid-immersed windings.
- C. Transformer and sectionalizer ratings shall not be less than shown on the drawings.
- D. Completely fabricate transformers and sectionalizers at the factory so that only the external cable connections are required at the project site.
- E. Thoroughly clean, phosphatize, and finish all the metal surfaces at the factory with a rust-resistant primer and dark green enamel finish coat, except where a different color is specified in Section 09 06 00, SCHEDULE FOR FINISHES. All surfaces of the transformer and sectionalizer that will be in contact with the concrete pad or manhole/vault shall be treated with corrosion-resistant compounds and epoxy resin or a rubberized sealing compound.

## **2.2 TRANSFORMER COMPARTMENTS**

- A. Construction:
  - 1. Enclosures shall be weatherproof and in accordance with IEEE C57.12.28.
  - 2. The medium- and low-voltage compartments shall be separated with a steel barrier that extends the full height and depth of the compartments.
  - 3. The compartments shall be constructed of sheet steel (gauge to meet ANSI requirements) with bracing and with reinforcing gussets using jig welds to assure rectangular rigidity.
  - 4. All bolts, nuts, and washers shall be zinc-plated steel.
  - 5. Sufficient space shall be provided for equipment, cabling, and terminations within the compartments.
  - 6. Affix transformer nameplate permanently within the low-voltage compartment. Voltage and kVA rating, connection configuration, impedance, date of manufacture, and serial number shall be shown on the nameplate.
- B. Doors:
  - 1. Provide a separate door for each compartment with provisions for a single padlock to secure all doors. Provide each compartment door with open-position doorstops and corrosion-resistant tamperproof hinges welded in place. The medium-voltage

compartment door shall be mechanically prevented from opening unless the low-voltage compartment door is open.

2. The secondary compartment door shall have a one-piece steel handle and incorporate three-point locking mechanisms.
3. Provide a 50 mm (2 inches) size padlock for each assembly, as approved by the COR. Padlocks shall be keyed to the COR's established key set. Firmly attach the padlock to the door assembly by a chain.

### **2.3 BIL RATING**

- A. 15 kV class equipment shall have a minimum 95 kV BIL rating.

### **2.4 TRANSFORMER FUSE ASSEMBLY**

- A. The primary fuse assembly shall be a combination of externally replaceable Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses.

### **2.5 TRANSFORMER PRIMARY CONNECTIONS**

- A. Primary connections shall be live-front bushings with NEMA spades or eyebolt terminals suitable for cable sizes shown on the drawings.

### **2.7 MEDIUM-VOLTAGE TERMINATIONS**

- A. Terminate the medium-voltage cables in the primary compartment with 200 A loadbreak premolded rubber elbow connectors, suitable for submersible applications. Elbow connectors shall have a semi-conductive shield material covering the housing. The separable connector system shall include the loadbreak elbow, the bushing insert, and the bushing well. Separable connectors shall comply with the requirements of IEEE 386, and shall be interchangeable between suppliers. Allow sufficient slack in medium-voltage cable, ground, and drain wires to permit elbow connectors to be moved to their respective parking stands.
- B. Ground metallic cable shield with a cable shield grounding adapter, consisting of a solderless connector enclosed in watertight rubber housing covering the entire assembly, bleeder wire, and ground braid.

## 2.9 TRANSFORMERS

- A. Transformer ratings shall be as shown on drawings. kVA ratings shown on the drawings are for continuous duty without the use of cooling fans.
- B. Temperature rises shall not exceed the NEMA TR 1 of 65° C (149° F) by resistance.
- C. Transformer insulating material shall be mineral oil in accordance with ASTM D 3487.
- D. Transformer impedance shall be not less than 4-1/2% for sizes 150 kVA and larger.  
Impedance shall be as shown on the drawings.
- E. Sound levels shall conform to NEMA TR 1 standards.
- F. Primary and Secondary Windings for Three-Phase Transformers:
  - 1. Primary windings shall be delta-connected.
  - 2. Secondary windings shall be wye-connected, except where otherwise indicated on the drawings. Provide isolated neutral bushings for secondary wye-connected transformers.
  - 3. Secondary leads shall be brought out through pressure-tight epoxy bushings.
- G. Primary windings shall have four 2-1/2% full-capacity voltage taps; two taps above and two taps below rated voltage.
- H. Core and Coil Assemblies:
  - 1. Cores shall be grain-oriented, non-aging, silicon steel to minimize losses.
  - 2. Core and coil assemblies shall be rigidly braced to withstand the stresses caused by rough handling during shipment, and stresses caused by any possible short-circuit currents.
  - 3. Coils shall be continuous-winding type without splices except for taps. Material shall be copper.
  - 4. Coil and core losses shall be optimum for efficient operation.
  - 5. Primary, secondary, and tap connections shall be brazed or pressure type.
  - 6. Provide end fillers or tie-downs for coil windings.
- I. The transformer tank, cover, and radiator gauge thickness shall not be less than that required by ANSI.
- J. Accessories:

1. Provide standard NEMA features, accessories, and the following:
    - a. No-load tap changer. Provide warning sign.
    - b. Lifting, pulling, and jacking facilities.
    - c. Globe-type valve for oil filtering and draining, including sampling device.
    - d. Pressure relief valve.
    - e. Liquid level gauge and filling plug.
    - f. A grounding pad in the medium- and low-voltage compartments.
    - g. A diagrammatic nameplate.
    - h. Dial-type liquid thermometer with a maximum reading pointer and an external reset.
    - i. Hot stick. Securely fasten hot stick within low-voltage compartment.
  2. The accessories shall be made accessible within the compartments without disassembling trims and covers.
- K. Transformers shall meet the energy conservation standards for transformers per the United States Department of Energy 10 CFR Part 431.

## **2.9 SECTIONALIZING CABINET**

- A. Construction:
1. The sectionalizing enclosure must be continuous seam-welded and manufactured of 12-gauge HRPO mild steel.
  2. All hardware must be stainless steel for corrosion resistance.
  3. Enclosure shall be finished with Munsell Green color 7GY 3.29-1.5 and meet the finish requirements as defined in IEEE Std. C57.12.28™-2014 standard.
  4. Enclosure must include a top hinged removable cover and allow one person operation. Cover must also include a wind stop to prevent accidental closing.
  5. Enclosure must include a deep angled recessed door with low sill for easy accessibility.
  6. Enclosure must include universal mounting plates painted light grey for optimum visibility of cable terminations and must accept 200 A, 15kV, two-, three- and four-position loadbreak junctions.

7. Enclosure must include “parking lot” parking stand design providing multiple options for parking of accessories and providing rigidity to the back of the enclosure to prevent oil-canning during operation.
  8. Enclosure must provide a minimum of 1 parking stand pocket per phase.
  9. Enclosure must include a minimum of one grounding provision per phase.
  10. Enclosure must include provisions for lifting.
  11. Enclosure must include a recessed lock pocket, padlock hasp and pentahead bolt for security.
- B. Dimensions: Minimum enclosure size shall be 30”H X 30”W X 22”D.
- C. Features: Grounding bar installed within enclosure, 3/8”.
- D. Ground Sleeves: Fiberglass ground sleeves to accommodate enclosures must be available in 18” and 30” heights.
- E. Base Extensions: Steel base extensions to accommodate enclosures must be available in 18” and 24” heights.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install transformers and sectionalizers outdoors, as shown on the drawings, in accordance with the NEC, and as recommended by the manufacturer.
- B. Anchor transformers and sectionalizers with rustproof bolts, nuts, and washers not less than 12 mm (1/2 inch) diameter, in accordance with manufacturer’s instructions, and as shown on drawings.
- C. In seismic areas, transformers and sectionalizers shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- D. Mount transformers on concrete slab. Unless otherwise indicated, the slab shall be at least 200 mm (8 inches) thick, reinforced with a 150 by 150 mm (6 by 6 inches) No. 6 mesh placed uniformly 100 mm (4 inches) from the top of the slab. Slab shall be placed on a 150 mm (6 inches) thick, well-compacted gravel base. The top of the concrete slab shall be approximately 100 mm (4 inches) above the finished grade. Edges above grade

shall have 12-1/2 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 200 mm (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

E. Grounding:

1. Ground each transformer and sectionalizer in accordance with the requirements of the NEC. Install ground rods per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS, to maintain a maximum resistance of 5 ohms to ground.
2. Transformer:
  - a. Connect the ground rod to the ground pads in the medium- and low-voltage compartments.
  - b. Install and connect the cable shield grounding adapter per the manufacturer's instructions. Connect the bleeder wire of the cable shield grounding adapter to the loadbreak elbow grounding point with minimum No. 14 AWG wire, and connect the ground braid to the grounding system with minimum No. 6 AWG bare copper wire. Use soldered or mechanical grounding connectors listed for this purpose.
3. Sectionalizer: Connect ground rod to grounding bar. Provide and install grounding per manufacturer's requirements.

F. Sectionalizers shall be mounted on manholes/vaults to provide adequate clearance for means of pulling cabling. Reference specification 26 05 42 for additional requirements.

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

- A. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. In addition, include the following:
1. Visual Inspection and Tests:



- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical and mechanical condition. Check for damaged or cracked bushings and liquid leaks.
- c. Verify that control and alarm settings on temperature indicators are as specified.
- d. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections, and perform thermographic survey after energization under load.
- e. Vacuum-clean transformer interior. Clean transformer enclosure exterior.
- f. Verify correct liquid level in transformer tank.
- g. Verify correct equipment grounding per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- h. Verify the presence and connection of transformer surge arresters, if provided.
- i. Verify that the tap-changer is set at rated system voltage.

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

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

### **3.4 SPARE PARTS**

- A. Deliver the following spare parts for the project to the COR two weeks prior to final inspection:
  1. Six insulated protective caps.
  2. One spare set of medium-voltage fuses for each size and type of fuse used in the project.

### **3.5 INSTRUCTION**

- A. The Contractor shall instruct maintenance personnel, for not less than one 2-hour period, on the maintenance and operation of the equipment on the date requested by the COR.

---END---

**SECTION 26 24 13**  
**DISTRIBUTION SWITCHBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of the low-voltage circuit-breaker distribution switchboards, indicated as switchboard(s) in this section.

**1.2 RELATED WORK**

- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint for nonstructural components.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- D. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible fault currents.
- F. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.
- G. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.
- H. Section 26 11 16, SECONDARY UNIT SUBSTATIONS: Switchboards as part of secondary unit substations.
- I. Section 26 25 11, BUSWAYS: Feeder busway and fittings.
- J. Section 26 43 13, SURGE PROTECTIVE DEVICES: Surge protective devices for switchboards.

**1.3 QUALITY ASSURANCE**

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

**1.4 FACTORY TESTS**

- A. Factory Tests shall be required.

- B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirement:
1. Tests shall be conducted per NEMA PB 2.
  2. Verify that circuit breaker sizes and types correspond to drawings, and the Overcurrent Protective Device Coordination Study.
  3. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
  5. Exercise all active components.
  6. Perform an insulation-resistance test, phase to ground, on each bus section, with phases not under test grounded, in accordance with manufacturer's published data.
  7. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 V DC for 300-volt rated cable and 1000 V DC for 600-volt rated cable, or as required if solid-state components or control devices cannot tolerate the applied voltage.
  8. If applicable, verify correct function of control transfer relays located in the switchboard with multiple control power sources.
  9. Perform phasing checks on double-ended or dual-source switchboards to insure correct bus phasing from each source.

### **1.5 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
    - a. Switchboard shop drawings shall be submitted simultaneously with or after the Overcurrent Protective Device Coordination Study.
    - b. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - c. Prior to fabrication of switchboards, submit the following data for approval:
      - 1) Complete electrical ratings.

- 2) Circuit breaker sizes.
- 3) Interrupting ratings.
- 4) Safety features.
- 5) Accessories and nameplate data.
- 6) Switchboard one line diagram, showing ampere rating, number of bars per phase and neutral in each bus run (horizontal and vertical), bus spacing, equipment ground bus, and bus material.
- 7) Elementary and interconnection wiring diagrams.
- 8) Technical data for each component.
- 9) Dimensioned exterior views of the switchboard.
- 10) Dimensioned section views of the switchboard.
- 11) Floor plan of the switchboard.
- 12) Foundation plan for the switchboard.
- 13) Provisions and required locations for external conduit and wiring entrances.
- 14) Approximate design weights.

2. Manuals:

- a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
  - 1) Schematic signal and control diagrams, with all terminals identified, matching terminal identification in the switchboard.
  - 2) Include information for testing, repair, trouble shooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.
  - 3) Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.

- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the switchboards conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the switchboards have been properly installed, adjusted, and tested.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. Institute of Engineering and Electronic Engineers (IEEE):
  - C37.13-15 .....Low Voltage AC Power Circuit Breakers Used in Enclosures
  - C57.13-16 .....Instrument Transformers
  - C62.41.1-02 .....Surge Environment in Low-voltage (1000V and less) AC  
Power Circuits
  - C62.45-02 .....Surge Testing for Equipment connected to Low-Voltage AC  
Power Circuits
- C. International Code Council (ICC):
  - IBC-15 .....International Building Code
- D. National Electrical Manufacturer's Association (NEMA):
  - PB 2-11 .....Deadfront Distribution Switchboards
  - PB 2.1-13 .....Proper Handling, Installation, Operation, and Maintenance  
of Deadfront Distribution Switchboards Rated 600 Volts or  
Less
- E. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
- F. Underwriters Laboratories, Inc. (UL):

67-09 .....	Panelboards
489-16 .....	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
891-05 .....	Switchboards

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Shall be in accordance with IEEE, NEMA, NFPA, UL, as shown on the drawings, and have the following features:
1. Switchboard shall be a complete, grounded, continuous-duty, integral assembly, dead-front, dead-rear, self-supporting, indoor type switchboard assembly,. Incorporate devices shown on the drawings and all related components required to fulfill operational and functional requirements.
  2. Ratings shall not be less than shown on the drawings. Short circuit ratings shall not be less than the available fault current shown in the Overcurrent Protective Device Coordination Study.
  3. Switchboard shall conform to the arrangements and details shown on the drawings.
  6. Switchboards shall be assembled, connected, and wired at the factory so that only external circuit connections are required at the construction site. Split the structure only as required for shipping and installation. Packaging shall provide adequate protection against rough handling during shipment.
  7. All non-current-carrying parts shall be grounded per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS for additional requirements.
  8. Series rated switchboards are not allowed.

### **2.2 BASIC ARRANGEMENT**

- A. Type 1: Switchboard shall be front accessible with the following features:
1. Device mounting:
    - a. Main breaker: Individually mounted and compartmented or group mounted with feeder breakers.

- b. Feeder breakers: Group mounted.
- 2. Section alignment: As shown on the drawings.
- 3. Accessibility:
  - a. Main section line and load terminals: Front and side.
  - b. Distribution section line and load terminals: Front.
  - c. Through bus connections: Front and end.
- 4. Bolted line and load connections.
- 5. Full height wiring gutter covers for access to wiring terminals.

## **2.3 HOUSING**

- A. Shall have the following features:
  - 1. Frames and enclosures:
    - a. The assembly shall be braced with reinforcing gussets using bolted connections to assure rectangular rigidity.
    - b. The enclosure shall be steel, leveled, and not less than the gauge required by applicable publications.
    - c. Die-pierce the holes for connecting adjacent structures to insure proper alignment, and to allow for future additions.
    - d. All bolts, nuts, and washers shall be zinc-plated steel.
- B. Finish:
  - 1. All metal surfaces shall be thoroughly cleaned, phosphatized and factory primed prior to applying baked enamel or lacquer finish.
  - 2. Provide a light gray finish for indoor switchboard.

## **2.4 BUSES**

- A. Bus Bars and Interconnections:
  - 1. Provide copper phase and neutral buses, fully rated for the amperage as shown on the drawings for the entire length of the switchboard. Bus laminations shall have a minimum of 6 mm (1/4 inch) spacing.
  - 2. Mount the buses on appropriately spaced insulators and brace to withstand the available short circuit currents.

3. The bus and bus compartment shall be designed so that the acceptable NEMA standard temperature rises are not exceeded.
4. Install a copper ground bus the full length of the switchboard assembly.
5. Main Bonding Jumper: An un-insulated copper bus, size as shown on drawings, shall interconnect the neutral and ground buses, when the switchboard is used to establish the system common ground point.
6. All bolts, nuts, and washers shall be zinc-plated steel. Bolts shall be torqued to the values recommended by the manufacturer.
7. Make provisions for future bus extensions by means of bolt holes or other approved method.

## **2.5 MAIN CIRCUIT BREAKERS**

A. Type I or Type II Switchboards: Provide molded case main circuit breakers as shown on the drawings. Circuit breakers shall be the solid state adjustable trip type.

1. Trip units shall have field adjustable tripping characteristics as follows:
  - a. Long time pickup.
  - b. Long time delay.
  - c. Short time pickup.
  - d. Short time delay.
  - e. Instantaneous.
2. Breakers with same frame size shall be interchangeable with each other.

## **2.6 FEEDER CIRCUIT BREAKERS**

A. Provide molded case circuit breakers as shown on the drawings.

B. Non-adjustable Trip Molded Case Circuit Breakers:

1. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time characteristics, and instantaneous magnetic trip.
2. Breaker features shall be as follows:
  - a. A rugged, integral housing of molded insulating material.



- b. Silver alloy contacts.
  - c. Arc quenchers and phase barriers for each pole.
  - d. Quick-make, quick-break, operating mechanisms.
  - e. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
  - f. Electrically and mechanically trip free.
  - g. An operating handle which indicates ON, TRIPPED, and OFF positions.
  - h. Line and load connections shall be bolted.
  - i. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
- C. Adjustable Trip Molded Case Circuit Breakers:
  - 1. Provide molded case, solid state adjustable trip type circuit breakers.
  - 2. Trip units shall have field adjustable tripping characteristics as follows:
    - a. Long time pickup.
    - b. Long time delay.
    - c. Short time pickup.
    - d. Short time delay.
    - e. Instantaneous.
  - 3. Breakers with same frame size shall be interchangeable with each other.

## **2.8 SURGE PROTECTIVE DEVICES**

- A. Refer to Section 26 43 13, SURGE PROTECTIVE DEVICES.

## **2.9 METERING**

- A. Refer to Section 25 10 10, ADVANCED UTILITY METERING. Refer to drawings for meter locations.
- B. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- C. Provide voltage transformers including primary fuses and secondary protective devices for metering as shown on the drawings.

## **2.10 OTHER EQUIPMENT**

- A. Furnish tools and accessories required for circuit breaker and switchboard test, inspection, maintenance, and proper operation.

## **2.11 CONTROL WIRING**

- A. Switchboard control wires shall not be less than No. 14 AWG copper 600 volt rated. Install wiring complete at the factory, adequately bundled and protected. Provide separate control circuit fuses in each breaker compartment and locate for ease of access and maintenance.

## **2.12 NAMEPLATES AND MIMIC BUS**

- A. Nameplates: For Normal Power system, provide laminated black phenolic resin with white core with 12 mm (1/2 inch) engraved lettered nameplates next to each circuit breaker. For Essential Electrical System, provide laminated red phenolic resin with white core with 12 mm (1/2 inch) engraved lettered nameplates next to each circuit breaker. Nameplates shall indicate equipment served, spaces, or spares in accordance with one line diagram shown on drawings. Nameplates shall be mounted with plated screws on front of breakers or on equipment enclosure next to breakers. Mounting nameplates only with adhesive is not acceptable.
- B. Mimic Bus: Provide an approved mimic bus on front of each switchboard assembly. Color shall be black for the Normal Power system and red for the Essential Electrical System, either factory-painted plastic or metal strips. Plastic tape shall not be used. Use symbols similar to one line diagram shown on drawings. Plastic or metal strips shall be mounted with plated screws.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install switchboards in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Anchor switchboards with rustproof bolts, nuts, and washers not less than 13 mm (1/2 inch) diameter, in accordance with manufacturer's instructions, and as shown on drawings.

- C. In seismic areas, switchboards shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- D. Exterior Location. Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 200 mm (8 inches) thick, reinforced with a 150 by 150 mm (6 by 6 inches) No. 6 mesh placed uniformly 100 mm (4 inches) from the top of the slab. Slab shall be placed on a 150 mm (6 inches) thick, well-compacted gravel base. The top of the concrete slab shall be approximately 100 mm (4 inches) above the finished grade. Edges above grade shall have 12.5 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 200 mm (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- E. Interior Location. Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 100 mm (4 inches) thick. The top of the concrete slab shall be approximately 100 mm (4 inches) above finished floor. Edges above floor shall have 12.5 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 200 mm (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

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

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:

- a. Compare equipment nameplate data with specifications and approved shop drawings.
  - b. Inspect physical, electrical, and mechanical condition.
  - c. Verify appropriate anchorage, required area clearances, and correct alignment.
  - d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
  - e. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
  - g. Vacuum-clean switchboard enclosure interior. Clean switchboard enclosure exterior.
  - h. Inspect insulators for evidence of physical damage or contaminated surfaces.
  - i. Verify correct shutter installation and operation.
  - j. Exercise all active components.
  - k. Verify the correct operation of all sensing devices, alarms, and indicating devices.
  - l. Verify that vents are clear.
2. Electrical tests:
- a. Perform insulation-resistance tests on each bus section.
  - b. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
  - c. Perform phasing check on double-ended switchboards to ensure correct bus phasing from each source.

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

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the switchboard is in good operating condition and properly performing the intended function.

### **3.4 WARNING SIGN**

- A. Mount on each entrance door of the switchboard room, approximately 1500 mm (5 feet) above grade or floor, a clearly lettered warning sign for warning personnel. The sign shall be attached with rustproof metal screws.

### **3.5 ONE LINE DIAGRAM AND SEQUENCE OF OPERATION**

- A. At final inspection, an as-built one line diagram shall be laminated or mounted under acrylic glass, and installed in a frame mounted in the switchboard room or in the outdoor switchboard enclosure.
- C. Deliver an additional four copies of the as-built one line diagram to the COTR.

### **3.6 AS-LEFT TRIP UNIT SETTINGS**

- A. The trip unit settings shall be set in the field by an authorized representative of the switchboard manufacturer per the approved Electrical System Protective Device Study in accordance with Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.
- B. Post a durable copy of the "as-left" trip unit settings in a convenient location in the switchboard room . Deliver four additional copies of the settings to the COTR. Furnish this information prior to the activation of the switchboard.

### **3.7 INSTRUCTION**

- A. Furnish the services of a factory-trained technician for one, 4-hour training period for instructing personnel in the maintenance and operation of the switchboards, on the dates requested by the COTR.

---END---

**SECTION 26 24 16  
PANELBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 09 91 00, PAINTING: Painting of panelboards.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of non-structural components.
- C. Section 25 10 10, ADVANCED UTILITY METERING: Requirements for electrical metering.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- E. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- F. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- G. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- H. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.
- I. Section 26 09 23, LIGHTING CONTROLS: Lighting controls integral to panelboards.
- J. Section 26 43 13, SURGE PROTECTIVE DEVICES: Surge protective devices integral to panelboards.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

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

1. Shop Drawings:
  - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
  - b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, circuit breakers, wiring and connection diagrams, accessories, and nameplate data.
  - c. Certification from the manufacturer that a representative panelboard has been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.
2. Manuals:
  - a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering circuit breakers and replacement parts.
    - 1) Include schematic diagrams, with all terminals identified, matching terminal identification in the panelboards.
    - 2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the panelboards conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the panelboards have been properly installed, adjusted, and tested.

## 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. International Code Council (ICC):
  - IBC-15 .....International Building Code
- C. National Electrical Manufacturers Association (NEMA):
  - PB 1-11 .....Panelboards
  - 250-14 .....Enclosures for Electrical Equipment (1,000V Maximum)
- D. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
  - 70E-18 .....Standard for Electrical Safety in the Workplace
- E. Underwriters Laboratories, Inc. (UL):
  - 50-15 .....Enclosures for Electrical Equipment
  - 67-09 .....Panelboards
  - 489-16 .....Molded Case Circuit Breakers and Circuit Breaker Enclosures

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Panelboards shall be in accordance with NEC, NEMA, UL, as specified, and as shown on the drawings.
- B. Panelboards shall have main breaker or main lugs, bus size, voltage, phases, number of circuit breaker mounting spaces, top or bottom feed, flush or surface mounting, branch circuit breakers, and accessories as shown on the drawings.
- C. Panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories as shown on the drawings or specified herein.



- D. Non-reduced size copper bus bars, rigidly supported on molded insulators, and fabricated for bolt-on type circuit breakers.
- E. Bus bar connections to the branch circuit breakers shall be the “distributed phase” or “phase sequence” type.
- F. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys listed for use with the conductors to which they will be connected.
- G. Neutral bus shall be 100% rated, mounted on insulated supports.
- H. Grounding bus bar shall be equipped with screws or lugs for the connection of equipment grounding conductors.
- I. Bus bars shall be braced for the available short-circuit current as shown on the drawings, but not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
- J. In two-section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type panelboards, and have field-installed cable connections to the second section as shown on the drawings. Panelboard sections with tapped bus or crossover bus are not acceptable.
- K. Series-rated panelboards are not permitted.
- L. Panelboards shall be door-in-door type..

## **2.2 ENCLOSURES AND TRIMS**

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

B. Trims:

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

**2.3 MOLDED CASE CIRCUIT BREAKERS**

- A. Circuit breakers shall be per UL, NEC, as shown on the drawings, and as specified.
- B. Circuit breakers shall be bolt-on type.
- C. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
  1. 120/208 V Panelboard: 10,000 A symmetrical.
  2. 120/240 V Panelboard: 10,000 A symmetrical.
  3. 277/480 V Panelboard: 14,000 A symmetrical.
- D. Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for less than 400 A frame. Circuit breakers with 400 A frames and above shall have magnetic trip, adjustable from 5x to 10x. Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY; Breaker magnetic trip setting shall be set to maximum, unless otherwise noted.
- E. Circuit breaker features shall be as follows:
  1. A rugged, integral housing of molded insulating material.
  2. Silver alloy contacts.
  3. Arc quenchers and phase barriers for each pole.
  4. Quick-make, quick-break, operating mechanisms.

5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
6. Electrically and mechanically trip free.
7. An operating handle which indicates closed, tripped, and open positions.
8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.
10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory accordingly.

## **2.4 SURGE PROTECTIVE DEVICES**

- A. Where shown on the drawings, furnish panelboards with integral surge protective devices. Refer to Section 26 43 13, SURGE PROTECTIVE DEVICES.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Locate panelboards so that the present and future conduits can be conveniently connected.
- C. In seismic areas, panelboards shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- D. Install a printed schedule of circuits in each panelboard after approval by the COR. Schedules shall reflect final load descriptions, room numbers, and room names connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards

- E. Mount panelboards such that the maximum height of the top circuit breaker above the finished floor shall not exceed 1980 mm (78 inches).
- F. Provide blank cover for each unused circuit breaker mounting space.
- I. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.

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

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Verify appropriate anchorage and required area clearances.
    - d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
    - e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.
    - f. Vacuum-clean enclosure interior. Clean enclosure exterior.

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

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

---END---

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- E. Section 26 51 00, INTERIOR LIGHTING: Fluorescent ballasts and LED drivers for use with manual dimming controls.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.
  - 2. Manuals:

- a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and information for ordering replacement parts.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the wiring devices conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the wiring devices have been properly installed and adjusted.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - WD 1-99(R2015).....General Color Requirements for Wiring Devices
  - WD 6-16 .....Wiring Devices – Dimensional Specifications
- C. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
  - 99-18 .....Health Care Facilities
- D. Underwriter’s Laboratories, Inc. (UL):
  - 5-16 .....Surface Metal Raceways and Fittings
  - 20-10 .....General-Use Snap Switches
  - 231-16 .....Power Outlets
  - 467-13 .....Grounding and Bonding Equipment
  - 498-17 .....Attachment Plugs and Receptacles
  - 943-16 .....Ground-Fault Circuit-Interrupters
  - 1449-14 .....Surge Protective Devices

1472-15 .....Solid State Dimming Controls

## **PART 2 - PRODUCTS**

SPEC WRITER NOTE: Hospital grade receptacles shall be specified and installed in patient care buildings.

### **2.1 RECEPTACLES**

- A. General: All receptacles shall comply with NEMA, NFPA, UL, and as shown on the drawings.
  - 1. Mounting straps shall be nickel plated brass, brass, nickel plated steel or galvanize steel with break-off plaster ears, and shall include a self-grounding feature.  
Terminal screws shall be brass, brass plated or a copper alloy metal.
  - 2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four minimum) and side wiring from four captively held binding screws.
- B. Duplex Receptacles - Hospital-grade: shall be listed for hospital grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, NEMA 5-20R, with break-off feature for two-circuit operation.
  - 1. Bodies shall be ivory in color.
  - 2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The lower receptacle shall be unswitched.
  - 3. Duplex Receptacles on Emergency Circuit:
    - a. Bodies shall be colored RED.
    - b. In rooms without emergency powered general lighting, the emergency receptacles shall be of the self-illuminated type.
  - 4. Ground Fault Current Interrupter (GFCI) Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box, with end-of-life indication and provisions to isolate the face due to improper wiring. GFCI receptacles shall be self-test receptacles in accordance with UL 943.
    - a. Ground fault interrupter shall consist of a differential current transformer, self-test, solid state sensing circuitry and a circuit interrupter switch. Device shall

have nominal sensitivity to ground leakage current of 4-6 milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or – 1 milliampere) on the load side of the device.

Device shall have a minimum nominal tripping time of 0.025 second.

- b. Self-test function shall be automatically initiated within 5 seconds after power is activated to the receptacles. Self-test function shall be periodically and automatically performed every 3 hours or less.
  - c. End-of-life indicator light shall be a persistent flashing or blinking light to indicate that the GFCI receptacle is no longer in service.
5. Tamper-Resistant Duplex Receptacles:
- a. Bodies shall be gray in color.
    - 1) Shall permit current to flow only while a standard plug is in the proper position in the receptacle.
    - 2) Screws exposed while the wall plates are in place shall be the tamperproof type.
- C. Duplex Receptacles – Non-hospital Grade: shall be the same as duplex receptacles – hospital grade in accordance with sections 2.1A and 2.1B of this specification, except for the hospital grade listing.
- 1. Bodies shall be brown nylon.
- D. Receptacles - 20, 30, and 50 ampere, 250 Volts: Shall be complete with appropriate cord grip plug.

SPEC WRITER NOTE: Specify type of receptacle.

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



- F. Surge Protective (TVSS) Receptacles shall have integral surge suppression in line to ground, line to neutral, and neutral to ground modes.
  - 1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 Volts, and minimum single transient pulse energy dissipation of 210 Joules.
  - 2. Active TVSS Indication: LED, visible in face of device to indicate device is active or no longer in service.
- G.

## **2.2 TOGGLE SWITCHES**

- A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles shall be ivory in color unless otherwise specified or shown on the drawings.
  - 1. Switches installed in hazardous areas shall be explosion-proof type in accordance with the NEC and as shown on the drawings.
  - 2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
  - 3. Switches shall be rated 20 amperes at 120-277 Volts AC.

## **2.3 MANUAL DIMMING CONTROL**

- A. Electronic full-wave manual slide dimmer with on/off switch and audible frequency and EMI/RFI suppression filters.
- B. Manual dimming controls shall be fully compatible with LED dimming driver and be approved by the driver manufacturer, shall operate over full specified dimming range, and shall not degrade the performance or rated life of the electronic dimming ballast and lamp.
- C. Provide single-pole, three-way or four-way, as shown on the drawings.
- D. Manual dimming control and faceplates shall be ivory in color unless otherwise specified.

## **2.4 WALL PLATES**

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

- C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- D. In areas requiring tamperproof wiring devices, wall plates shall be type 302 stainless steel, and shall have tamperproof screws and beveled edges.
- E. Duplex Receptacles on Emergency Circuit: Wall plates shall be type 302 stainless steel, with the word "EMERGENCY" engraved in 6 mm (1/4 inch) red letters. Receptacles shall have red body color.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.
- B. Install wiring devices after wall construction and painting is complete.
- C. The ground terminal of each wiring device shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the branch circuit equipment grounding conductor.
- D. Outlet boxes for toggle switches and manual dimming controls shall be mounted on the strike side of doors.
- E. Provide barriers in multi-gang outlet boxes to comply with the NEC.
- F. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
- G. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades.
- H. Install wall switches 1.2 M (48 inches) above floor, with the toggle OFF position down.
- I. Install wall dimmers 1.2 M (48 inches) above floor.

- J. Install receptacles 450 mm (18 inches) above floor, and 152 mm (6 inches) above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.
- K. Install horizontally mounted receptacles with the ground pin to the right.
- L. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.
- M. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

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

- A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations, and the latest NFPA 99. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Inspect physical and electrical conditions.
    - b. Vacuum-clean surface metal raceway interior. Clean metal raceway exterior.
    - c. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
    - d. Test GFCI receptacles.
  - 2. Receptacle testing in the Patient Care Spaces, such as retention force of the grounding blade of each receptacle, shall comply with the latest NFPA 99.

---END---

**SECTION 26 29 21**  
**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of non-structural components.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- F. Section 26 24 16, PANELBOARDS: Molded-case circuit breakers.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Submit the following data for approval:

- 1) Electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, fuses, circuit breakers, wiring and connection diagrams, accessories, and device nameplate data.
- c. Certification from the manufacturer that representative enclosed switches and circuit breakers have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.
2. Manuals:
  - a. Submit complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering fuses, circuit breakers, and replacement parts.
    - 1) Include schematic diagrams, with all terminals identified, matching terminal identification in the enclosed switches and circuit breakers.
    - 2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the enclosed switches and circuit breakers conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the enclosed switches and circuit breakers have been properly installed, adjusted, and tested.

### **1.5 APPLICABLE PUBLICATIONS**

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

IBC-15 .....International Building Code

C. National Electrical Manufacturers Association (NEMA):

FU I-12 .....Low Voltage Cartridge Fuses

KS I-13.....Heavy Duty Enclosed and Dead-Front Switches (600 Volts  
Maximum)

D. National Fire Protection Association (NFPA):

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

E. Underwriters Laboratories, Inc. (UL):

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

248 1-11 .....Low Voltage Fuses

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

## **PART 2 - PRODUCTS**

### **2.1 FUSED SWITCHES RATED 600 AMPERES AND LESS**

- A. Switches shall be in accordance with NEMA, NEC, UL, as specified, and as shown on the drawings.
- B. Shall be NEMA classified General Duty (GD) for 240 V switches, and NEMA classified Heavy Duty (HD) for 480 V switches.
- C. Shall be horsepower (HP) rated.
- D. Shall have the following features:
  - 1. Switch mechanism shall be the quick-make, quick-break type.
  - 2. Copper blades, visible in the open position.
  - 3. An arc chute for each pole.
  - 4. External operating handle shall indicate open and closed positions, and have lock-open padlocking provisions.
  - 5. Mechanical interlock shall permit opening of the door only when the switch is in the open position, defeatable to permit inspection.
  - 6. Fuse holders for the sizes and types of fuses specified.

7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
8. Ground lugs for each ground conductor.
9. Enclosures:
  - a. Shall be the NEMA types shown on the drawings.
  - b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
  - c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel.
10. Electrically operated switches shall only be installed where shown on the drawings.

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

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

## **2.3 SEPARATELY-ENCLOSED CIRCUIT BREAKERS**

- A. Provide circuit breakers in accordance with the applicable requirements in Section 26 24 16, PANELBOARDS.
- B. Enclosures shall be the NEMA types shown on the drawings. Where the types are not shown, they shall be the NEMA type most suitable for the ambient environmental conditions.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. In seismic areas, enclosed switches and circuit breakers shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- C. Fused switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuses.

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

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.
    - d. Vacuum-clean enclosure interior. Clean enclosure exterior.

### **3.3 SPARE PARTS**

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

---END---



**SECTION 26 43 13**  
**SURGE PROTECTIVE DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of Type 2 Surge Protective Devices, as defined in NFPA 70, and indicated as SPD in this section.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: For factory-installed or external SPD.
- C. Section 26 24 13, DISTRIBUTION SWITCHBOARDS: For factory-installed or external SPD.
- D. Section 26 24 16, PANELBOARDS: For factory-installed or external SPD.
- E. Section 26 26 00, POWER DISTRIBUTION UNITS FOR STATIC UNINTERRUPTIBLE POWER SYSTEMS: For factory-installed or external SPD.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Include electrical ratings and device nameplate data.
  - 2. Manuals:
    - a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.

- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the SPD conforms to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the SPD has been properly installed.

### **1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplement and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. Institute of Engineering and Electronic Engineers (IEEE):
  - IEEE C62.41.2-02 .....Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
  - IEEE C62.45-08 .....Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
- C. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  - UL 1283-15 .....Electromagnetic Interference Filters
  - UL 1449-14 .....Surge Protective Devices

## **PART 2 - PRODUCTS**

### **2.1 SWITCHGEAR/SWITCHBOARD SPD**

- A. General Requirements:
  - 1. Comply with IEEE and UL.
  - 2. Modular design with field-replaceable modules, or non-modular design.
  - 3. Fuses, rated at 200 kA interrupting capacity.
  - 4. Bolted compression lugs for internal wiring.
  - 5. Integral disconnect switch.

6. Redundant suppression circuits.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device.
10. Four-digit transient-event counter.

B. Surge Current per Phase: Minimum 240kA per phase.

## **2.2 PANELBOARD SPD**

A. General Requirements:

1. Comply with UL 1449 and IEEE C62.41.2.
2. Modular design with field-replaceable modules, or non-modular design.
3. Fuses, rated at 200 kA interrupting capacity.
4. Bolted compression lugs for internal wiring.
5. Integral disconnect switch.
6. Redundant suppression circuits.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device.
10. Four-digit transient-event counter.

B. Surge Current per Phase: Minimum 120kA per phase.

## **2.3 ENCLOSURES**

A. Enclosures: NEMA 1.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

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

- B. Factory-installed SPD: Switchgear, switchboard, or panelboard manufacturer shall install SPD at the factory.
- C. Field-installed SPD: Contractor shall install SPD with conductors or buses between SPD and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
  - 1. Provide a circuit breaker as a dedicated disconnecting means for TVSS as shown on drawings.
- D. Do not perform insulation resistance tests on switchgear, switchboards, panelboards, or feeders with the SPD connected. Disconnect SPD before conducting insulation resistance tests, and reconnect SPD immediately after insulation resistance tests are complete.

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

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Verify that disconnecting means and feeder size and maximum length to SPD corresponds to approved shop drawings.
    - d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.
    - e. Vacuum-clean enclosure interior. Clean enclosure exterior.
    - f. Verify the correct operation of all sensing devices, alarms, and indicating devices.

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

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

### **3.4 INSTRUCTION**

- A. Provide the services of a factory-trained technician for one 2-hour training period for instructing personnel in the maintenance and operation of the SPD, on the date requested by the COR.

`---END---

**SECTION 26 51 00  
INTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies the furnishing, installation, and connection of the interior lighting systems. The terms “lighting fixture,” “fixture,” and “luminaire” are used interchangeably.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Disposal of lamps.
- D. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirement for seismic restraint for nonstructural components.
- E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- F. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- G. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- H. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

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

- a. Submit the following information for each type of lighting fixture designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of lighting fixture designation.
  - b. Material and construction details, include information on housing and optics system.
  - c. Physical dimensions and description.
  - d. Wiring schematic and connection diagram.
  - e. Installation details.
  - f. Energy efficiency data.
  - g. Photometric data based on laboratory tests complying with IES Lighting Measurements testing and calculation guides.
  - h. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours), and color temperature (degrees Kelvin).
  - i. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts, and total harmonic distortion (THD).
  - j. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.
2. Manuals:
- a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the Contractor that the interior lighting systems have been properly installed and tested.

## 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Society for Testing and Materials (ASTM):  
C635/C635M REV A-13 .....Manufacture, Performance, and Testing of Metal  
Suspension Systems for Acoustical Tile and Lay-in Panel  
Ceilings
- C. Environmental Protection Agency (EPA):  
40 CFR 261 .....Identification and Listing of Hazardous Waste
- D. Federal Communications Commission (FCC):  
CFR Title 47, Part 15.....Radio Frequency Devices  
CFR Title 47, Part 18.....Industrial, Scientific, and Medical Equipment
- E. Illuminating Engineering Society of North America (IESNA):  
LM-79-08.....Electrical and Photometric Measurements of Solid-State  
Lighting Products  
LM-80-15.....Measuring Lumen Maintenance of LED Light Sources  
LM-82-12.....Characterization of LED Light Engines and LED Lamps for  
Electrical and Photometric Properties as a Function of  
Temperature
- F. Institute of Electrical and Electronic Engineers (IEEE):  
C62.41-91(R1995) .....Surge Voltages in Low Voltage AC Power Circuits
- G. International Code Council (ICC):  
IBC-15 .....International Building Code
- H. National Electrical Manufacturer's Association (NEMA):  
C78.376-14.....Chromaticity of Fluorescent Lamps  
C82.1-04(R2015) .....Lamp Ballasts – Line Frequency Fluorescent Lamp Ballasts  
C82.2-02(R2016) .....Method of Measurement of Fluorescent Lamp Ballasts



- C82.4-17 .....Lamp Ballasts - Ballasts for High-Intensity Discharge and  
Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
- C82.11-17 .....Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts
- LL 9-11 .....Dimming of T8 Fluorescent Lighting Systems
- SSL 1-16 .....Electronic Drivers for LED Devices, Arrays, or Systems
- I. National Fire Protection Association (NFPA):
  - 70-17 .....National Electrical Code (NEC)
  - 101-18 .....Life Safety Code
- J. Underwriters Laboratories, Inc. (UL):
  - 496-17 .....Lampholders
  - 542-05 .....Fluorescent Lamp Starters
  - 844-12 .....Luminaires for Use in Hazardous (Classified) Locations
  - 924-16 .....Emergency Lighting and Power Equipment
  - 935-01 .....Fluorescent-Lamp Ballasts
  - 1029-94 .....High-Intensity-Discharge Lamp Ballasts
  - 1029A-06.....Ignitors and Related Auxiliaries for HID Lamp Ballasts
  - 1598-08 .....Luminaires
  - 1574-04.....Track Lighting Systems
  - 2108-15.....Low-Voltage Lighting Systems
  - 8750-15.....Light Emitting Diode (LED) Light Sources for Use in Lighting Products

SPEC WRITER NOTE: Delete between // ---- // if not applicable to project. Also delete any other item or paragraph not applicable to the section and renumber the paragraphs.

## **PART 2 - PRODUCTS**

### **2.1 LIGHTING FIXTURES**

- A. Shall be in accordance with NFPA, UL, as shown on drawings, and as specified.
- B. Sheet Metal:

1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
  2. Wireways and fittings shall be free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.
  3. When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.
  4. Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.
- C. Ballasts and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts shall not be mounted to removable reflectors or wireway covers unless so specified.
- D. Lamp Sockets:
1. Fluorescent: Single slot entry type, requiring a one-quarter turn of the lamp after insertion. Lampholder contacts shall be the biting edge type.
  2. Compact Fluorescent: 4-pin.
  3. High Intensity Discharge (HID): Porcelain.
- E. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- F. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- G. Metal Finishes:
1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.

2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
3. Exterior finishes shall be as shown on the drawings.
- H. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
- I. Light Transmitting Components for Fluorescent Fixtures:
  1. Shall be 100 percent virgin acrylic.
  2. Flat lens panels shall have not less than 3 mm (1/8 inch) of average thickness.
  3. Unless otherwise specified, lenses, reflectors, diffusers, and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction without distortion or cracking.
- J. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Division areas as defined in NFPA 70.
- K. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballast integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures.

## **2.2 BALLASTS**

- A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 – 277V), electronic type, designed for type and quantity of lamps indicated. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated. Ballasts shall include the following features:
  1. Lamp end-of-life detection and shutdown circuit (T5 lamps only).
  2. Automatic lamp starting after lamp replacement.
  3. Sound Rating: Class A.
  4. Total Harmonic Distortion (THD): 10 percent or less.
  5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  6. Operating Frequency: 20 kHz or higher.

7. Lamp Current Crest Factor: 1.7 or less.
8. Ballast Factor: 0.87 or higher unless otherwise indicated.
9. Power Factor: 0.98 or higher.
10. EMR/RFI Interference: Comply with CFR Title 47 Part 18 for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
11. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.
12. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.
13. Dimming ballasts shall be as per above, except dimmable from 100% to 5 % of rated lamp lumens. Dimming ballasts shall be fully compatible with the dimming controls.

B.

## **2.4 EMERGENCY LIGHTING UNIT**

- A. Complete, self-contained unit with batteries, battery charger, one or more local or remote lamp heads with lamps, under-voltage relay, and test switch.
  1. Enclosure: Shall be impact-resistant thermoplastic. Enclosure shall be suitable for the environmental conditions in which installed.
  2. Lamp Heads: Horizontally and vertically adjustable, mounted on the face of the unit, except where otherwise indicated.
  3. Lamps: Shall be LED.
  4. Battery: Shall be maintenance-free nickel-cadmium. Minimum normal life shall be minimum of 10 years.

5. Battery Charger: Dry-type full-wave rectifier with charging rates to maintain the battery in fully-charged condition during normal operation, and to automatically recharge the battery within 12 hours following a 1-1/2 hour continuous discharge.
6. Integral Self-Test: Automatically initiates test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing LED.

## **2.8 X-RAY FILM ILLUMINATORS**

- A. Shall be the high-intensity type, flush-mounted in the walls. Multiples of the basic unit may be combined in a common housing.
- B. Shall have the following features:
  1. Fluorescent lighting, designed to provide uniform diffusion of the light.
  2. Box dimensions approximately 530 mm (21 inches) high, 355 mm (14 inches) wide and 100 mm (4 inches) deep.
  3. Housing shall be steel. Trim shall be stainless steel and shall extend approximately 40 mm (1-1/2 inches) from the edges of the housing.
  4. Viewing panel shall thermoplastic, not less than 3 mm (1/8 inch) thick.
  5. Viewing panel shall have adequate dimensions so the films will not overlap the frame and will be positioned with respect to the light source for even illumination without shadows.
  6. An ON-OFF double-pole, double-throw switch.

## **2.9 LED EXIT LIGHT FIXTURES**

- A. Exit light fixtures shall meet applicable requirements of NFPA and UL.
- B. Housing and door shall be die-cast aluminum.
- C. For general purpose exit light fixtures, door frame shall be hinged, with latch. For vandal-resistant exit light fixtures, door frame shall be secured with tamper-resistant screws.
- D. Finish shall be satin or fine-grain brushed aluminum.
- E. There shall be no radioactive material used in the fixtures.
- F. Fixtures:

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

G. Voltage: Multi-voltage (120 – 277V).

## **2.10 LED LIGHT FIXTURES**

### **A. General:**

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
  - a. Minimum efficiency: 85% at full load.
  - b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
  - c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
  - d. Integral short circuit, open circuit, and overload protection.
  - e. Power Factor: ≥ 0.95.
  - f. Total Harmonic Distortion: ≤ 20%.
  - g. Comply with FCC 47 CFR Part 15.
4. LED modules shall include the following features unless otherwise indicated:
  - a. Comply with IES LM-79 and LM-80 requirements.
  - b. Minimum CRI 80 and color temperature 3000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
  - c. Minimum Rated Life: 50,000 hours per IES L70.
  - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights:

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

C. LED Troffers:

1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
2. Housing, LED driver, and LED module shall be products of the same manufacturer.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, manufacturer's instructions, and as shown on the drawings or specified.
- B. Align, mount, and level the lighting fixtures uniformly.
- C. Wall-mounted fixtures shall be attached to the studs in the walls, or to a 20 gauge metal backing plate that is attached to the studs in the walls. Lighting fixtures shall not be attached directly to gypsum board.
- D. Lighting Fixture Supports:
  1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.
  2. Shall maintain the fixture positions after cleaning and relamping.
  3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
  7. Surface mounted lighting fixtures:
    - a. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts (or stud-clips) shall be minimum 6 mm (1/4 inch) bolt, secured to main ceiling runners and/or secured to cross runners. Non-turning studs may be attached to the main ceiling runners and cross runners with special non-friction clip devices designed for the purpose, provided they bolt through the runner, or are also secured to the building structure by 12 gauge safety hangers. Studs or bolts securing fixtures weighing in

excess of 25 kg (56 pounds) shall be supported directly from the building structure.

- b. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.
  - c. Fixtures less than 6.8 kg (15 pounds) in weight and occupying less than 3715 sq cm (two square feet) of ceiling area may, when designed for the purpose, be supported directly from the outlet box when all the following conditions are met.
    - 1) Screws attaching the fixture to the outlet box pass through round holes (not key-hole slots) in the fixture body.
    - 2) The outlet box is attached to a main ceiling runner (or cross runner) with approved hardware.
    - 3) The outlet box is supported vertically from the building structure.
  - d. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.
8. Single or double pendant-mounted lighting fixtures:
- a. Each stem shall be supported by an approved outlet box mounted swivel joint and canopy which holds the stem captive and provides spring load (or approved equivalent) dampening of fixture oscillations. Outlet box shall be supported vertically from the building structure.
9. Outlet boxes for support of lighting fixtures (where permitted) shall be secured directly to the building structure with approved devices or supported vertically in a hung ceiling from the building structure with a nine gauge wire hanger, and be secured by an approved device to a main ceiling runner or cross runner to prevent any horizontal movement relative to the ceiling.
- E. Furnish and install the new lamps as specified for all lighting fixtures installed under this project, and for all existing lighting fixtures reused under this project.



- F. The electrical and ceiling trades shall coordinate to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges, etc.), to match the ceiling system being installed.
- G. Bond lighting fixtures to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- H. At completion of project, replace all defective components of the lighting fixtures at no cost to the Government.
- I. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT, and Section 02 41 00, DEMOLITION.

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

- A. Perform the following:
  - 1. Visual Inspection:
    - a. Verify proper operation by operating the lighting controls.
    - b. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.
  - 2. Electrical tests:
    - a. Exercise dimming components of the lighting fixtures over full range of dimming capability by operating the control devices(s) in the presence of the COTR. Observe for visually detectable flicker over full dimming range, and replace defective components at no cost to the Government.
    - b. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless specifically recommended otherwise by the lamp manufacturer. Burn-in dimmed fluorescent and compact fluorescent lamps for at least 100 hours at full voltage, unless specifically recommended otherwise by the lamp manufacturer. Replace any lamps and ballasts which fail during burn-in.

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

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

---END---

**SECTION 26 56 00  
EXTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- B. Section 09 06 00, SCHEDULE FOR FINISHES: Finishes for exterior light poles and luminaires.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- D. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage power and lighting wiring.
- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- F. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings, and boxes for raceway systems.
- G. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground handholes and conduits.
- H. Section 26 09 23, LIGHTING CONTROLS: Controls for exterior lighting.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

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

1. Shop Drawings:

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

2. Manuals:

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

3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the Contractor that the exterior lighting systems have been properly installed and tested.

### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):  
LRFDLTS-17.....Structural Supports for Highway Signs, Luminaires and  
Traffic Signals
- C. American Concrete Institute (ACI):  
318-14 .....Building Code Requirements for Structural Concrete
- D. American National Standards Institute (ANSI):  
H35.1/H35 1M-17 .....American National Standard Alloy and Temper Designation  
Systems for Aluminum
- E. American Society for Testing and Materials (ASTM):  
A123/A123M-17 .....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel  
Products  
A153/A153M-16 .....Zinc Coating (Hot-Dip) on Iron and Steel Hardware  
B108/B108M-15 .....Aluminum-Alloy Permanent Mold Castings  
C1089-13 .....Spun Cast Prestressed Concrete Poles
- F. Federal Aviation Administration (FAA):  
AC 70/7460-IL-15 .....Obstruction Lighting and Marking  
AC 150/5345-43H-16 .....Obstruction Lighting Equipment
- G. Illuminating Engineering Society of North America (IESNA):  
HB-9-00 .....Lighting Handbook  
RP-8-14.....Roadway Lighting  
LM-52-03.....Photometric Measurements of Roadway Sign Installations  
LM-72-97(R2010) .....Directional Positioning of Photometric Data

- LM-79-08.....Approved Method for the Electrical and Photometric  
Measurements of Solid-State Lighting Products
- LM-80-15.....Approved Method for Measuring Luminous Flux and Color  
Maintenance of LED Packages, Arrays and Modules
- TM-15-11.....Luminaire Classification System for Outdoor Luminaires
- H. National Electrical Manufacturers Association (NEMA):
- C78.41-16.....Electric Lamps – Guidelines for Low-Pressure Sodium  
Lamps
- C78.42-09(R2016) .....Electric Lamps – Guidelines for High-Pressure Sodium  
Lamps
- C78.43-13 .....Electric Lamps – Single-Ended Metal-Halide Lamps
- C78.1381-98.....Electric Lamps – 70-Watt M85 Double-Ended Metal-Halide  
Lamps
- C81.61-17 .....Electrical Lamp Bases – Specifications for Bases (Caps) for  
Electric Lamps
- C82.4-17 .....Ballasts for High-Intensity-Discharge and Low-Pressure  
Sodium Lamps (Multiple-Supply Type)
- C136.3-14 .....For Roadway and Area Lighting Equipment – Luminaire  
Attachments
- C136.17-05(R2010)(S2017) ..Roadway and Area Lighting Equipment – Enclosed Side-  
Mounted Luminaires for Horizontal-Burning High-  
Intensity-Discharge Lamps – Mechanical Interchangeability  
of Refractors
- ICS 2-00(R2005) .....Controllers, Contactors and Overload Relays Rated 600  
Volts
- ICS 6-93(R2016) .....Enclosures
- I. National Fire Protection Association (NFPA):
- 70-17 .....National Electrical Code (NEC)
- 101-18 .....Life Safety Code

J. Underwriters Laboratories, Inc. (UL):

- 496-17 .....Lampholders
- 773-16 .....Plug-In, Locking Type Photocontrols for Use with Area  
Lighting
- 773A-16 .....Nonindustrial Photoelectric Switches for Lighting Control
- 1029-94 .....High-Intensity-Discharge Lamp Ballasts
- 1598-08 .....Luminaires
- 8750-15.....Light Emitting Diode (LED) Equipment for Use in Lighting Products

**1.6 DELIVERY, STORAGE, AND HANDLING**

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

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS**

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

**2.2 POLES**

A. General:

1. Poles shall be as shown on the drawings, and as specified. Finish shall be as specified on the drawings.
2. The pole and arm assembly shall be designed for wind loading of 161 km/hr (100 mph) minimum, as required by wind loading conditions at project site, with an additional 30% gust factor and supporting luminaire(s) and accessories such as shields, banner arms, and banners that have the effective projected areas indicated. The effective projected area of the pole shall be applied at the height of the pole base, as shown on the drawings.

3. Poles shall be anchor-bolt type designed for use with underground supply conductors. Poles shall have handhole having a minimum clear opening of 65 x 125 mm (2.5 x 5 inches). Handhole covers shall be secured by stainless steel captive screws.
4. Provide a steel-grounding stud opposite handhole openings, designed to prevent electrolysis when used with copper wire.
5. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts.
6. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.
7. Provide manufacturer's standard finish, as scheduled on the drawings. Where indicated on drawings, provide finishes as indicated in Section 09 06 00, SCHEDULE FOR FINISHES.

B. Types:

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

## 2.3 FOUNDATIONS FOR POLES

- A. Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.
- B. Foundations shall support the effective projected area of the specified pole, arm(s), luminaire(s), and accessories, such as shields, banner arms, and banners, under wind conditions previously specified in this section.
- C. Place concrete in spirally-wrapped treated paper forms for round foundations, and construct forms for square foundations.
- D. Rub-finish and round all above-grade concrete edges to approximately 6 mm (0.25-inch) radius.



- E. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings. Anchor bolts shall be in a welded cage or properly positioned by the tiewire to stirrups.
- F. Prior to concrete pour, install electrode per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

## **2.4 LUMINAIRES**

- A. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of lamp and ballast heat, and safe cleaning and relamping.
- B. Illumination distribution patterns, BUG ratings and cutoff types as defined by the IESNA shall be as shown on the drawings.
- C. Incorporate ballasts in the luminaire housing, except where otherwise shown on the drawings.
- D. Lenses shall be frame-mounted, heat-resistant, borosilicate glass, with prismatic refractors, unless otherwise shown on the drawings. Attach the frame to the luminaire housing by hinges or chain. Use heat and aging-resistant, resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. Lamp sockets for high intensity discharge (H.I.D) fixture shall have locking-type porcelain enclosures in conformance to the applicable requirements of ANSI C81.61-09 and UL 496-08.
- F. Pre-wire internal components to terminal strips at the factory.
- G. Bracket-mounted luminaires shall have leveling provisions and clamp-type adjustable slip-fitters with locking screws.
- H. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.
- I. Provide manufacturer's standard finish, as scheduled on the drawings. Where indicated on drawings, match finish process and color of pole or support materials. Where indicated on drawings, provide finishes as indicated in Section 09 06 00, SCHEDULE FOR FINISHES.

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

## **2.5 LAMPS**

- A. Install the proper lamps in every luminaire installed as shown on the drawings.
- B. Lamps shall be general-service, outdoor lighting types.
- F. LED sources shall meet the following requirements:
  - 1. Operating temperature rating shall be between -40 degrees C (-40 degrees F) and 50 degrees C (120 degrees F).
  - 2. Correlated Color Temperature (CCT): 4000K.
  - 3. Color Rendering Index (CRI):  $\geq 85$ .
  - 4. The manufacturer shall have performed reliability tests on the LEDs luminaires complying with Illuminating Engineering Society (IES) LM79 for photometric performance and LM80 for lumen maintenance and L70 life.
- G. Mercury vapor lamps shall not be used.

## **2.9 LED DRIVERS**

- A. LED drivers shall meet the following requirements:
  - 1. Drivers shall have a minimum efficiency of 85%.
  - 2. Starting Temperature: -40 degrees C (-40 degrees F).
  - 3. Input Voltage: 120 to 480 ( $\pm 10\%$ ) volt.
  - 4. Power Supplies: Class I or II output.
  - 5. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50  $\mu$ s, 10kA/8 x 20  $\mu$ s) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
  - 6. Power Factor (PF):  $\geq 0.90$ .
  - 7. Total Harmonic Distortion (THD):  $\leq 20\%$ .
  - 8. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
  - 9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

## **2.10 EXISTING LIGHTING SYSTEMS**

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

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install lighting in accordance with the NEC, as shown on the drawings, and in accordance with manufacturer's recommendations.
- B. Pole Foundations:
  - 1. Excavate only as necessary to provide sufficient working clearance for installation of forms and proper use of tamper to the full depth of the excavation. Prevent surface water from flowing into the excavation. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath, and the end of conduit.
  - 2. Set anchor bolts according to anchor-bolt templates furnished by the pole manufacturer.
  - 3. Install poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.
  - 4. After the poles have been installed, shimmed, and plumbed, grout the spaces between the pole bases and the concrete base with non-shrink concrete grout material. Provide a plastic or copper tube, of not less than 9 mm (0.375-inch) inside diameter through the grout, tight to the top of the concrete base to prevent moisture weeping from the interior of the pole.
- C. Install lamps in each luminaire.
- D. Adjust luminaires that require field adjustment or aiming.

### **3.2 GROUNDING**

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

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

Verify operation after installing luminaires and energizing circuits.

--- E N D ---

**SECTION 27 05 11**  
**REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section includes common requirements to communications installations and applies to all sections of Division 27 and Division 28.
- B. Provide completely functioning communications systems.
- C. Comply with VAAR 852.236.91 and FAR clause 52.236-21 in circumstance of a need for additional detail or conflict between drawings, specifications, reference standards or code.

**1.2 REFERENCES**

- A. Abbreviations and Acronyms
  - 1. Refer to <http://www.cfm.va.gov/til/sdetail.asp> for Division 00, ARCHITECTURAL ABBREVIATIONS.
  - 2. Additional Abbreviations and Acronyms:

A	Ampere
AC	Alternating Current
AE	Architect and Engineer
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
AWG	American Wire Gauge (refer to STP and UTP)
AWS	Advanced Wireless Services
BCT	Bonding Conductor for Telecommunications (also Telecommunications Bonding Conductor (TBC))
BDA	Bi-Directional Amplifier
BICSI	Building Industry Consulting Service International
BIM	Building Information Modeling
BOM	Bill of Materials

BTU	British Thermal Units
BU CR	Back-up Computer Room
BTS	Base Transceiver Station
CAD	AutoCAD
CBOPC	Community Based Out Patient Clinic
CBC	Coupled Bonding Conductor
CBOC	Community Based Out Patient Clinic (refer to CBOPC, OPC, VAMC)
CCS	TIP's Cross Connection System (refer to VCCS and HCCS)
CFE	Contractor Furnished Equipment
CFM	US Department of Veterans Affairs Office of Construction and Facilities Management
CFR	Consolidated Federal Regulations
CIO	Communication Information Officer (Facility, VISN or Region)
cm	Centimeters
CO	Central Office
COR	Contracting Officer Representative
CPU	Central Processing Unit
CSU	Customer Service Unit
CUP	Conditional Use Permit(s) – Federal/GSA for VA
dB	Decibel
dBm	Decibel Measured
dBmV	Decibel per milli-Volt
DC	Direct Current
DEA	United States Drug Enforcement Administration
DSU	Data Service Unit
EBC	Equipment Bonding Conductor
ECC	Engineering Control Center (refer to DCR, EMCR)
EDGE	Enhanced Data (Rates) for GSM Evolution

EDM	Electrical Design Manual
EMCR	Emergency Management Control Room (refer to DCR, ECC)
EMI	Electromagnetic Interference (refer to RFI)
EMS	Emergency Medical Service
EMT	Electrical Metallic Tubing or thin wall conduit
ENTR	Utilities Entrance Location (refer to DEMARC, POTS, LEC)
EPBX	Electronic Digital Private Branch Exchange
ESR	Vendor's Engineering Service Report
FA	Fire Alarm
FAR	Federal Acquisition Regulations in Chapter 1 of Title 48 of Code of Federal Regulations
FMS	VA's Headquarters or Medical Center Facility's Management Service
FR	Frequency (refer to RF)
FTS	Federal Telephone Service
GFE	Government Furnished Equipment
GPS	Global Positioning System
GRC	Galvanized Rigid Metal Conduit
GSM	Global System (Station) for Mobile
HCCS	TIP's Horizontal Cross Connection System (refer to CCS & VCCS)
HDPE	High Density Polyethylene Conduit
HDTV	Advanced Television Standards Committee High-Definition Digital Television
HEC	Head End Cabinets(refer to HEIC, PA)
HEIC	Head End Interface Cabinets(refer to HEC, PA)
HF	High Frequency (Radio Band; Re FR, RF, VHF & UHF)
HSPA	High Speed Packet Access
HZ	Hertz
IBT	Intersystem Bonding Termination (NEC 250.94)

IC	Intercom
ICRA	Infectious Control Risk Assessment
IDEN	Integrated Digital Enhanced Network
IDC	Insulation Displacement Contact
IDF	Intermediate Distribution Frame
ILSM	Interim Life Safety Measures
IMC	Rigid Intermediate Steel Conduit
IRM	Department of Veterans Affairs Office of Information Resources Management
ISDN	Integrated Services Digital Network
ISM	Industrial, Scientific, Medical
IWS	Intra-Building Wireless System
LAN	Local Area Network
LBS	Location Based Services, Leased Based Systems
LEC	Local Exchange Carrier (refer to DEMARC, PBX & POTS)
LED	Light Emitting Diode
LMR	Land Mobile Radio
LTE	Long Term Evolution, or 4G Standard for Wireless Data Communications Technology
M	Meter
MAS	Medical Administration Service
MATV	Master Antenna Television
MCR	Main Computer Room
MCOR	Main Computer Operators Room
MDF	Main Distribution Frame
MH	Manholes or Maintenance Holes
MHz	Megahertz (10 <sup>6</sup> Hz)
mm	Millimeter



MOU	Memorandum of Understanding
MW	Microwave (RF Band, Equipment or Services)
NID	Network Interface Device (refer to DEMARC)
NEC	National Electric Code
NOR	Network Operations Room
NRTL	OSHA Nationally Recognized Testing Laboratory
NS	Nurse Stations
NTIA	U.S. Department of Commerce National Telecommunications and Information Administration
OEM	Original Equipment Manufacturer
OI&T	Office of Information and Technology
OPC	VA's Outpatient Clinic (refer to CBOC, VAMC)
OSH	Department of Veterans Affairs Office of Occupational Safety and Health
OSHA	United States Department of Labor Occupational Safety and Health Administration
OTDR	Optical Time-Domain Reflectometer
PA	Public Address System (refer to HE, HEIC, RPEC)
PBX	Private Branch Exchange (refer to DEMARC, LEC, POTS)
PCR	Police Control Room (refer to SPCC, could be designated SCC)
PCS	Personal Communications Service (refer to UPCS)
PE	Professional Engineer
PM	Project Manager
PoE	Power over Ethernet
POTS	Plain Old Telephone Service (refer to DEMARC, LEC, PBX)
PSTN	Public Switched Telephone Network
PSRAS	Public Safety Radio Amplification Systems
PTS	Pay Telephone Station
PVC	Poly-Vinyl Chloride

PWR	Power (in Watts)
RAN	Radio Access Network
RBB	Rack Bonding Busbar
RE	Resident Engineer or Senior Resident Engineer
RF	Radio Frequency (refer to FR)
RFI	Radio Frequency Interference (refer to EMI)
RFID	RF Identification (Equipment, System or Personnel)
RMC	Rigid Metal Conduit
RMU	Rack Mounting Unit
RPEC	Radio Paging Equipment Cabinets(refer to HEC, HEIC, PA)
RTLS	Real Time Location Service or System
RUS	Rural Utilities Service
SCC	Security Control Console (refer to PCR, SPCC)
SMCS	Spectrum Management and Communications Security (COMSEC)
SFO	Solicitation for Offers
SME	Subject Matter Experts (refer to AHJ)
SMR	Specialized Mobile Radio
SMS	Security Management System
SNMP	Simple Network Management Protocol
SPCC	Security Police Control Center (refer to PCR, SMS)
STP	Shielded Balanced Twisted Pair (refer to UTP)
STR	Stacked Telecommunications Room
TAC	VA's Technology Acquisition Center, Austin, Texas
TCO	Telecommunications Outlet
TER	Telephone Equipment Room
TGB	Telecommunications Grounding Busbar (also Secondary Bonding Busbar (SBB))
TIP	Telecommunications Infrastructure Plant

TMGB	Telecommunications Main Grounding Busbar (also Primary Bonding Busbar (PBB))
TMS	Traffic Management System
TOR	Telephone Operators Room
TP	Balanced Twisted Pair (refer to STP and UTP)
TR	Telecommunications Room (refer to STR)
TWP	Twisted Pair
UHF	Ultra High Frequency (Radio)
UMTS	Universal Mobile Telecommunications System
UPCS	Unlicensed Personal Communications Service (refer to PCS)
UPS	Uninterruptible Power Supply
USC	United States Code
UTP	Unshielded Balanced Twisted Pair (refer to TP and STP)
UV	Ultraviolet
V	Volts
VAAR	Veterans Affairs Acquisition Regulation
VACO	Veterans Affairs Central Office
VAMC	VA Medical Center (refer to CBOC, OPC, VACO)
VCCS	TIP's Vertical Cross Connection System (refer to CCS and HCCS)
VHF	Very High Frequency (Radio)
VISN	Veterans Integrated Services Network (refers to geographical region)
VSWR	Voltage Standing Wave Ratio
W	Watts
WEB	World Electronic Broadcast
WIMAX	Worldwide Interoperability (for MW Access)
WI-FI	Wireless Fidelity
WMTS	Wireless Medical Telemetry Service
WSP	Wireless Service Providers

B. Definitions:

1. Access Floor: Pathway system of removable floor panels supported on adjustable pedestals to allow cable placement in area below.
2. BNC Connector (BNC): United States Military Standard MIL-C-39012/21 bayonet-type coaxial connector with quick twist mating/unmating, and two lugs preventing accidental disconnection from pulling forces on cable.
3. Bond: Permanent joining of metallic parts to form an electrically conductive path to ensure electrical continuity and capacity to safely conduct any currents likely to be imposed to earth ground.
4. Bundled Microducts: All forms of jacketed microducts.
5. Conduit: Includes all raceway types specified.
6. Conveniently Accessible: Capable of being reached without use of ladders, or without climbing or crawling under or over obstacles such as, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
7. Distributed (in house) Antenna System (DAS): An Emergency Radio Communications System installed for Emergency Responder (or first responders and Government personnel) use while inside facility to maintain contact with each respective control point; refer to Section 27 53 19, DISTRIBUTED RADIO ANTENNA (WITHIN BUILDING) EQUIPMENT AND SYSTEMS.
8. DEMARC, Extended DMARC or ENTR: Service provider's main point of demarcation owned by LEC or service provider and establishes a physical point where service provider's responsibilities for service and maintenance end. This point is called NID, in data networks.
9. Effectively Grounded: Intentionally bonded to earth through connections of low impedance having current carrying capacity to prevent buildup of currents and voltages resulting in hazard to equipment or persons.
10. Electrical Supervision: Analyzing a system's function and components (i.e. cable breaks / shorts, inoperative stations, lights, LEDs and states of change, from primary

- to backup) on a 24/7/365 basis; provide aural and visual emergency notification signals to minimum two remote designated or accepted monitoring stations.
11. Electrostatic Interference (ESI) or Electrostatic Discharge Interference: Refer to EMI and RFI.
  12. Emergency Call Systems: Wall units (in parking garages and stairwells) and pedestal mounts (in parking lots) typically provided with a strobe, camera and two-way audio communication functions.
  13. Project 25 (2014) (P25 (TIA-102 Series)): Set of standards for local, state and Federal public safety organizations and agencies digital LMR services. P25 is applicable to LMR equipment authorized or licensed under the US Department of Commerce National Telecommunications and Information Administration or FCC rules and regulations, and is a required standard capability for all LMR equipment and systems.
  14. Grounding Electrode Conductor: (GEC) Conductor connected to earth grounding electrode.
  15. Grounding Electrode System: Electrodes through which an effective connection to earth is established, including supplementary, communications system grounding electrodes and GEC.
  16. Grounding Equalizer or Backbone Bonding Conductor (BBC): Conductor that interconnects elements of telecommunications grounding infrastructure.
  17. Head End (HE): Equipment, hardware and software, or a master facility at originating point in a communications system designed for centralized communications control, signal processing, and distribution that acts as a common point of connection between equipment and devices connected to a network of interconnected equipment, possessing greatest authority for allowing information to be exchanged, with whom other equipment is subordinate.
  18. Microducts: All forms of air blown fiber pathways.
  19. Ohm: A unit of restive measurement.

20. Received Signal Strength Indication (RSSI): A measurement of power present in a received RF signal.
21. Service Provider Demarcation Point (SPDP): Not owned by LEC or service provider, but designated by Government as point within facility considered the DEMARC.
22. Sound (SND): Changing air pressure to audible signals over given time span.
23. System: Specific hardware, firmware, and software, functioning together as a unit, performing task for which it was designed.
24. Telecommunications Bonding Backbone (TBB): Conductors of appropriate size (minimum 53.49 mm<sup>2</sup> [1/0 AWG]) stranded copper wire, that connect to Grounding Electrode System and route to telecommunications main grounding busbar (TMGB) and circulate to interconnect various TGBs and other locations shown on drawings.
25. Voice over Internet Protocol (VoIP): A telephone system in which voice signals are converted to packets and transmitted over LAN network using Transmission Control Protocol (TCP)/Internet Protocol (IP). VA'S VoIP is not listed or coded for life and public safety, critical, emergency or other protection functions. When VoIP system or equipment is provided instead of PBX system or equipment, each TR (STR) and DEMARC requires increased AC power provided to compensate for loss of PBX's telephone instrument line power; and, to compensate for absence of PBX's UPS capability.
26. Wide Area Network (WAN): A digital network that transcends localized LANs within a given geographic location. VA'S WAN/LAN is not nationally listed or coded for life and public safety, critical, emergency or other safety functions.

### **1.3 APPLICABLE PUBLICATIONS**

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

1. Each entity engaged in construction must be familiar with industry standards applicable to its construction activity.
  2. Obtain standards directly from publication source, where copies of standards are needed to perform a required construction activity.
- B. Government Codes, Standards and Executive Orders: Refer to  
<http://www.cfm.va.gov/TIL/cPro.asp>:
1. Federal Communications Commission, (FCC) CFR, Title 47:

Part 15	Restrictions of use for Part 15 listed RF Equipment in Safety of Life Emergency Functions and Equipment Locations
Part 47	Chapter A, Paragraphs 6.1-6.23, Access to Telecommunications Service, Telecommunications Equipment and Customer Premises Equipment
Part 58	Television Broadcast Service
Part 73	Radio and Television Broadcast Rules
Part 90	Rules and Regulations, Appendix C
Form 854	Antenna Structure Registration
Chapter XXIII	National Telecommunications and Information Administration (NTIA, P/O Commerce, Chapter XXIII) the 'Red Book' – Chapters 7, 8 & 9 compliments CFR, Title 47, FCC Part 15, RF Restriction of Use and Compliance in "Safety of Life" Functions & Locations
  2. US Department of Agriculture, (Title 7, USC, Chapter 55, Sections 2201, 2202 & 2203:RUS 1755    Telecommunications Standards and Specifications for Materials, Equipment and Construction:

RUS Bull 1751F-630	Design of Aerial Cable Plants
RUS Bull 1751F-640	Design of Buried Cable Plant, Physical Considerations
RUS Bull 1751F-643	Underground Plant Design
RUS Bull 1751F-815	Electrical Protection of Outside Plants,

- |                    |                                                      |
|--------------------|------------------------------------------------------|
| RUS Bull 1753F-201 | Acceptance Tests of Telecommunications Plants (PC-4) |
| RUS Bull 1753F-401 | Splicing Copper and Fiber Optic Cables (PC-2)        |
| RUS Bull 345-50    | Trunk Carrier Systems (PE-60)                        |
| RUS Bull 345-65    | Shield Bonding Connectors (PE-65)                    |
| RUS Bull 345-72    | Filled Splice Closures (PE-74)                       |
| RUS Bull 345-83    | Gas Tube Surge Arrestors (PE-80)                     |
3. US Department of Commerce/National Institute of Standards Technology,(NIST):
- |                |                                                                                                                                                                               |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FIPS PUB 1-1   | Telecommunications Information Exchange                                                                                                                                       |
| FIPS PUB 100/1 | Interface between Data Terminal Equipment (DTE) Circuit<br>Terminating Equipment for operation with Packet<br>Switched Networks, or Between Two DTEs, by Dedicated<br>Circuit |
| FIPS PUB 140/2 | Telecommunications Information Security Algorithms                                                                                                                            |
| FIPS PUB 143   | General Purpose 37 Position Interface between DTE and<br>Data Circuit Terminating Equipment                                                                                   |
| FIPS 160/2     | Electronic Data Interchange (EDI),                                                                                                                                            |
| FIPS 175       | Federal Building Standard for Telecommunications<br>Pathway and Spaces                                                                                                        |
| FIPS 191       | Guideline for the Analysis of Local Area Network Security                                                                                                                     |
| FIPS 197       | Advanced Encryption Standard (AES)                                                                                                                                            |
| FIPS 199       | Standards for Security Categorization of Federal<br>Information and Information Systems                                                                                       |
4. US Department of Defense, (DoD):
- |                 |                                                               |
|-----------------|---------------------------------------------------------------|
| MIL-STD-188-110 | Interoperability and Performance Standards for Data<br>Modems |
| MIL-STD-188-114 | Electrical Characteristics of Digital Interface Circuits      |
| MIL-STD-188-115 | Communications Timing and Synchronizations Subsystems         |
| MIL-C-28883     | Advanced Narrowband Digital Voice Terminals                   |



- MIL-C-39012/21                      Connectors, Receptacle, Electrical, Coaxial, Radio  
Frequency, (Series BNC (Uncabled), Socket Contact, Jam  
Nut Mounted, Class 2)
5. US Department of Health and Human Services:  
The Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy,  
Security and Breach Notification Rules
6. US Department of Justice:  
2010 Americans with Disabilities Act Standards for Accessible Design (ADAAD).
7. US Department of Labor, (DoL) - Public Law 426-62 – CFR, Title 29, Part 1910,  
Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational  
Safety and Health Standards):
- Subpart 7                              Approved NRTLs; obtain a copy at  
<https://www.osha.gov/dts/otpc/nrtl/nrtllist.html>
- Subpart 35                            Compliance with NFPA 101, Life Safety Code
- Subpart 36                            Design and Construction Requirements for Exit Routes
- Subpart 268                           Telecommunications
- Subpart 305                           Wiring Methods, Components, and Equipment for General  
Use
- Subpart 508                           Americans with Disabilities Act Accessibility Guidelines;  
technical requirement for accessibility to buildings and  
facilities by individuals with disabilities
8. US Department of Transportation, (DoT):
- a. Public Law 85-625, CFR, Title 49, Part 1, Subpart C – Federal Aviation  
Administration (FAA):AC 110/460-ID & AC 707 / 460-2E – Advisory Circulars  
Standards for Construction of Antenna Towers, and 7450 and 7460-2 – Antenna  
Construction Registration Forms.
9. US Department of Veterans Affairs (VA): Office of Telecommunications (OI&T), MP-  
6, PART VIII, TELECOMMUNICATIONS, CHAPTER 5, AUDIO, RADIO AND TELEVISION

(and COMSEC) COMMUNICATIONS SYSTEMS: Spectrum Management and COMSEC Service (SMCS), AHJ for:

- a. CoG, “Continuance of Government” communications guidelines and compliance.
- b. COMSEC, “VA wide coordination and control of security classified communication assets.”
- c. COOP, “Continuance of Operations” emergency communications guidelines and compliance.
- d. FAA, FCC, and US Department of Commerce National Telecommunications and Information Administration, “VA wide RF Co-ordination, Compliance and Licensing.”
- e. Handbook 6100 – Telecommunications: Cyber and Information Security Office of Cyber and Information Security, and Handbook 6500 – Information Security Program.
- f. Low Voltage Special Communications Systems “Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance and Life Safety Certifications for CFM and VA Facility Low Voltage Special Communications Projects (except Fire Alarm, Telephone and Data Systems).”
- g. SATCOM, “Satellite Communications” guidelines and compliance, and Security and Law Enforcement Systems – “Coordinates the Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance, DEA and Public Safety Certification(s) for CFM and VA Facility Security Low Voltage Special Communications and Physical Security Projects.
- h. VHA’s National Center for Patient Safety – Veterans Health Administration (VHA) Warning System, Failure of Medical Alarm Systems using Paging Technology to Notify Clinical Staff, July 2004.
- i. VA’s CEOSH, concurrence with warning identified in VA Directive 7700.
- j. Wireless and Handheld Devices, “Guidelines and Compliance,”

- k. Office of Security and Law Enforcement: VA Directive 0730 and Health Special Presidential Directive (HSPD)-12.
- c. NRTL Standards: Refer to <https://www.osha.gov/laws-regs/regulations/standardnumber/1926>
  - 1. Canadian Standards Association (CSA); same tests as presented by UL
  - 2. Communications Certifications Laboratory (CEL); same tests as presented by UL.
  - 3. Intertek Testing Services NA, Inc., (ITSNA), formerly Edison Testing Laboratory (ETL) same tests as presented by UL).
  - 4. Underwriters Laboratory (UL):

1-2005	Flexible Metal Conduit
5-2011	Surface Metal Raceway and Fittings
6-2007	Rigid Metal Conduit
44-010	Thermoset-Insulated Wires and Cables
50-1995	Enclosures for Electrical Equipment
65-2010	Wired Cabinets
83-2008	Thermoplastic-Insulated Wires and Cables
96-2005	Lightning Protection Components
96A-2007	Installation Requirements for Lightning Protection Systems
360-2013	Liquid-Tight Flexible Steel Conduit
444-2008	Communications Cables
467-2013	Grounding and Bonding Equipment
486A-486B-2013	Wire Connectors
486C-2013	Splicing Wire Connectors
486D-2005	Sealed Wire Connector Systems
486E-2009	Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
493-2007	Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
497/497A/497B/497C	

497D/497E	Protectors for Paired Conductors/Communications Circuits/Data Communications and Fire Alarm Circuits/coaxial circuits/voltage protections/Antenna Lead In
510-2005	Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
514A-2013	Metallic Outlet Boxes
514B-2012	Fittings for Cable and Conduit
514C-1996	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-2011	Schedule 40 and 80 Rigid PVC Conduit
651A-2011	Type EB and A Rigid PVC Conduit and HDPE Conduit
797-2007	Electrical Metallic Tubing
884-2011	Underfloor Raceways and Fittings
1069-2007	Hospital Signaling and Nurse Call Equipment
1242-2006	Intermediate Metal Conduit
1449-2006	Standard for Transient Voltage Surge Suppressors
1479-2003	Fire Tests of Through-Penetration Fire Stops
1480-2003	Speaker Standards for Fire Alarm, Emergency, Commercial and Professional use
1666-2007	Standard for Wire/Cable Vertical (Riser) Tray Flame Tests
1685-2007	Vertical Tray Fire Protection and Smoke Release Test for Electrical and Fiber Optic Cables
1861-2012	Communication Circuit Accessories
1863-2013	Standard for Safety, communications Circuits Accessories
1865-2007	Standard for Safety for Vertical-Tray Fire Protection and Smoke-Release Test for Electrical and Optical-Fiber Cables
2024-2011	Standard for Optical Fiber Raceways
2024-2014	Standard for Cable Routing Assemblies and Communications Raceways

2196-2001	Standard for Test of Fire Resistive Cable
60950-1 ed. 2-2014	Information Technology Equipment Safety

D. Industry Standards:

1. Advanced Television Systems Committee (ATSC):

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

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

3. American Society of Mechanical Engineers (ASME):

A17.1 (2013)	Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices
17.3 (2011)	Safety Code for Existing Elevators and Escalators
17.4 (2009)	Guide for Emergency Personnel
17.5 (2011)	Elevator and Escalator Electrical Equipment

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

B1 (2001)	Standard Specification for Hard-Drawn Copper Wire
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|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| B8 (2004)      | Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft                                                         |
| D1557 (2012)   | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft <sup>3</sup> (2,700 kN-m/m <sup>3</sup> ) |
| D2301 (2004)   | Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape                                                          |
| B258-02 (2008) | Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors          |
| D709-01(2007)  | Standard Specification for Laminated Thermosetting Materials                                                                                             |
| D4566 (2008)   | Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable                             |
5. American Telephone and Telegraph Corporation (AT&T) - Obtain following AT&T Publications at <https://ebiznet.sbc.com/sbcnebs/>
- |                     |                                                                                                |
|---------------------|------------------------------------------------------------------------------------------------|
| ATT-TP-76200 (2013) | Network Equipment and Power Grounding, Environmental, and Physical Design Requirements         |
| ATT-TP-76300(2012)  | Merged AT&T Affiliate Companies Installation Requirements                                      |
| ATT-TP-76305 (2013) | Common Systems Cable and Wire Installation and Removal Requirements - Cable Racks and Raceways |
| ATT-TP-76306 (2009) | Electrostatic Discharge Control                                                                |
| ATT-TP-76400 (2012) | Detail Engineering Requirements                                                                |
| ATT-TP-76402 (2013) | AT&T Raised Access Floor Engineering and Installation Requirements                             |
| ATT-TP-76405 (2011) | Technical Requirements for Supplemental Cooling Systems in Network Equipment Environments      |

- |                     |                                                                                      |
|---------------------|--------------------------------------------------------------------------------------|
| ATT-TP-76416 (2011) | Grounding and Bonding Requirements for Network Facilities                            |
| ATT-TP-76440 (2005) | Ethernet Specification                                                               |
| ATT-TP-76450 (2013) | Common Systems Equipment Interconnection Standards for AT&T Network Equipment Spaces |
| ATT-TP-76461 (2008) | Fiber Optic Cleaning                                                                 |
| ATT-TP-76900 (2010) | AT&T Installation Testing Requirement                                                |
| ATT-TP-76911 (1999) | AT&T LEC Technical Publication Notice                                                |
6. British Standards Institution (BSI):
- |               |                                                                                                                                                                            |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BS EN 50109-2 | Hand Crimping Tools - Tools for The Crimp Termination of Electric Cables and Wires for Low Frequency and Radio Frequency Applications – All Parts & Sections. October 1997 |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
7. Building Industry Consulting Service International(BICSI):
- |                          |                                                                                                                    |
|--------------------------|--------------------------------------------------------------------------------------------------------------------|
| ANSI/BICSI 002-2011      | Data Center Design and Implementation Best Practices                                                               |
| ANSI/BICSI 004-2012      | Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities |
| ANSI/NECA/BICSI 568-2006 | Standard for Installing Commercial Building Telecommunications Cabling                                             |
| NECA/BICSI 607-2011      | Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings   |
| ANSI/BICSI 005-2013      | Electronic Safety and Security (ESS) System Design and Implementation Best Practices                               |
8. Electronic Components Assemblies and Materials Association,(ECA).
- |                       |                                                                                            |
|-----------------------|--------------------------------------------------------------------------------------------|
| ECA EIA/RS-270 (1973) | Tools, Crimping, Solderless Wiring Devices – Recommended Procedures for User Certification |
|-----------------------|--------------------------------------------------------------------------------------------|

- EIA/ECA 310-E (2005)      Cabinets, and Associated Equipment
9. Facility Guidelines Institute: 2010 Guidelines for Design and Construction of Health Care Facilities.
10. Insulated Cable Engineers Association (ICEA):
- ANSI/ICEA
- S-80-576-2002                      Category 1 & 2 Individually Unshielded Twisted-Pair Indoor Cables for Use in Communications Wiring Systems
- ANSI/ICEA
- S-84-608-2010                      Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor, S-87-640(2011) Optical Fiber Outside Plant Communications Cable
- ANSI/ICEA
- S-90-661-2012                      Category 3, 5, & 5e Individually Unshielded Twisted-Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems
- S-98-688 (2012)                      Broadband Twisted Pair Cable Aircore, Polyolefin Insulated, Copper Conductors
- S-99-689 (2012)                      Broadband Twisted Pair Cable Filled, Polyolefin Insulated, Copper Conductors
- ICEA S-102-700  
(2004)                                  Category 6 Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for use in Communications Wiring Systems Technical Requirements
11. Institute of Electrical and Electronics Engineers (IEEE):
- ISSN 0739-5175                      March-April 2008 Engineering in Medicine and Biology Magazine, IEEE (Volume: 27, Issue:2) Medical Grade-Mission Critical-Wireless Networks
- IEEE C2-2012                                  National Electrical Safety Code (NESC)
- C62.41.2-2002/



- |                 |                                                                                                                       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------|
| Cor 1-2012 IEEE | Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits 4)              |
| C62.45-2002     | IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits |
| 81-2012 IEEE    | Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System           |
| 100-1992        | IEEE the New IEEE Standards Dictionary of Electrical and Electronics Terms                                            |
| 602-2007        | IEEE Recommended Practice for Electric Systems in Health Care Facilities                                              |
| 1100-2005       | IEEE Recommended Practice for Powering and Grounding Electronic Equipment                                             |
12. International Code Council:
- |              |                                         |
|--------------|-----------------------------------------|
| AC193 (2014) | Mechanical Anchors in Concrete Elements |
|--------------|-----------------------------------------|
13. International Organization for Standardization (ISO):
- |                     |                                                                                                                                                                                                                            |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ISO/TR 21730 (2007) | Use of Mobile Wireless Communication and Computing Technology in Healthcare Facilities - Recommendations for Electromagnetic Compatibility (Management of Unintentional Electromagnetic Interference) with Medical Devices |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
14. National Electrical Manufacturers Association (NEMA):
- |                       |                                                                                                      |
|-----------------------|------------------------------------------------------------------------------------------------------|
| NEMA 250 (2008)       | Enclosures for Electrical Equipment (1,000V Maximum)                                                 |
| ANSI C62.61 (1993)    | American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits              |
| ANSI/NEMA FB 1 (2012) | Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing EMT) and Cable |
| ANSI/NEMA OS 1 (2009) | Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports                                     |

- |                    |                                                                                |
|--------------------|--------------------------------------------------------------------------------|
| NEMA SB 19 (R2007) | NEMA Installation Guide for Nurse Call Systems                                 |
| TC 3 (2004)        | Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC<br>Conduit and Tubing |
| NEMA VE 2 (2006)   | Cable Tray Installation Guidelines                                             |
15. National Fire Protection Association (NFPA):
- |            |                                                                                                          |
|------------|----------------------------------------------------------------------------------------------------------|
| 70E-2015   | Standard for Electrical Safety in the Workplace                                                          |
| 70-2014    | National Electrical Code (NEC)                                                                           |
| 72-2013    | National Fire Alarm Code                                                                                 |
| 75-2013    | Standard for the Fire Protection of Information<br>Technological Equipment                               |
| 76-2012    | Recommended Practice for the Fire Protection of<br>Telecommunications Facilities                         |
| 77-2014    | Recommended Practice on Static Electricity                                                               |
| 90A-2015   | Standard for the Installation of Air Conditioning and<br>Ventilating Systems                             |
| 99-2015    | Health Care Facilities Code                                                                              |
| 101-2015   | Life Safety Code                                                                                         |
| 241        | Safeguarding construction, alternation and Demolition<br>Operations                                      |
| 255-2006   | Standard Method of Test of Surface Burning<br>Characteristics of Building Materials                      |
| 262 - 2011 | Standard Method of Test for Flame Travel and Smoke of<br>Wires and Cables for Use in Air-Handling Spaces |
| 780-2014   | Standard for the Installation of Lightning Protection<br>Systems                                         |
| 1221-2013  | Standard for the Installation, Maintenance, and Use of<br>Emergency Services Communications Systems      |
| 5000-2015  | Building Construction and Safety Code                                                                    |
16. Society for Protective Coatings (SSPC):

- SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning
17. Society of Cable Telecommunications Engineers (SCTE):
- ANSI/SCTE 15 2006      Specification for Trunk, Feeder and Distribution Coaxial Cable
18. Telecommunications Industry Association (TIA):
- TIA-120 Series      Telecommunications Land Mobile communications (APCO/Project 25) (January 2014)
- TIA TSB-140      Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems (2004)
- TIA-155      Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T (2010)
- TIA TSB-162-A      Telecommunications Cabling Guidelines for Wireless Access Points (2013)
- TIA-222-G      Structural Standard for Antenna Supporting Structures and Antennas (2014)
- TIA/EIA-423-B      Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits (2012)
- TIA-455-C      General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components (August 2014)
- TIA-455-53-A      FOTP-53 Attenuation by Substitution Measurements for Multimode Graded-Index Optical Fibers in Fiber Assemblies (Long Length) (September 2001)
- TIA-455-61-A      FOTP-61 Measurement of Fiber of Cable Attenuation Using an OTDR (July 2003)
- TIA-472D000-B      Fiber Optic Communications Cable for Outside Plant Use (July 2007)

ANSI/TIA-492-B	62.5-μ Core Diameter/125-um Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers (November 2009)
ANSI/TIA-492AAAB-A	50-um Core Diameter/125-um Cladding Diameter Class IA Graded-Index Multimode Optically Optimized American Standard Fibers (November 2009)
TIA-492CAAA	Detail Specification for Class IVa Dispersion- Unshifted Single-Mode Optical Fibers (September 2002)
TIA-492E000	Sectional Specification for Class IVd Nonzero- Dispersion Single-Mode Optical Fibers for the 1,550 nm Window (September 2002)
TIA-526-7-B	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7 (December 2008)
TIA-526.14-A	Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – SFSTP-14 (August 1998)
TIA-568	Revision/Edition: C Commercial Building Telecommunications Cabling Standard Set: (TIA-568-C.0-2 Generic Telecommunications Cabling for Customer Premises (2012), TIA-568-C.1-1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements (2012), TIA-568-C.2 Commercial Building Telecommunications Cabling Standard—Part 2: Balanced Twisted Pair Cabling Components (2009), TIA-568-C.3-1 Optical Fiber Cabling Components Standard, (2011) AND TIA-568-C.4 Broadband Coaxial Cabling and Components Standard (2011) with addendums and erratas
TIA-569	Revision/Edition C Telecommunications Pathways and Spaces (March 2013)
TIA-574	Position Non-Synchronous Interface between Data Terminal equipment and Data Circuit Terminating

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

#### **1.4 SINGULAR NUMBER**

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

#### **1.5 RELATED WORK**

- A. Specification Order of Precedence: FAR Clause 52.236-21, VAAR Clause 852.236-71.
  - 1. Field Cutting and Patching: Section 09 91 00, PAINTING.
  - 2. Additional submittal requirements: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
  - 3. Availability and source of references and standards specified in applicable publications: Section 01 42 19, REFERENCE STANDARDS.
  - 4. Control of environmental pollution and damage for air, water, and land resources: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
  - 5. Requirements for non-hazardous building construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
  - 6. General requirements and procedures to comply with various federal mandates and U.S. Department of Veterans Affairs (VA) policies for sustainable design: Section 01 81 13, SUSTAINABLE DESIGN REQUIREMENTS.
  - 7. Closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction: Section 07 84 00, FIRESTOPPING.
  - 8. Sealant and caulking materials and their application: Section 07 92 00, JOINT SEALANTS.
  - 9. General electrical requirements that are common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 10. Electrical conductors and cables in electrical systems rated 600 V and below: Section 26 05 21, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

11. Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
12. Conduit and boxes: Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
13. Wiring devices: Section 26 27 26, WIRING DEVICES.
14. Underground ducts, raceways, precast manholes and pull boxes: Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.
15. Lightning protection: Section 26 41 00, FACILITY LIGHTNING PROTECTION.
16. General requirements common to more than one section in Division 28: Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
17. Conductors and cables for electronic safety and security systems: Section 28 05 13, CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY.
18. Low impedance path to ground for electronic safety and security system ground fault currents: Section 28 05 26, GROUNDING AND BONDING FOR SECURITY SYSTEMS.
19. Conduits and partitioned telecommunications raceways for Electronic Safety and Security systems: Section 28 05 28.33, CONDUITS AND BACK BOXES FOR ELECTRONIC SAFETY AND SECURITY.
20. Physical Access Control System field-installed controllers connected by data transmission network: Section 28 13 00, PHYSICAL ACCESS DETECTION.
21. Detection and screening systems: Section 28 13 53, SECURITY ACCESS DETECTION.
22. Intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions: Section 28 16 11, INTRUSION DETECTION EQUIPMENT AND SYSTEMS.
23. Video surveillance system cameras, data transmission wiring, and control stations with associated equipment: Section 28 23 00, VIDEO SURVEILLANCE EQUIPMENT AND SYSTEMS.

24. Duress-panic alarms, emergency phones or call boxes, intercom systems, data transmission wiring and associated equipment: Section 28 26 00, ELECTRONIC PERSONAL PROTECTION EQUIPMENT AND SYSTEMS.
25. Alarm initiating devices, alarm notification appliances, control units, fire safety control devices, annunciators, power supplies, and wiring: Section 28 31 00, FIRE DETECTION AND ALARM.
26. Emergency Call telephones, intercom systems, with blue strobe light and equipment: Section 28 52 31, SECURITY EMERGENCY CALL/DURESS ALARM/COMMUNICATIONS SYSTEM AND EQUIPMENT.

#### **1.6 ADMINISTRATIVE REQUIREMENTS**

- A. Assign a single communications project manager to serve as point of contact for Government, contractor, and design professional.
- B. Be proactive in scheduling work.
  1. Use of premises is restricted at times directed by COR.
  2. Movement of materials: Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.
  3. Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
  4. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work. Plan for large equipment requiring positioning prior to closing in building.
  5. Coordinate connection of materials, equipment, and systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies; provide required connection for each service.
  6. Initiate and maintain discussion regarding schedule for ceiling construction and install cables to meet that schedule.



- c. Contact the Office of Telecommunications, Special Communications Team (005OP2H3) (202)461-5310 to have a Government-accepted Telecommunications COR assigned to project for telecommunications review, equipment and system approval and coordination with other VA personnel.
- D. Communications Project Manager Responsibilities:
  - 1. Assume responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and authorized system installers.
  - 2. Coordinate with related work indicated on drawings or specified.
  - 3. Manage work related to telecommunications system installation in a manner approved by manufacturer.

#### **1.7 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Provide parts list including quantity of spare parts.
- C. Provide manufacturer product information. Government reserves the right to require a list of installations where products have been in operation.
- D. Provide Source Quality Control Submittal:
  - 1. Submit written certification from OEM indicating that proposed supervisor of installation and proposed provider of warranty maintenance are authorized representatives of OEM. Include individual's legal name, contact information and OEM credentials in certification.
  - 2. Submit written certification from OEM that wiring and connection diagrams meet Government Life Safety Guidelines, NFPA, NEC, NRTL, these specifications, and Joint Commission requirements and instructions, requirements, recommendations, and guidance set forth by OEM for the proper performance of system.
  - 3. Pre-acceptance Certification: Certification in accordance with procedure outlined in Section 01 00 00, GENERAL REQUIREMENTS and specific Division 27 qualification documentation.

- E. Installer Qualifications: Submit three installations of similar size and complexity furnished and installed by installer; include:
  - 1. Installation location and name.
  - 2. Owner's name and contact information including, address, telephone and email.
  - 3. Date of project start and date of final acceptance.
  - 4. System project number.
  - 5. Three paragraph description of each system related to this project; include function, operation, and installation.
- F. Provide delegated design submittals (e.g. seismic support design).
- G. Submittals are required for all equipment anchors and supports. Include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or conduit. Anchors and supports to resist seismic load based on seismic design categories per section 4.0 of VA seismic design requirements H-18-8 dated August, 2013.
- H. Test Equipment List:
  - 1. Supply test equipment of accuracy better than parameters to be tested.
  - 2. Submit test equipment list including make and model number:
    - a. ANSI/TIA-1152 Level III twisted pair cabling test instrument.
    - b. Fiber optic insertion loss power meter with light source.
    - c. Optical time domain reflectometer (OTDR).
    - d. Volt-Ohm meter.
    - e. Digital camera.
  - 3. Supply only test equipment with a calibration tag from Government-accepted calibration service dated not more than 12 months prior to test.
  - 4. Provide sample test and evaluation reports.
- I. Submittal Drawings:
  - 1. Telecommunications Space Plans/Elevations: Provide enlarged floor plans of telecommunication spaces indicating layout of equipment and devices, including

receptacles and grounding provisions. Submit detailed plan views and elevations of telecommunication spaces showing racks, termination blocks, and cable paths.

Include following rooms:

- a. Telecommunications rooms.
  - b. Building Entrance Facility/Demarcation rooms.
  - c. Server rooms/Data Center.
  - d. Equipment rooms.
  - e. Antenna Head End rooms.
2. Logical Drawings: Provide logical riser or schematic drawings for all systems.
    - a. Provide riser diagrams systems and interconnection drawings for equipment assemblies; show termination points and identify wiring connections.
  3. Access Panel Schedule on Submittal Drawings: Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment.
- J. Provide sustainable design submittals.
- K. Furnish electronic certified test reports to COR prior to final inspection and not more than 90 days after completion of tests.

#### **1.8 CLOSEOUT SUBMITTALS**

- A. Provide following closeout submittals prior to project closeout date:
1. Warranty certificate.
  2. Evidence of compliance with requirements such as low voltage certificate of inspection.
  3. Project record documents.
  4. Instruction manuals and software that are a part of system.
- B. Maintenance and Operation Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
1. Prepare a manual for each system and equipment specified.
  2. Furnish on portable storage drive in PDF format or equivalent accepted by COR.
  3. Furnish complete manual as specified in specification section, fifteen days prior to performance of systems or equipment test.

4. Furnish remaining manuals prior to final completion.
5. Identify storage drive "MAINTENANCE AND OPERATION MANUAL" and system name.
6. Include name, contact information and emergency service numbers of each subcontractor installing system or equipment and local representatives for system or equipment.
7. Provide a Table of Contents and assemble files to conform to Table of Contents.
8. Operation and Maintenance Data includes:
  - a. Approved shop drawing for each item of equipment.
  - b. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of equipment.
  - c. A control sequence describing start-up, operation, and shutdown.
  - d. Description of function of each principal item of equipment.
  - e. Installation and maintenance instructions.
  - f. Safety precautions.
  - g. Diagrams and illustrations.
  - h. Test Results and testing methods.
  - i. Performance data.
  - j. Pictorial "exploded" parts list with part numbers. Emphasis to be placed on use of special tools and instruments. Indicate sources of supply, recommended spare parts, and name of servicing organization.
  - k. Warranty documentation indicating end date and equipment protected under warranty.
  - l. Appendix; list qualified permanent servicing organizations for support of equipment, including addresses and certified personnel qualifications.
- c. Record Wiring Diagrams:
  1. Red Line Drawings: Keep one E size 91.44 cm x 121.92 cm (36 inches x 48 inches) set of floor plans, on site during work hours, showing installation progress marked and

- backbone cable labels noted. Make these drawings available for examination during construction meetings or field inspections.
2. General Drawing Specifications: Detail and elevation drawings to be D size 61 cm x 91.44 cm (24 inches x 36 inches) with a minimum scale of 0.635 cm = 30.48 cm (1/4 inch = 12 inches). ER, TR and other enlarged detail floor plan drawings to be D size 61 cm x 91.44 cm (24" x 36") with a minimum scale of 0.635 cm = 30.48 cm (1/4 inch = 12 inches). Building composite floor plan drawings to be D size 61 cm x 91.44 cm (24 inches x 36 inches) with a minimum scale of 3.175 mm = 30.48 cm (1/8 inch = 1' 0 inch).
  3. Building Composite Floor Plans: Provide building floor plans showing work area outlet locations and configuration, types of jacks, distance for each cable, and cable routing locations.
  4. Floor plans to include:
    - a. Final room numbers and actual backbone cabling and pathway locations and labeling.
    - b. Inputs and outputs of equipment identified according to labels installed on cables and equipment
    - c. Device locations with labels.
    - d. Conduit.
    - e. Head-end equipment.
    - f. Wiring diagram.
    - g. Labeling and administration documentation.
  5. Submit Record Wiring Diagrams within five business days after final cable testing.
  6. Deliver Record Wiring Diagrams as CAD files in .dwg formats as determined by COR.
  7. Deliver four complete sets of electronic record wiring diagrams to COR on portable storage drive.
- D. Service Qualifications: Submit name and contact information of service organizations providing service to this installation within four hours of receipt of notification service is needed.

### **1.9 MAINTENANCE MATERIAL SUBMITTALS**

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

### **1.10 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Manufacturer must produce, as a principal product, the equipment and material specified for this project, and have manufactured item for at least three years.
- B. Product and System Qualification:
  - 1. OEM must have three installations of equipment submitted presently in operation of similar size and type as this project, that have continuously operated for a minimum of three years.
  - 2. Government reserves the right to require a list of installations where products have been in operation before approval.
  - 3. Authorized representative of OEM must be responsible for design, satisfactory operation of installed system, and certification.
- C. Trade Contractor Qualifications: Trade contractor must have completed three or more installations of similar systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identify these installations as a part of submittal.
- D. System Supplier Qualifications: System supplier must be authorized by OEM to warranty installed equipment.
- E. Telecommunications technicians assigned to system must be trained, and certified by OEM on installation and testing of system; provide written evidence of current OEM certifications for installers.
- F. Manufactured Products:

1. Comply with FAR clause 52.236-5 for material and workmanship.
2. When more than one unit of same class of equipment is required, units must be product of a single manufacturer.
3. Equipment Assemblies and Components:
  - a. Components of an assembled unit need not be products of same manufacturer.
  - b. Manufacturers of equipment assemblies, which include components made by others, to assume complete responsibility for final assembled unit.
  - c. Provide compatible components for assembly and intended service.
  - d. Constituent parts which are similar must be product of a single manufacturer.
4. Identify factory wiring on equipment being furnished and on wiring diagrams.
- G. Testing Agencies: Government reserves the option of witnessing factory tests. Notify COR minimum 15 working days prior to manufacturer performing the factory tests.
  1. When equipment fails to meet factory test and re-inspection is required, contractor is liable for additional expenses, including expenses of Government.

#### **1.11 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery and Acceptance Requirements:
  1. Government's approval of submittals must be obtained for equipment and material before delivery to job site.
  2. Deliver and store materials to job site in OEM's original unopened containers, clearly labeled with OEM's name and equipment catalog numbers, model and serial identification numbers for COR to inventory cable, patch panels, and related equipment.
- B. Storage and Handling Requirements:
  1. Equipment and materials must be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
    - a. Store and protect equipment in a manner that precludes damage or loss, including theft.
    - b. Protect painted surfaces with factory installed removable heavy kraft paper, sheet vinyl or equivalent.

- c. Protect enclosures, equipment, controls, controllers, circuit protective devices, and other like items, against entry of foreign matter during installation; vacuum clean both inside and outside before testing and operating.
- c. Coordinate storage.

#### **1.12 FIELD CONDITIONS**

- A. Where variations from documents are requested in accordance with GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, connecting work and related components must include additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.
- B. A contract adjustment or additional time will not be granted because of field conditions pursuant to FAR 52.236-2 and FAR 52.236-3; a contract adjustment or additional time will not be granted for additional work required for complete and usable construction and systems pursuant to FAR 52.246-12.

#### **1.13 WARRANTY**

- A. Comply with FAR clause 52.246-21.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE AND DESIGN CRITERIA**

- A. Provide communications spaces and pathways conforming to TIA 569, at a minimum.
- B. In cases of renovations in historic or otherwise restrictive buildings, where it has been determined as impossible to follow above stated guidelines, exceptions must not modify maximum distances set forth in TIA 568 and 569; and exceptions must not in any way effect performance of entire TIP system.
- C. Modification to administrative issues requires written approvals from COR with concurrence from SMCS 005OP2H3, OEM, contractor, and local authorities.

#### **2.2 EQUIPMENT IDENTIFICATION**

- A. Provide laminated black phenolic resin with a white core nameplates with minimum 6 mm (1/4 inch) high engraved lettering.



- B. Nameplates furnished by manufacturer as standard catalog items, unless other method of identification is indicated.

### **2.3 UNDERGROUND WARNING TAPE**

- A. Underground Warning: Standard 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type; red with black letters imprinted with "CAUTION BURIED ELECTRIC LINE BELOW", orange with black letters imprinted with "CAUTION BURIED TELEPHONE LINE BELOW" or orange with black letters imprinted with "CAUTION BURIED FIBER OPTIC LINE BELOW", as applicable.

### **2.4 WIRE LUBRICATING COMPOUND**

- A. Provide non-hardening or forming adhesive coating cable lubricants suitable for cable jacket material and raceway.

### **2.5 FIREPROOFING TAPE**

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

### **2.6 UNDERGROUND CABLES**

- A. Provide buried closure suitable for enclosing a straight, butt, and branch splice in a container into which can be poured an encapsulating compound.
- B. Provide closure of adequate strength to protect splice and maintain cable shield electrical continuity in buried environment.
- C. Provide re-enterable encapsulating compound maintaining chemical stability of closure.
- D. Provide filled splice cases in accordance with RUS Bull 345-72.
- E. Provide gel filled cable meeting requirements of ICEA S-99-689 .

- F. In Vault or Manhole:
  - 1. Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing into which can be poured an encapsulating compound
  - 2. Closure must be suitable thermoplastic, thermo-set, or stainless steel material supplying structural strength to pass mechanical and electrical requirements in a vault or maintenance hole (manhole) environment.
- G. Re-Enterable Encapsulating Compound: Product maintaining chemical stability of closure.
- H. Provide gel-filled splice cases in accordance with RUS Bull 345-72.
  - 1. \
  - 2. \
- I. \

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Penetrations and Sleeves:
  - 1. Lay out penetration and sleeve openings in advance, to permit provision in work.
  - 2. Set sleeves in forms before concrete is poured.
  - 3. Set sleeves prior to installation of structure for passage of pipes, conduit, ducts, etc.
  - 4. Provide sleeves and packing materials at penetrations of foundations, walls, slabs, partitions, and floors.
  - 5. Make sleeves that penetrate outside walls, basement slabs, footings, and beams waterproof.
  - 6. Fill slots, sleeves and other openings in floors or walls if not used.
    - a. Fill spaces in openings after installation of conduit or cable.
    - b. Provide fill for floor penetrations to prevent passage of water, smoke, fire, and fumes.
    - c. Provide fire resistant fill in rated floors and walls, to prevent passage of air, smoke and fumes.

7. Install sleeves through floors watertight and extend minimum 50.8 mm (2 inches) above floor surface.
  8. Match and set sleeves flush with adjoining floor, ceiling, and wall finishes where raceways passing through openings are exposed in finished rooms.
  9. Annular space between conduit and sleeve must be minimum 6 mm (1/4 inch).
  10. Do not provide sleeves for slabs-on-grade, unless specified or indicated otherwise.
  11. Comply with requirements for firestopping, for sleeves through rated fire walls and smoke partitions.
  12. Do not support piping risers or conduit on sleeves.
  13. Identify unused sleeves and slots for future installation.
  14. Provide core drilling if walls are poured or otherwise constructed without sleeves and wall penetration is required; do not penetrate structural members.
- B. Core Drilling:
1. Avoid core drilling whenever possible.
  2. Coordinate openings with other trades and utilities, and prevent damage to structural reinforcement.
  3. Investigate existing conditions in vicinity of required opening prior to coring, including an x-ray of floor if determined necessary by competent person or COR.
  4. Protect areas from damage.
- C. Verification of In-Place Conditions:
1. Verify location, use and status of all material, equipment, and utilities that are specified, indicated, or determined necessary for removal.
    - a. Verify materials, equipment, and utilities to be removed are inactive, not required, or in use after completion of project.
    - b. Replace with equivalent any material, equipment and utilities that were removed by contractor that are required to be left in place.
  2. Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted under following conditions and then only after arranging to provide temporary utility services, according to requirements indicated:

- a. Notify COR in writing at least 14 days in advance of proposed utility interruptions.
- b. Do not proceed with utility interruptions without Government's written permission.
- D. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs for floor, wall and ceiling mounting of equipment as required.
- E. Provide steel supports and hardware for installation of hangers, anchors, guides, and other support hardware.
- F. Obtain and analyze catalog data, weights, and other pertinent data required for coordination of equipment support provisions and installation.
- G. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that would void warranty.

### **3.2 INSTALLATION - GENERAL**

- A. Coordinate systems, equipment, and materials installation with other building components.
- B. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
- C. Conform to VAAR 852.236.91 arrangements indicated, recognizing that work may be shown in diagrammatic form or have been impracticable to detail all items because of variances in manufacturers' methods of achieving specified results.
- D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed in both exposed and un-exposed spaces.
- E. Install equipment according to manufacturers' written instructions.
- F. Install wiring and cabling between equipment and related devices.
- G. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum interference of adjacent other installations.
- H. Provide access panel or doors where units are concealed behind finished surfaces.

- I. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for wiring, cabling, and equipment installations.
- J. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom and access for service and maintenance as possible.
- K. Install systems, materials, and equipment giving priority to systems required to be installed at a specified slope.
- L. Avoid interference with structure and with work or other trades, preserving adequate headroom and clearing doors and passageways to satisfaction of COR and code requirements.
- M. Install equipment and cabling to distribute equipment loads on building structural members provided for equipment support under other sections; install and support roof-mounted equipment on structural steel or roof curbs as appropriate.
- N. Provide supplementary or miscellaneous items, appurtenances, devices and materials for a complete installation.

### **3.3 EQUIPMENT INSTALLATION**

- A. Locate equipment as close as practical to locations shown on drawings.
- B. Note locations of equipment requiring access on record drawings.
- C. Access and Access Panels: Verify access panel locations and construction with COR.
- D. Inaccessible Equipment:
  - 1. Where Government determines that contractor has installed equipment not conveniently accessible for operation and maintenance, equipment must be removed and reinstalled as directed and without additional cost to Government.
  - 2. Refer to Section 27 11 00, TELECOMMUNICATIONS ROOM FITTINGS for communication equipment cabinet assembly.
  - 3. Refer to Section 27 11 00, TELECOMMUNICATIONS ROOM FITTINGS for equipment labeling.

### **3.4 EQUIPMENT IDENTIFICATION**

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Secure identification signs with screws.

### **3.5 CUTTING AND PATCHING**

- A. Perform cutting and patching according to contract general requirements and as follows:
  - 1. Remove samples of installed work as specified for testing.
  - 2. Perform cutting, fitting, and patching of equipment and materials required to uncover existing infrastructure in order to provide access for correction of improperly installed existing or new work.
  - 3. Remove and replace defective work.
  - 4. Remove and replace non-conforming work.
- B. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
- C. Protect adjacent installations during cutting and patching operations.
- D. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Patch finished surfaces and building components using new materials specified for original installation and experienced installers.

### **3.6 FIELD QUALITY CONTROL**

- A. Provide work according to VAAR 852.236.91 and FAR clause 52.236-5.
- B. Provide minimum clearances and work required for compliance with NFPA 70, National Electrical Code (NEC), and manufacturers' instructions; comply with additional requirements indicated for access and clearances.
- C. Verify all field conditions and dimensions that affect selection and provision of materials and equipment, and provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment.

1. Protect facility, equipment, and wiring from damage.
- D. Submit written notice that:
  1. Project has been inspected for compliance with documents.
  2. Work has been completed in accordance with documents.
- E. Non-Conforming Work: Conduct project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing and demonstrations after verification of system operation and completeness by Contractor.
- F. For project acceptance inspections, final completion inspections, substantial completion inspections, and testing/demonstrations that require more than one site visit by COR or design professional to verify project compliance for same material or equipment, Government reserves right to obtain compensation from contractor to defray cost of additional site visits that result from project construction or testing deficiencies and incompleteness, incorrect information, or non-compliance with project provisions.
  1. COR will notify contractor, of hourly rates and travel expenses for additional site visits, and will issue an invoice to Contractor for additional site visits.
  2. Contractor is not be eligible for extensions of project schedule or additional charges resulting from additional site visits that result from project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions.
- G. Tests:
  1. Interim inspection is required at approximately 50 percent of installation.
  2. Request inspection ten working days prior to interim inspection start date by notifying COR in writing; this inspection must verify equipment and system being provided adheres to installation, mechanical and technical requirements of construction documents.
  3. Inspection to be conducted by OEM and factory-certified contractor representative, and witnessed by COR, facility and SMCS 0050P2H3 representatives.
  4. Check each item of installed equipment to ensure appropriate NRTL listing labels and markings are fixed in place.

5. Verify cabling terminations in DEMARC, MCR, TER, SCC, ECC, TRs and head end rooms, workstation locations and TCO adhere to color code for T568A pin assignments and cabling connections are in compliance with TIA standards.
6. Visually confirm minimum Category 5e cable marking at TCOs, CCSs locations, patch cords and origination locations.
7. Review entire communications circulating ground system, each TGB and grounding connection, grounding electrode and outside lightning protection system.
8. Review cable tray, conduit and path/wire way installation practice.
9. OEM and contractor to perform:
  - a. Fiber optical cable field inspection tests via attenuation measurements on factory reels; provide results along with OEM certification for factory reel tests.

SPEC WRITER NOTES:

1. TIA-568-C.0 and addendum, TIA-568-C.0-2, provide requirements for testing installed optical fiber cabling systems.
  2. Optical loss testing is defined therein as Tier 1 testing, while Optical Time Domain Reflectometry (OTDR) testing is Tier 2.
  3. Tier 2 is an optional test and not recommended for installations containing branching devices and isolators.
- b. Coaxial cable field inspection tests via attenuation measurements on factory reels; provide results along with OEM certification for factory reel tests.
    - c. Baseband cable field inspection tests via attenuation measurements on factory reels and provide results along with OEM certification for factory reel tests.
  10. Relocate failed cable reels to a secured location for inventory, as directed by COR, and then remove from project site within two working days; provide COR with written confirmation of defective cable reels removal from project site.
  11. Provide results of interim inspections to COR.
  12. If major or multiple deficiencies are discovered, additional interim inspections could be required until deficiencies are corrected, before permitting further system installation.



- a. Additional inspections are scheduled at direction of COR.
  - b. Re-inspection of deficiencies noted during interim inspections, must be part of system's Final Acceptance Proof of Performance Test.
  - c. The interim inspection cannot affect the system's completion date unless directed by COR.
13. Facility COR will ensure test documents become a part of system's official documentation package.
- H. Pretesting: Re-align, re-balance, sweep, re-adjust and clean entire system and leave system working for a "break-in" period, upon completing installation of system and prior to Final Acceptance Proof of Performance Test. System RF transmitting equipment must not be connected to keying or control lines during "break-in" period.
  1. Pretesting Procedure:
    - a. Verify systems are fully operational and meet performance requirements, utilizing accepted test equipment and spectrum analyzer.
    - b. Pretest and verify system functions and performance requirements conform to construction documents and, that no unwanted physical, aural and electronic effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise are present.
  2. Measure and record signal, aural and control carrier levels of each DAS RF, voice and data channel, at each of the following minimum points in system:
    - a. Utility provider entrance.
    - b. Buried conduit duct locations.
    - c. Maintenance Holes (Manholes) and hand holes.
    - d. ENTR or DEMARC.
    - e. PBX interconnections.
    - f. MCR interconnections.
    - g. MCOR interconnections.
    - h. TER interconnections.
    - i. TOR interconnections.

- j. Control room interconnections.
  - k. TR interconnections.
  - l. System interfaces in locations listed herein.
  - m. HE interconnections.
  - n. Antenna (outside and inside) interconnections.
  - o. System and lightning ground interconnections.
  - p. Communications circulating ground system.
  - q. UPS areas.
  - r. Emergency generator interconnections.
  - s. Each general floor areas.
  - t. Others as required by AHJ (SMCS 005OP2H3).
3. Provide recorded system pretest measurements and certification that the system is ready for formal acceptance test to COR.
- I. Acceptance Test:
- 1. Schedule an acceptance test date after system has been pretested, and pretest results and certification submitted to COR.
  - 2. Give COR fifteen working days written notice prior to date test is expected to begin; include expected duration of time for test in notification.
  - 3. Test in the presence of the following:
    - a. COR.
    - b. OEM representatives.
    - c. VACO:
      - 1) CFM representative.
      - 2) AHJ–SMCS 005OP2H3, (202)461-5310.
    - d. VISN–CIO, Network Officer and VISN representatives.
    - e. Facility:
      - 1) FMS Service Chief, Bio-Medical Engineering and facility representatives.
      - 2) OI&T Service Chief and OI&T representatives.
      - 3) Safety Officer, Police Chief and facility safety representatives.

- f. Local Community Safety Personnel:
  - 1) Fire Marshal representative.
  - 2) Disaster Coordinator representative.
  - 3) EMS Representatives: Police, Sherriff, City, County or State representatives.
- 4. Test system utilizing accepted test equipment to certify proof of performance and Life and Public Safety compliance, FCC, NRTL, NFPA and OSHA compliance.
  - a. Rate system as acceptable or unacceptable at conclusion of test; make only minor adjustments and connections required to show proof of performance.
    - 1) Demonstrate and verify that system complies with performance requirements under operating conditions.
    - 2) Failure of any part of system that precludes completion of system testing, and which cannot be repaired within four hours, terminates acceptance test of that portion of system.
    - 3) Repeated failures that result in a cumulative time of eight hours to affect repairs is cause for entire system to be declared unacceptable.
    - 4) If system is declared unacceptable, retesting must be rescheduled at convenience of Government and costs borne by the contractor.
- J. Acceptance Test Procedure:
  - 1. Physical and Mechanical Inspection: The test team representatives must tour major areas to determine system and sub-systems are completely and properly installed and are ready for acceptance testing.
  - 2. A system inventory including available spare parts must be taken at this time.
  - 3. Each item of installed equipment must be re-checked to ensure appropriate NRTL (i.e. UL) certification listing labels are affixed.
  - 4. Confirm that deficiencies reported during Interim Inspections and Pretesting are corrected prior to start of Acceptance Test.
  - 5. Inventory system diagrams, record drawings, equipment manuals, pretest results.
  - 6. Failure of system to meet installation requirements of specifications is grounds for terminating testing and to schedule re-testing.

K. Operational Test:

1. Individual Item Test: VACO AHJ representative (SMCS 005OP2H3) may select individual items of DAS equipment for detailed proof of performance testing until 100 percent of system has been tested and found to meet requirements of the construction documents.
2. Government's Condition of Acceptance of System Language:
  - a. Without Acceptance: Until system fully meets conditions of construction documents, system's ownership, use, operation and warranty commences at Government's final acceptance date.
  - b. With Conditional Acceptance: Stating conditions that need to be addressed by contractor or OEM and stating system's use and operation to commence immediately while its warranty commences only at Government's agreed final extended acceptance date.
  - c. With Full Acceptance: Stating system's ownership, use, operation and warranty to immediately commence at Government's agreed to date of final acceptance.

L. Acceptance Test Conclusion: Reschedule testing on deficiencies and shortages with COR, after COR and SMCS AHJ jointly agree to results of the test, using the generated punch list or discrepancy list. Perform retesting to comply with these specifications at contractor's expense.

M. Proof of Performance Certification:

1. If system is declared acceptable, AHJ (SMCS 005OP2H3) provides COR notice stating system processes to required operating standards and functions and is Government accepted for use by facility.
2. Validate items with COR needing to be provided to complete project contract (i.e. charts & diagrams, manuals, spare parts, system warranty documents executed, etc.). Once items have been provided, COR contacts FMS service chief to turn over system from CFM oversight for beneficial use by facility.

3. If system is declared unacceptable without conditions, rescheduled testing expenses are to be borne by contractor.

### **3.7 CLEANING**

- A. Remove debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from project site and clean work area, prior to final inspection and acceptance of work.
- B. Put building and premises in neat and clean condition.
- C. Remove debris on a daily basis.
- D. Remove unused material, during progress of work.
- E. Perform cleaning and washing required to provide acceptable appearance and operation of equipment to satisfaction of COR.
- F. Clean exterior surface of all equipment, including concrete residue, dirt, and paint residue, after completion of project.
- G. Perform final cleaning prior to project acceptance by COR.
- H. Remove paint splatters and other spots, dirt, and debris; touch up scratches and mars of finish to match original finish.
- I. Clean devices internally using methods and materials recommended by manufacturer.
- J. Tighten wiring connectors, terminals, bus joints, and mountings, to include lugs, screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. In absence of published connection or terminal torque values, comply with torque values specified in UL 486A-486B.

### **3.8 TRAINING**

- A. Provide training in accordance with subsection, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Provide training for equipment or system as required in each associated specification.
- C. Develop and submit training schedule for approval by COR, at least 30 days prior to planned training.

### **3.9 PROTECTION**

- A. Protection of Fireproofing:

1. Install clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed, if possible, prior to start of spray fireproofing work.
  2. Install conduits and other items that would interfere with proper application of fireproofing after completion of spray fire proofing work.
  3. Patch and repair fireproofing damaged due to cutting or course of work must be performed by installer of fireproofing and paid for by trade responsible for damage.
- B. Maintain equipment and systems until final acceptance.
- C. Ensure adequate protection of equipment and material during installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

--- E N D ---

**SECTION 27 05 26**  
**GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section identifies common and general grounding and bonding requirements of communication installations and applies to all sections of Divisions 27 and 28.

**1.2 RELATED WORK**

- A. Requirements for a lightning protection system: Section 26 41 00, FACILITY LIGHTNING PROTECTION.
- B. Low voltage wiring: Section 27 10 00, STRUCTURED CABLING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Provide plan indicating location of system grounding electrode connections and routing of aboveground and underground grounding electrode conductors.
- C. Closeout Submittals: In addition to Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS provide the following:
  - 1. Certified test reports of ground resistance.
  - 2. Certifications: Two weeks prior to final inspection, submit following to COR:
    - a. Certification materials and installation is in accordance with construction documents.
    - b. Certification complete installation has been installed and tested.

**PART 2 - PRODUCTS**

**2.1 COMPONENTS**

- A. Grounding and Bonding Conductors:
  - 1. Provide UL 83 insulated stranded copper equipment grounding conductors for sizes 12 AWG and larger. Identify all grounding conductors with continuous green insulation color, except identify wire sizes 25 mm<sup>2</sup> (4 AWG) and larger per NEC.

2. Provide ASTM B8 bare stranded copper bonding conductors, with the exception of ASTM B1 solid bare copper for wire sizes 6 mm<sup>2</sup> (10 AWG) and smaller.
- B. Ground Rods:
1. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
  2. Provide quantity of rods required to obtain specified ground resistance.
- C. Splices and Termination Components: Provide components meeting or exceeding UL 467 and clearly marked with manufacturer's name, catalog number, and permitted conductor sizes.
- D. Telecommunication System Ground Busbars:
1. Telecommunications Main Grounding Busbar (TMGB):
    - a. 6.4 mm (1/4 inch) thick solid copper bar.
    - b. Minimum 100 mm (4 inches) high and length sized in accordance application requirements and future growth of minimum 510 mm (20 inches) long.
    - c. Minimum thirty predrilled attachment points (two rows of fifteen each) for attaching standard sized two-hole grounding lugs.
      - 1) 27 lugs with 15.8 mm (5/8 inch) hole centers.
      - 2) 3 lugs with 25.4 mm (1 inch) hole centers.
    - d. Wall-mount stand-off brackets, assembly screws and insulators for 100 mm (4 inches) standoff from wall.
    - e. Listed as grounding and bonding equipment.
  2. Telecommunications Grounding Busbar (TGB):
    - a. 6.4 mm (1/4 inch) thick solid copper bar.
    - b. Minimum 50 mm (2 inches) high and length sized in accordance application requirements and future growth of minimum 300 mm long (12 inches) long.
    - c. Minimum nine predrilled attachment points (one row) for attaching standard sized two-hole grounding lugs.
      - 1) 6 lugs with 15.8 mm (5/8 inch) hole centers.
      - 2) 3 lugs with 25.4 mm (1 inch) hole centers.



- d. Wall-mount stand-off brackets, assembly screws and insulators for 100 mm (4 inches) standoff from wall.
- e. Listed as grounding and bonding equipment.
- E. Equipment Rack and Cabinet Ground Bars:
  - 1. Solid copper ground bars designed for horizontal mounting to framework of open racks or enclosed equipment cabinets:
    - a. 4.7 mm (3/16 inch) thick by 19.1 mm (3/4 inch) high hard-drawn electrolytic tough pitch 110 alloy copper bar.
    - b. 482 mm (19 inches) or 584 mm (23 inches) EIA/ECA-310-E rack mounting width (as required) for mounting on racks or cabinets.
    - c. Eight 6-32 tapped ground mounting holes on 25.4 mm (1 inch) intervals.
    - d. Four 7.1 mm (0.281 inch) holes for attachment of two-hole grounding lugs.
    - e. Copper splice bar of same material to transition between adjoining racks.
    - f. Two each 12-24 x 19.1 mm (3/4 inch) copper-plated steel screws and flat washers for attachment to rack or cabinet.
    - g. Listed as grounding and bonding equipment.
  - 2. Solid copper ground bars designed for vertical mounting to framework of open racks or enclosed equipment cabinets:
    - a. 1.3 mm (0.05 inch) thick by 17 mm (0.68 inch) wide tinned copper strip.
    - b. 1997 mm (78 inches) high for mounting vertically on full height racks.
    - c. Holes punched on 15.875 mm-15.875 mm-12.7 mm (5/8"-5/8"-1/2") alternating vertical centers to match EIA/ECA-310-E Universal Hole Pattern for a 45 RMU rack.
    - d. Three #12-24 zinc-plated thread forming hex washer head installation screws, an abrasive pad and antioxidant joint compound.
    - e. NRTL listed as grounding and bonding equipment.
- F. Ground Terminal Blocks: Provide screw lug-type terminal blocks at equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted.

1. Electroplated tin aluminum extrusion.
  2. Accept conductors ranging from #14 AWG through 2/0.
  3. Hold conductors in place by two stainless steel set screws.
  4. Two 6 mm (1/4 inch) holes spaced on 15.8 mm (5/8 inch) centers to allow secure two-bolt attachment.
  5. Listed as a wire connector.
- G. Splice Case Ground Accessories: Provide splice case grounding and bonding accessories manufactured by splice case manufacturer when available. Otherwise, use 16 mm<sup>2</sup> (6 AWG) insulated ground wire with shield bonding connectors.
- H. Irreversible Compression Lugs:
1. Electroplated tinned copper.
  2. Two holes spaced on 15.8 mm (5/8 inch) or 25.4 mm (1 inch) centers.
  3. Sized to fit the specific size conductor.
  4. Listed as wire connectors.
- I. Antioxidant Joint Compound: Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

### **PART 3 - EXECUTION**

#### **3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Exterior Equipment Grounding: Bond exterior metallic components (including masts and cabinets), antennas, satellite dishes, towers, raceways, primary telecommunications protector/arresters, secondary surge protection, waveguides, cable shields, down conductors and other conductive items to directly to Intersystem Bonding Termination.
- B. Install telecommunications bonding backbone conductor throughout building via telecommunications backbone pathways effectively bonding all interior telecommunications grounding busbars in telecommunications rooms, to telecommunications main grounding busbar in Demarc room after testing bond to verify bonding conductor for telecommunications from grounding electrode conductor is installed per NEC. Size telecommunications bonding backbone conductor as specified in TIA-607-B.

1. A green insulated ground wire shall be installed in all raceways.
- C. Inaccessible Grounding Connections: Utilize exothermic welding for bonding of buried or otherwise inaccessible connections with the exception of connections requiring periodic testing.
- D. Conduit Systems:
  1. Bond ferrous metallic conduit to ground.
  2. Bond grounding conductors installed in ferrous metallic conduit at both ends of conduit using grounding bushing with #6 AWG conductor.
- E. Boxes, Cabinets, and Enclosures:
  1. Bond each pull box, splice box, equipment cabinet, and other enclosures through which conductors pass (except for special grounding systems for intensive care units and other critical units shown) to ground.
  2. Raised Floors: Bonding raised floor components to ground.
- F. Corrosion Inhibitors: Apply corrosion inhibitor for protecting connection between metals used to contact surfaces, when making ground and ground bonding connections.
- G. Telecommunications Grounding System:
  1. Bond telecommunications grounding systems and equipment to facility's electrical grounding electrode at Intersystem Bonding Termination.
  2. Provide hardware as required to effectively bond metallic cable shields communications pathways, cable runway, and equipment chassis to ground.
  3. Install bonding conductors without splices using shortest length of conductor possible to maintain clearances required by NEC.
  4. Provide paths to ground that are permanent and continuous with a resistance of 1 ohm or less from each raceway, cable tray, and equipment connection to telecommunications grounding busbar.
  5. Below-Grade Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with manufacturer's recommendations. After welds have been

made and cooled, brush slag from weld area and thoroughly clean joint areas. Notify COR prior to backfilling at ground connections.

6. Above-Grade Bolted or Screwed Grounding Connections:

- a. Remove paint to expose entire contact surface by grinding.
- b. Clean all connector, plate and contact surfaces.
- c. Apply corrosion inhibitor to surfaces before joining.

7. Bonding Jumpers:

- a. Assemble bonding jumpers using insulated ground wire of size and type shown on drawings or use a minimum of 16 mm<sup>2</sup> (6 AWG) insulated copper wire terminated with compression connectors of proper size for conductors.
- b. Use connector manufacturer's compression tool.

8. Bonding Jumper Fasteners:

- a. Conduit: Connect bonding jumpers using lugs on grounding bushings or clamp pads on push-type conduit fasteners. Where appropriate, use zinc-plated external tooth lockwashers or Belleville Washers.
- b. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers or Belleville washers and nuts. Install protective cover, e.g., zinc-plated acorn nuts, on bolts extending into wireway or cable tray to prevent cable damage.
- c. Grounding Busbars: Fasten bonding conductors using two-hole compression lugs. Use 300 series stainless steel bolts, Belleville Washers, and nuts.
- d. Slotted Channel Framing and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and Belleville washers or external tooth lock washers.

H. Telecommunications Room Bonding:

1. Telecommunications Grounding Busbars:

- a. Install busbar hardware no less than 950 mm (18 inches) A.F.F.

- b. Where other grounding busbars are located in same room, e.g. electrical panelboard for telecommunications equipment, bond busbars together as indicated on grounding riser diagrams.
  - c. Make conductor connections with two-hole compression lugs sized to fit busbar and conductors.
  - d. Attach lugs with stainless steel hardware after preparing bond according to manufacturer recommendations and treating bonding surface on busbar with anti-oxidant to help prevent corrosion.
- 2. Telephone-Type Cable Rack Systems:
  - a. Aluminum pan installed on telephone-type cable rack serves as primary ground conductor within communications room.
  - b. Make ground connections by installing bonding jumpers:
    - 1) Install minimum 16 mm<sup>2</sup> (6 AWG) bonding between telecommunications ground busbars and the aluminum pan installed on cable rack.
    - 2) Install 16 mm<sup>2</sup> (6 AWG) bonding jumpers across aluminum pan junctions.
- I. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:
  - 1. Install rack-mount horizontal busbar or vertical busbar to provide multiple bonding points,
  - 2. At each rack or cabinet containing active equipment or shielded cable terminations:
    - a. Bond busbar to ground as part of overall telecommunications bonding and grounding system.
    - b. Bond copper ground bars together using solid copper splice plates manufactured by same ground bar manufacturer, when ground bars are provided at rear of lineup of bolted together equipment racks.
    - c. Bond non-adjacent ground bars on equipment racks and cabinets with 16 mm<sup>2</sup> (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
    - d. Provide 16 mm<sup>2</sup> (6 AWG) bonding jumpers between rack and cabinet ground busbars and overhead cable runway or raised floor stringers, as appropriate.

- J. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near top of backboards used for communications cross-connect systems. Connect backboard ground terminals to cable runway using an insulated 16 mm<sup>2</sup> (6 AWG) bonding jumper.
- K. Other Communication Room Ground Systems: Ground metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray or telecommunications ground busbar, whichever is closer, using insulated 16 mm<sup>2</sup> (6 AWG) ground wire bonding jumpers.
- L. Communications Cable Grounding:
  - 1. Bond all metallic cable sheaths in multi-pair communications cables together at each splicing or terminating location to provide 100 percent metallic sheath continuity throughout communications distribution system.
  - 2. Install a cable shield bonding connector with a screw stud connection for ground wire, at terminal points. Bond cable shield connector to ground.
  - 3. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or splice case manufacturer's splice case grounding and bonding accessories. When an external ground connection is provided as part of splice closure, connect to an effective ground source and bond all other metallic components and equipment at that location.
- M. Communications Cable Tray Systems:
  - 1. Bond metallic structures of cable tray to provide 100 percent electrical continuity throughout cable tray systems.
  - 2. Where metallic cable tray systems are mechanically discontinuous:
    - a. Install splice plates provided by cable tray manufacturer between cable tray sections so resistance across a bolted connection is 0.010 ohms or less, as verified by measuring across splice plate connection.
    - b. Install 16 mm<sup>2</sup> (6 AWG) bonding jumpers across each cable tray splice or junction where splice plates cannot be used.

3. Bond cable tray installed in same room as telecommunications grounding busbar to busbar.
- N. Communications Raceway Grounding:
1. Conduit: Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to bond metallic conduit at both ends and intermediate metallic enclosures to ground.
  2. Cable Tray Systems: Use insulated 16 mm<sup>2</sup> (6 AWG) grounding jumpers to bond cable tray to column-mounted building ground plates (pads) at both ends and approximately 16 meters (50 feet) on centers.
- O. Ground Resistance:
1. Install telecommunications grounding system so resistance to grounding electrode system measures 5 ohms or less.
  2. Measure grounding electrode system resistance using an earth test meter, clamp-on ground tester, or computer-based ground meter as defined in IEEE 81. Record ground resistance measurements before electrical distribution system is energized.
  3. Backfill only after below-grade connection have been visually inspected by COR. Notify COR twenty-four hours before below-grade connections are ready for inspection.
- P. Ground Rod Installation:
1. Drive each rod vertically in earth minimum 3000 mm (10 feet) in depth.
  2. Make connections by exothermic process to form solid metal joints, where permanently concealed ground connections are required. Make accessible ground connections with mechanical pressure type ground connectors.
  3. Install angled ground rods or grounding electrodes in horizontal trenches to achieve specified resistance, where rock prevents driving of vertical ground rods.

### **3.2 FIELD QUALITY CONTROL**

- A. Perform tests per BICSI's Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria.
- B. Perform two-point bond test using trained installers qualified to use test equipment.

- c. Conduct continuity test to verify that metallic pathways in telecommunications spaces are bonded to TGB or TMGB.
- d. Conduct electrical continuity test to verify that TMGB is effectively bonded to grounding electrode conductor.
- e. Visually inspect to verify that screened and shielded cables are bonded to TGB or TMGB.
- f. Perform a resistance test to ensure patch panel, rack and cabinet bonding connection resistance measures less than 5 Ohms to TGB or TMGB.

--- E N D ---



**SECTION 27 05 33**  
**RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for communications cabling unless shown or specified otherwise.
- B. Provide cable tray as required (12"W x 4"D minimum) throughout all corridors; cable tray shall be sized as required to not exceed tray fill rating. Where cable tray cannot physically be installed due to obstructions (mechanical ducting, architectural features, etc), provide j-hooks as required to support cabling. Cable tray shall be Cablofil Wire Basket by Legrand, or equal, length as required. J-hook shall be EATON B series or equal.

**1.2 RELATED WORK**

- A. Bedding of conduits: Section 31 20 00, EARTH MOVING.
- B. Mounting board for Telecommunication Rooms: Section 06 10 00, ROUGH CARPENTRY.
- C. Sealing around penetrations to maintain integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- D. Fabrications for deflection of water away from building envelope at penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- E. Sealing around conduit penetrations through building envelope to prevent moisture migration into building: Section 07 92 00, JOINT SEALANTS.
- F. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.
- G. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

**1.3 SUBMITTALS**

- A. In accordance with Section 27 50 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, submit the following:
  - 1. Size and location of cabinets, splice boxes and pull boxes.

2. Layout of required conduit penetrations through structural elements.
3. Catalog cuts marked with specific item proposed and area of application identified.
- B. Certification: Provide letter prior to final inspection, certifying material is in accordance with construction documents and properly installed.

## **PART 2 - PRODUCTS**

### **2.1 MATERIAL**

- A. Minimum Conduit Size: 19 mm (3/4 inch).
- B. Conduit:
  1. Rigid Galvanized Steel: Conform to UL 6, ANSI C80.1.
  2. Rigid Intermediate Steel Conduit (IMC): Conform to UL 1242, ANSI C80.6.
  3. Electrical Metallic Tubing (EMT):
    - a. Maximum Size: 105 mm (4 inches).
    - b. Install only for cable rated 600 volts or less.
    - c. Conform to UL 797, ANSI C80.3.
  4. Flexible Galvanized Steel Conduit: Conform to UL 1.
  5. Liquid-tight Flexible Metal Conduit: Conform to UL 360.
  6. Direct Burial Plastic Conduit: Conform to UL 651 and UL 651A, heavy wall PVC, or high density polyethylene (HDPE).
  7. Surface Metal Raceway: Conform to UL 5.
  8. Wireway, Approved "Basket": Provide "Telecommunications Service" rated with approved length way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.
- C. Conduit Fittings:
  1. Rigid Galvanized Steel and Rigid Intermediate Steel Conduit Fittings:
    - a. Provide fittings meeting requirements of UL 514B and ANSI/ NEMA FB 1.
    - b. Sealing: Provide threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water and vapor. In concealed work, install sealing fittings in flush steel boxes with blank cover plates having same finishes as other electrical plates in room.

- c. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
  - d. Locknuts: Bonding type with sharp edges for digging into metal wall of an enclosure.
  - e. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into metallic body of fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
  - f. Erickson (union-type) and Set Screw Type Couplings:
    - 1) Couplings listed for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete.
    - 2) Use set screws of case hardened steel with hex head and cup point to seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
  - g. Provide OEM approved fittings.
2. Electrical Metallic Tubing Fittings:
- a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
  - b. Couplings and Connectors: Concrete tight and rain tight, with connectors having insulated throats.
    - 1) Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller.
    - 2) Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches).
    - 3) Use set screws of case-hardened steel with hex head and cup point to seat in wall of conduit for positive grounding.
  - c. Indent type connectors or couplings are not permitted.
  - d. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are not permitted.

- e. Provide OEM approved fittings.
- 3. Flexible Steel Conduit Fittings:
  - a. Conform to UL 514B; only steel or malleable iron materials are acceptable.
  - b. Provide clamp type, with insulated throat.
  - c. Provide OEM approved fittings.
- 4. Liquid-tight Flexible Metal Conduit Fittings:
  - a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
  - b. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
  - c. Provide connectors with insulated throats to prevent damage to cable jacket.
  - d. Provide OEM approved fittings.
- 5. Direct Burial Plastic Conduit Fittings: Provide fittings meeting requirements of UL 514C and NEMA TC3, and as recommended by conduit manufacturer.
- 6. Surface Metal Raceway: Conform to UL 5 and “telecommunications service” rated with approved length-way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.
- 7. Surface Metal Raceway Fittings: As recommended by raceway manufacturer.
- 8. Expansion and Deflection Couplings:
  - a. Conform to UL 467 and UL 514B.
  - b. Accommodate 19 mm (3/4 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
  - c. Include internal flexible metal braid sized to ensure conduit ground continuity and fault currents in accordance with UL 467, and NEC code tables for ground conductors.
  - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
- 9. Wireway Fittings: As recommended by wireway OEM.
- D. Conduit Supports:

1. Parts and Hardware: Provide zinc-coat or equivalent corrosion protection.
  2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
  3. Multiple Conduit (Trapeze) Hangers: Minimum 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 2.78 mm (12 gage) steel, cold formed, lipped channels; with minimum 9 mm (3/8 inch) diameter steel hanger rods.
  4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Splice, and Pull Boxes:
1. Conform to UL-50 and UL-514A.
  2. Cast metal where required by NEC or shown, and equipped with rustproof boxes.
  3. Sheet Metal Boxes: Galvanized steel, except where otherwise shown.
  4. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with wall.
  5. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.
- G. Warning Tape: Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters, and imprinted with "CAUTION BURIED COMMUNICATIONS CABLE BELOW".
- H. Flexible Nonmetallic Communications Raceway (Innerduct) and Fittings:
1. General: Provide UL 910 listed plenum, riser, and general purpose corrugated pliable communications raceway for optical fiber cables and communications cable applications; select in accordance with provisions of NEC Articles 770 and 800.
  2. Provide Communications Raceway with a factory installed 567 kg (1250 lb.) tensile pre-lubricated pull tape.
  3. Use only metallic straps, hangers and fittings to support raceway from building structure. Cable ties are not permitted for securing raceway to building structure.

4. Provide fittings to be installed in spaces used for environmental air made of materials that do not exceed flammability, smoke generation, ignitibility, and toxicity requirements of environmental air space.
5. Size: Metric Designator 53 (trade size 2) or smaller.
6. Outside Plant: Plenum-rated where each interduct is 75 mm (3 inches) and larger.
7. Inside Plant: Listed and marked for installation in plenum airspaces and minimum 25 mm (1 inch) inside diameter.
8. Plenum: Non-metallic communications raceway.
  - a. Constructed of low smoke emission, flame retardant PVC with corrugated construction.
  - b. UL 94 V-O rating for flame spreading limitation.
9. Provide innerduct reel lengths as necessary to ensure ducts are continuous; one piece runs from ENTR to MH; MH to MH; DEMARC to MCR/TER; TR to TR. Innerduct connectors are not permitted between rooms.
10. Provide pulling accessories used for innerduct including but not limited to, inner duct lubricants, spreaders, applicators, grips, swivels, harnesses, and line missiles (blown air) compatible with materials being pulled.
- I. Outlet Boxes:
  1. Flush wall mounted minimum 11.9 cm (4-11/16 inches) square, 9.2 cm (3-5/8 inches) deep pressed galvanized steel.
  2. 2-Gang Tile Box:
    - a. Flush backbox type for installation in block walls.
    - b. Minimum 92 mm (3-5/8 inches) deep.
- J. Weatherproof Outlet Boxes: Surface mount two gang, 67 mm (2-5/8 inches) deep weatherproof cast aluminum with powder coated finish internal threads on hubs 19 mm (3/4 inch) minimum.
- K. Cable Tray:
  1. Provide wire basket type of sizes indicated; with all required splicing and mounting hardware.

2. Materials and Finishes:
  - a. Electro-plated zinc galvanized (post plated) made from carbon steel and plated to ASTM B 633, Type III, SC-1.
  - b. Remove soot, manufacturing residue/oils, or metallic particles after fabrication.
  - c. Rounded edges and smooth surfaces.
3. Provide continuous welded top side wire to protect cable insulation and installers.
4. High strength steel wires formed into a 50 x 100 mm (2 inches by 4 inches) wire mesh pattern with intersecting wires welded together.
5. Wire Basket Sizes:
  - a. Wire Diameter: 5 mm (0.195 inch) minimum on all mesh sections.
  - b. Usable Loading Depth: 105 mm (4 inch) minimum.
  - c. Width: 300 mm (12 inches) minimum .
6. Fittings: Field-formed, from straight sections, in accordance with manufacturer's instructions.
7. Provide accessories to protect, support and install wire basket tray system.
8. Cable tray shall be Cablofil Wire Basket by Legrand, or equal, length as required.
- L. Cable Duct: Equip with hinged covers, except where removable covers are accepted by COR.
- M. Cable Duct Fittings: As recommended by cable duct OEM.
- N. Conduit sizes 2" and smaller shall utilize compression type fittings. Conduit sizes 2" and larger are permitted to utilize set screw type fittings.
- O. J-hooks shall be EATON B-series or equal.

## **PART 3 - EXECUTION**

### **3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Raceways typically required for cabling systems unless otherwise indicated:

System	Specification Section	Installed Method
Grounding	27 05 26	Conduit Not Required Unless Required by Code
Control, Communication and Signal Wiring	27 10 00	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms

System	Specification Section	Installed Method
Communications Structured Cabling	27 15 00	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Master Antenna Television Equipment and Systems	27 41 31	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Public Address and Mass Notification Systems	27 51 16	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Intercommunications and Program systems	27 51 23	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Nurse Call	27 52 23	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Security Emergency Call, Duress Alarm, and Telecommunications	27 52 31	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Miscellaneous Medical Systems	27 52 41	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Distributed Radio Antenna Equipment and System	27 53 19	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Grounding and Bonding for Electronic Safety and Security	28 05 26	Conduit Not Required Unless Required by Code
Physical Access Control System	28 13 00	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Physical Access Control System and Database Management	28 13 16	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Security Access Detection	28 13 53	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Intrusion Detection System	28 16 00	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Video Surveillance	28 23 00	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Electronic Personal Protection System	28 26 00	In-wall Conduit, Cable Tray in Corridors, J-hooks in Rooms
Fire Detection and Alarm	28 31 00	Complete Conduit



B. Penetrations:

1. Cutting or Holes:

- a. Locate holes in advance of installation. Where they are proposed in structural sections, obtain approval of structural engineer and COR prior to drilling through structural sections.
- b. Make holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not permitted; COR may grant limited permission by request, in condition of limited working space.
- c. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.
  - 1) Fill and seal clearances between raceways and openings with fire stop material.
  - 2) Install only retrofittable, non-hardening, and reusable firestop material that can be removed and reinstalled to seal around cables inside conduits.
- d. Waterproofing at Floor, Exterior Wall, and Roof Conduit Penetrations:
  - 1) Seal clearances around conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS or directed by waterproofing manufacturer.

C. Conduit Installation:

1. Minimum conduit size of 19 mm (3/4 inch), but not less than size required for 40 percent fill.
2. Install insulated bushings on all conduit ends.
3. Install pull boxes after every 180 degrees of bends (two 90 degree bends). Size boxes per TIA 569.
4. Extend vertical conduits/sleeves through floors minimum 75 mm (3 inches) above floor and minimum 75 mm (3 inches) below ceiling of floor below.

5. Terminate conduit runs to and from a backboard in a closet or interstitial space at top or bottom of backboard. Install conduits to enter telecommunication rooms next to wall and flush with backboard.
6. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections.
7. Seal empty conduits located in telecommunications rooms or on backboards with a standard non-hardening putty compound to prevent entrance of moisture and gases and to meet fire resistance requirements.
8. Minimum radius of communication conduit bends:

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

9. Provide 19 mm (3/4 inch) thick fire retardant plywood specified in Section 06 10 00, ROUGH CARPENTRY on wall of communication closets where shown on drawings. Mount plywood with bottom edge 300 mm (12 inches) above finished floor and top edge 2.74 m (9 feet) A.F.F.
10. Provide pull wire in all empty conduits; sleeves through floor are exceptions.
11. Complete each entire conduit run installation before pulling in cables.
12. Flattened, dented, or deformed conduit is not permitted.
13. Ensure conduit installation does not encroach into ceiling height head room, walkways, or doorways.

14. Cut conduit square with a hacksaw, ream, remove burrs, and draw tight.
  15. Install conduit mechanically continuous.
  16. Independently support conduit at 2.44 m (8 feet) on center; do not use other supports (i.e., suspended ceilings, suspended ceiling supporting members, luminaires, conduits, mechanical piping, or mechanical ducts).
  17. Support conduit within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
  18. Close ends of empty conduit with plugs or caps to prevent entry of debris, until cables are pulled in.
  19. Attach conduits to cabinets, splice cases, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on inside of enclosure, made up wrench tight. Do not make conduit connections to box covers.
  20. Aluminum conduit is not permitted.
  21. Unless otherwise indicated on drawings or specified herein, conceal conduits within finished walls, floors and ceilings.
  22. Conduit Bends:
    - a. Make bends with standard conduit bending machines; observe minimum bend radius for cable type and outside diameter.
    - b. Conduit hickey is permitted only for slight offsets, and for straightening stubbed conduits.
    - c. Bending of conduits with a pipe tee or vise is not permitted.
  23. Layout and Homeruns - Deviations: Make only where necessary to avoid interferences and only after drawings showing proposed deviations have been submitted and approved by COR.
- D. Concealed Work Installation:
1. In Concrete:
    - a. Conduit: Rigid steel or IMC.
    - b. Align and run conduit in direct lines.
    - c. Install conduit through concrete beams only when the following occurs:

- 1) Where shown on structural drawings.
- 2) As accepted by COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
- d. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
  - 1) Conduit outside diameter larger than 1/3 of slab thickness is prohibited.
  - 2) Space between Conduits in Slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
  - 3) Install conduits approximately in center of slab to ensure a minimum of 19 mm (3/4 inch) of concrete around conduits.
- e. Make couplings and connections watertight. Use thread compounds that are NRTL listed conductive type to ensure low resistance ground continuity through conduits. Tightening set screws with pliers is not permitted.
- E. Furred or Suspended Ceilings and in Walls:
  1. Rigid steel. Different type conduits mixed indiscriminately in same system is not permitted.
  2. Align and run conduit parallel or perpendicular to building lines.
  3. Tightening set screws with pliers is not permitted.
- F. Exposed Work Installation:
  1. Unless otherwise indicated on drawings, exposed conduit is only permitted in telecommunications rooms.
    - a. Provide rigid steel, IMC..
    - b. Different type of conduits mixed indiscriminately in system is not permitted.
  2. Align and run conduit parallel or perpendicular to building lines.
  3. Install horizontal runs close to ceiling or beams and secure with conduit straps.
  4. Support horizontal or vertical runs at not over 2400 mm (96 inches) intervals.
  5. Surface Metal Raceways: Use only where shown on drawings.
  6. Painting:
    - a. Paint exposed conduit as specified in Section 09 91 00, PAINTING.

- b. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color.
  - c. Provide labels where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.
- G. Expansion Joints:
  - 1. Conduits 75 mm (3 inches) and larger, that are secured to building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install couplings in accordance with manufacturer's recommendations.
  - 2. Provide conduits smaller than 75 mm (3 inches) with pull boxes on both sides of expansion joint. Connect conduits to expansion and deflection couplings as specified.
  - 3. Install expansion and deflection couplings where shown.
- H. Seismic Areas:
  - 1. In seismic areas, follow H-18-8 Seismic Design Requirements.
  - 2. Rigidly secure conduit to building structure on opposite sides of a building expansion joint with pull boxes on both sides of joint.
  - 3. Connect conduits to pull boxes with 375 mm (15 inches) of slack flexible conduit.
  - 4. Install green copper wire minimum #6 AWG in flexible conduit for bonding jumper.
- I. Conduit Supports, Installation:
  - 1. Select AC193 code listed mechanical anchors or fastening devices with safe working load not to exceed 1/4 of proof test load.
  - 2. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
  - 3. Support multiple conduit runs with trapeze hangers. Use trapeze hangers designed to support a load equal or greater than sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other accepted fasteners.
  - 4. Support conduit independent of pull boxes, luminaires, suspended ceiling components, angle supports, duct work, and similar items.
  - 5. Fastenings and Supports in Solid Masonry and Concrete:

- a. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing concrete.
- b. Existing Construction:
  - 1) Code AC193 listed wedge type steel expansion anchors minimum 6 mm (1/4 inch) bolt size and minimum 28 mm (1-1/8 inch) embedment.
  - 2) Power set fasteners minimum 6 mm (1/4 inch) diameter with depth of penetration minimum 75 mm (3 inches).
  - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- 6. Fastening to Hollow Masonry: Toggle bolts are permitted.
- 7. Fastening to Metal Structures: Use machine screw fasteners or other devices designed and accepted for application.
- 8. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- 9. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- 10. Do not support conduit from chain, wire, or perforated strap.
- 11. Spring steel type supports or fasteners are not permitted except horizontal and vertical supports/fasteners within walls.
- 12. Vertical Supports:
  - a. Install riser clamps and supports for vertical conduit runs in accordance with NEC.
  - b. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.
- J. Box Installation:
  - 1. Boxes for Concealed Conduits:
    - a. Flush mounted.
    - b. Provide raised covers for boxes to suit wall or ceiling, construction and finish.
  - 2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables during pulling.

3. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
  4. Stencil or install phenolic nameplates on covers of boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
  5. Outlet boxes mounted back-to-back in same wall are not permitted. A minimum 600 mm (24 inches) center-to-center lateral spacing must be maintained between boxes.
  6. For boxes installed in metal stud construction, use rigid support metal bar hangers or metal bar fasteners attached to (2) studs. Screwing boxes directly to joists or studs is not acceptable.
- k. Flexible Nonmetallic Communications Raceway (Innerduct), Installation:
1. Install supports from building structure for horizontal runs at intervals not to exceed 900 mm (3 feet) and at each end.
  2. Install supports from building structure for vertical runs at intervals not to exceed 1.2 m (4 feet) and at each side of joints.
  3. Install only in accessible spaces not subject to physical damage or corrosive influences.
  4. Make bends manually to assure internal diameter of tubing is not effectively reduced.
  5. Extend each segment of innerduct minimum 300 mm (12 inches) beyond end of service conduit tie or cable tray. Restrain innerduct ends with wall mount clamps and seal when cable is installed.

### 3.2 TESTING

- A. Examine fittings and locknuts for secureness.
- B. Test RMC, IMC and EMT systems for electrical continuity.
- C. Perform simple continuity test after cable installation.

--- E N D ---

**SECTION 27 10 00**  
**CONTROL, COMMUNICATION AND SIGNAL WIRING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section includes control, communication and signal wiring for a comprehensive systems infrastructure.
- B. This section applies to all sections of Divisions 27 and 28.

**1.2 RELATED WORK**

- A. Excavation and backfill for cables that are installed in conduit: Section 31 20 00, EARTH MOVING.
- B. Sealing around penetrations to maintain integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- C. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- D. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- E. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Submit written certification from OEM:
  - 1. Indicate wiring and connection diagrams meet National and Government Life Safety Guidelines, NFPA, NEC, NRTL, Joint Commission, OEM, this section and Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
  - 2. Include instructions, requirements, recommendations, and guidance for proper performance of system as described herein.
  - 3. Government will not approve any submittal without this certification.



- c. Identify environmental specifications on technical submittals; identify requirements for installation.
  - 1. Minimum floor space and ceiling heights.
  - 2. Minimum size of doors for cable reel passage.
- D. Power: Provide specific voltage, amperage, phases, generator equipment and quantities of circuits.
- E. Provide conduit size requirements.
- F. Closeout Submittals:
  - 1. Provide contact information for maintenance personnel to contact contractor for emergency maintenance and logistic assistance, and assistance in resolving technical problems at any time during warranty period.
  - 2. Provide certified OEM sweep test tags from each cable reel to COR.
  - 3. Furnish spare or unused wire and cable with appropriate connectors (female types) for installation in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.
  - 4. Turn over unused and opened installation kit boxes, coaxial, fiber optic, and twisted pair cable reels, conduit, cable tray, cable duct bundles, wire rolls, physical installation hardware to COR.
  - 5. Documentation: Include any item or quantity of items, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide system documentation required herein.

## **PART 2 - PRODUCTS**

### **2.1 CONTROL WIRING**

- A. Provide control wiring large enough so voltage drop under in-rush conditions does not adversely affect operation of controls.
- B. Provide cable meeting specifications for type of cable.
- C. Outside Location (i.e. above ground, underground in conduit, ducts, pathways, etc.):  
Provide cables filled with a waterproofing compound between outside jacket (not

touching any provided armor) and inter conductors to seal punctures in jacket and protect conductors from moisture.

D. Remote Control Cable:

1. Multi-conductor with stranded conductors able to handle power and voltage required to control specified system equipment, from a remote location.
2. NRTL listed and pass VW-1 vertical wire flame test (UL 83) (formerly FR-1).
3. Color-coded Conductors: Combined multi-conductor and coaxial cables are acceptable for this installation, on condition system performance standards are met.
4. Technical Characteristics:
  - a. Length: As required, in 1K (3,000 ft.) reels minimum.
  - b. Connectors: As required by system design.
  - c. Size:
    - 1) 18 AWG, minimum, Outside.
    - 2) 20 AWG, minimum, Inside.
  - d. Color Coding: Required, EIA industry standard.
  - e. Bend Radius: 10 times cable outside diameter.
  - f. Impedance: As required.
  - g. Shield Coverage: As required by OEM specification.
  - h. Attenuation:

Frequency in MHz	dB per 305 Meter (1,000 feet), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
50.0	52.0

E. Distribution System Signal Wires and Cables:

1. Provide in same manner, and use construction practices, as Fire Protective and other Emergency Systems identified and defined in NFPA 101, Life Safety Code, Chapters 7, 12, and 13, NFPA 70, National Electrical Code, Chapter 7, Special Conditions.
2. Provide system able to withstand adverse environmental conditions without deterioration, in their respective location.
3. Provide entering of each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of cables.
4. Terminate on an item of equipment by direct connection.

**2.2 COMMUNICATION AND SIGNAL WIRING**

- A. Provide communications and signal wiring conforming to recommendations of manufacturers of systems; provide not less than TIA Performance Category 6A for all patient care areas and Category 6 for all other areas. Basis of design shall be "Berk-Tek LANmark-XTP UTP Riser Category 6A or approved equal..
- B. Wiring shown is for typical systems; provide wiring as required for systems being provided.
- C. Provide color-coded conductor insulation for multi-conductor cables.
- D. Connectors:
  1. Provide connectors for transmission lines, and signal extensions to maintain uninterrupted continuity, ensure effective connection, and preserve uniform polarity between all points in system.
    - a. Provide AC barrier strips with a protective cover to prevent accidental contact with wires carrying live AC current.
    - b. Provide punch blocks for signal connection, not AC power. AC power twist-on wire connectors are not permitted for signal wire terminations.
  2. Cables: Provide connectors designed for specific size cable and conductors being installed with OEM's approved installation tool. Typical system cable connectors include:

- a. Audio spade lug.
- b. Punch block.
- c. Wirewrap.

## **2.3 INSTALLATION KIT**

- A. Include connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, cable tray, etc., required to accomplish a neat and secure installation.
- B. Terminate conductors in a spade lug and barrier strip, wire wrap terminal or punch block, so there are no unfinished or unlabeled wire connections.
- C. Minimum required installation sub-kits:
  - 1. System Grounding:
    - a. Provide required cable and installation hardware for effective ground path, including the following:
      - 1) Control Cable Shields.
      - 2) Data Cable Shields.
      - 3) Equipment Racks.
      - 4) Equipment Cabinets.
      - 5) Conduits.
      - 6) Ducts.
      - 7) Cable Trays.
      - 8) Power Panels.
      - 9) Connector Panels.
      - 10) Grounding Blocks.
    - b. Bond radio equipment to earth ground via internal building wiring, according to NEC.
  - 2. Wire and Cable: Provide connectors and terminals, punch blocks, tie wraps, hangers, clamps, labels, etc. required to accomplish termination in an orderly installation.

3. Conduit, Cable Duct, and Cable Tray: Provide conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, cable tray installation in accordance with NEC and documents.
  4. Equipment Interface: Provide any items or quantity of equipment, cable, mounting hardware and materials to interface systems with identified sub-systems, according to OEM requirements and construction documents.
  5. Labels: Provide any item or quantity of labels, tools, stencils, and materials to label each subsystem according to OEM requirements, as-installed drawings, and construction documents.
- D. Cross-Connection System (CCS) Equipment Breakout, Termination Connector (or Bulkhead), and Patch Panels:
1. Connector Panels: Flat smooth 3.175 mm (1/8 inch) thick solid aluminum, custom designed, fitted and installed in cabinet. Install bulkhead equipment connectors on panel to enable cabinet equipment's signal, control, and coaxial cables to be connected through panel. Match panel color to cabinet installed.
    - a. Voice (or Telephone):
      - 1) Provide industry standard Type 110 (minimum) punch blocks for voice or telephone, and control wiring instead of patch panels, each being certified for category 6A for all patient areas and Category 6 for all other areas..
      - 2) IDC punch blocks (with internal RJ45 jacks) are acceptable for use in CCS when designed for Category 6A for all patient areas and Category 6 for all other areas, and the size and type of cable used.
      - 3) Secure punch block strips to OEM designed physical anchoring unit on a wall location in TRS; console, cabinet, rail, panel, etc. mounting is permitted at OEM recommendation and as accepted by COR. Punch blocks are not permitted for Class II or 120 VAC power wiring.
      - 4) Technical Characteristics:
        - a) Number of Horizontal Rows: Minimum 100.

- b) Number of Terminals per Row: Minimum 4.
- c) Terminal Protector: Required for each used or unused terminal.
- d) Insulation Splicing: Required between each row of terminals.
- b. Digital or High Speed Data:
  - 1) Provide 480 mm (19 inches) horizontal EIA/ECA 310 rack mountable patch panel with EIA/ECA 310 standard spaced vertical mounting holes for digital or high-speed data service CSS, with modular female Category 6A for all patient areas and Category 6 for all other areas RJ45 jacks designed for size and type of UTP or F/UTP cable installed in rows.
  - 2) Technical Characteristics:
    - a) Number of Horizontal Rows: Minimum 2.
    - b) Number of Jacks Per Row: Minimum 24.
    - c) Type of Jacks: RJ45.
    - d) Terminal Protector: Required for each used or unused jack.
    - e) Insulation: Required between each row of jacks.

SPEC WRITER NOTE:

- 1. Include following subsection as appropriate for existing facilities only.

## 2.4 EXISTING WIRING

- A. Reuse existing wiring only where indicated on plans and accepted by SMCS 005OP2H3.
- B. Only existing wiring that conforms to specifications and applicable codes can be reused; existing wiring that does not meet these requirements cannot be reused and must be removed by contractor.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General:
  - 1. Install wiring in cable tray or raceway.
  - 2. Seal cable entering a building from underground, between wire and conduit where cable exits conduit, with non-hardening approved compound.
  - 3. Wire Pulling:

- a. Provide installation equipment that prevents cutting or abrasion of insulation during pulling of cables.
  - b. Use ropes made of nonmetallic material for pulling feeders.
  - c. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached to conductors, as accepted by COR.
  - d. Pull multiple cables into a single conduit together.
- B. Installation in Maintenance or Man holes:
1. Install and support cables in maintenance holes on steel racks with porcelain or equal insulators.
  2. Train cables around maintenance hole walls, but do not bend to a radius less than six times overall cable diameter.
  3. Fireproofing:
    - a. Install fireproofing where low voltage cables are installed in same maintenance holes with high voltage cables; also cover low voltage cables with arc proof and fireproof tape.
    - b. Use tape of same type used for high voltage cables, and apply tape in a single layer, one-half lapped or as recommended by manufacturer. Install tape with coated side towards the cable and extend minimum 25 mm (1 inch) into each duct.
    - c. Secure tape in place by a random wrap of glass cloth tape.
- C. Control, Communication and Signal Wiring Installation:
1. Unless otherwise specified in other sections, provide wiring and connect to equipment/devices to perform required functions as indicated.
  2. Install separate cables for each system so that malfunctions in any system does not affect other systems, except where otherwise required.
  3. Group wires and cables according to service (i.e. AC, grounds, signal, DC, control, etc.); DC, control and signal cables can be included with any group.
  4. Form wires and cables to not change position in group throughout the conduit run. Bundle wires and cables in accepted signal duct, conduit, cable ducts, or cable trays

neatly formed, tied off in 600 mm to 900 mm (24 inch to 36 inch) lengths to not change position in group throughout run.

5. Concealed splices are not allowed.
6. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure.
7. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right.
8. Provide ties and fasteners that do not damage or distort wires or cables. Limit spacing between tied points to maximum 150 mm (6 inches).
9. Install wires or cables outside of buildings in conduit, secured to solid building structures.
10. Wires or cables must be specifically accepted, on a case by case basis, to be installed outside of conduit. Bundled wires or cables must be tied at minimum 460 mm (18 inches) intervals to a solid building structure; bundled wires or cables must have ultra violet protection and be waterproof (including all connections).
11. Laying wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not permitted.
12. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.:
  - a. Only when authorized, can wires or cables be identified and approved to be installed outside of conduit.
  - b. Provide wire or cable rated plenum and OEM certified for use in air plenums.
  - c. Provide wires and cables hidden, protected, fastened and tied at maximum 600 mm (24 inches) intervals, to building structure.
  - d. Provide closer wire or cable fastening intervals to prevent sagging, maintain clearance above suspended ceilings.
  - e. Remove unsightly wiring and cabling from view, and discourage tampering and vandalism.



- f. Sleeve and seal wire or cable runs, not installed in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers, with an approved fire retardant sealant.
- D. AC Power:
  - 1. Bond to ground contractor-installed equipment and identified Government-furnished equipment, to eliminate shock hazards and to minimize ground loops, common mode returns, noise pickup, crosstalk, etc. for total ground resistance of 0.1 Ohm or less.
  - 2. Use of conduit, signal duct or cable trays as system or electrical ground is not permitted; use these items only for dissipation of internally generated static charges (not to be confused with externally generated lightning) that can be applied or generated outside mechanical and physical confines of system to earth ground. Discovery of improper system grounding is grounds to declare system unacceptable and termination of all system acceptance testing.
  - 3. Cabinet Bus: Extend a common ground bus of at least #10 AWG solid copper wire throughout each equipment cabinet and bond to system ground. Provide a separate isolated ground connection from each equipment cabinet ground bus to system ground. Do not tie equipment ground busses together.
  - 4. Equipment: Bond equipment to cabinet bus with copper braid equivalent to at least #12 AWG. Self-grounding equipment enclosures, racks or cabinets, that provide OEM certified functional ground connections through physical contact with installed equipment, are acceptable alternatives.

### **3.2 EQUIPMENT IDENTIFICATION**

- A. Control, Communication and Signal System Identification:
  - 1. Install a permanent wire marker on each wire at each termination.
  - 2. Identify cables with numbers and letters on the labels corresponding to those on wiring diagrams used for installing systems.
  - 3. Install labels retaining their markings after cleaning.

4. In each maintenance hole (manhole) and handhole, install embossed brass tags to identify system served and function.
- B. Labeling:
1. Industry Standard: ANSI/TIA-606-B.
  2. Print lettering for voice and data circuits using laser printers; handwritten labels are not acceptable.
  3. Cable and Wires (hereinafter referred to as “cable”): Label cables at both ends in accordance with industry standard. Provide permanent labels in contrasting colors. Identify cables matching system Record Wiring Diagrams.
  4. Equipment: Permanently labeled system equipment with contrasting plastic laminate or bakelite material. Label system equipment on face of unit corresponding to its source.
  5. Conduit, Cable Duct, and Cable Tray: Label conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying system. Label each enclosure according to this standard.
  6. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and Record Wiring Diagrams.

### 3.3 TESTING

- A. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on cables in frequency ranges specified.
- B. Tests required for data cable must be made to confirm operation of this cable at minimum 10 Mega (M) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of  $10^{-6}$  at maximum rate of speed.
- C. Provide cable installation and test records at acceptance testing to COR and thereafter maintain in facility's telephone switch room.
- D. Record changes (used pair, failed pair, etc.) in these records as change occurs.
- E. Test cables after installation and replace any defective cables.

CONSTRUCT PRIMARY CARE / MENTAL HEALTH BUILDING  
BOISE VA MEDICAL CENTER – BOISE, ID

PROJECT #: 531-325  
CONSTRUCTION DOCUMENTS

--- E N D ---

**SECTION 27 11 00**  
**TELECOMMUNICATIONS ROOM FITTINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies equipment cabinets, interface enclosures, relay racks, and associated hardware in service provider DEMARC, computer and telecommunications rooms.
- B. Telephone system is defined as an Emergency Critical Care Communication System by the National Fire Protection Association (NFPA). Adhere to Seismic reference standards for systems connecting to or extending telephone system and cabling.

**1.2 RELATED WORK**

- A. Wiring devices: Section 26 27 26, WIRING DEVICES.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.
- D. Lightning protection system: Section 26 41 00, FACILITY LIGHTNING PROTECTION.
- E. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- F. Low voltage cabling system infrastructure: Section 27 10 00, CONTROL, COMMUNICATION AND SIGNAL WIRING.
- G. Voice communication switching and routing equipment: Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT.
- H. Extension of a voice communication switching and routing system: Section 27 31 31, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT EXTENSION.
- I. Emergency 2-way radio equipment: Section 27 32 41, TWO-WAY RADIO EQUIPMENT AND SYSTEMS.

### **1.3 SUBMITTALS**

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATION.
- B. Separate submittal into sections for each subsystem containing the following:
  - 1. Pictorial layouts of each Telecommunications Room and Cross Connection Space (VCCS, and HCCS termination cabinets), each distribution cabinet layout, and TCO as each is expected to be installed and configured.
  - 2. Equipment technical literature detailing electrical and technical characteristics of each item of equipment to be furnished.
- C. Environmental Requirements: Identify environmental specifications for housing system as initial and expanded system configurations.
  - 1. Floor loading for batteries and cabinets.
  - 2. Minimum floor space and ceiling height.
  - 3. Minimum door size for equipment passage.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT AND MATERIALS**

- A. Provide components of cabinet system (cabinet, thermal, cable and power management accessories) from a single manufacturer.
- B. Equipment Standards and Testing:
  - 1. Equipment must be listed by a NRTL where a UL standard is in existence; active and passive equipment must conform with each UL standard in effect for equipment, on the submittal date.
  - 2. Each item of electronic equipment must be labeled by a NRTL that warrants equipment has been tested in accordance with, and conforms to specified standards.
- C. Equipment Cabinets (Enclosures):
  - 1. Fully enclose and physically secure internally mounted and connected, active and passive equipment.

2. Types of Equipment Enclosures accepted for specific VA Spectrum Management, FMS and OI&T applications in CFM and Facility Projects:

CABINET	FUNCTION
Communications	FMS Special Communications Equipment
Server / Router	OI&T Data/LAN/WAN Equipment
Seismic	Either FMS or OI&T use, specify need
Environmental	Either FMS or OI&T use, specify need

3. Each cabinet to be:
- Provided in head end, MCR, TER, PCR, EMGR, each TR and at a minimum.
  - Fabricated with minimum 1.59 mm (16 gauge) steel.
  - Provided with manufacturer's standard painted finish in a color accepted by COR with concurrence from FMS Service Chief.
  - Mounted on floor or wall.
  - Lockable; tubular locks keyed alike. Provide six keys to COR for each cabinet.
  - Compliant with facility's SMS card access system.
4. Provide equipment mounting shelves; attach to front and rear mounting rails and allowing equipment to be secured to respective mounting rails.
5. Each enclosure to include:
- Floor or wall mounting.
  - Knock out holes for conduit connections or cable entrance.
  - Front and rear locking doors; wall mounted cabinets require only front locking door.
  - Power outlet strips.
6. Provide quiet ventilation fan with non-disposable locally cleanable air filter.
7. Size each cabinet in order to contain and maintain internal mounted equipment items.
8. Provide OEM's fully assembled unit.
9. Provide OEM assembled side-by-side enclosures in a single unit, at locations requiring more than two enclosures.

10. Provide minimum one cabinet with blank rack space, for additional system expansion equipment.
11. Bond to communications circulating grounding system.
12. Technical Characteristics:
  - a. External:
    - 1) Overall Height:
      - a) Communications/Server: Maximum 2,184 mm (86 inches).
      - b) Seismic: Maximum 1,905 mm (75 inches).
    - 2) Overall Depth:
      - a) Communications/Server: Maximum 914 mm (36 inches).
      - b) Seismic: Maximum 762 mm (30 inches).
    - 3) Overall Width - All: Maximum 864 mm (34 inches).
  - b. Front Panel Openings:
    - 1) Width:
      - a) Communications: 482.6 mm (19 inches), per EIA.
      - b) Server: 584 mm (23 inches), per EIA/ECA 310.
      - c) Seismic: 483 mm (19 inches), per EIA/ECA 310.
    - 2) Height:
      - a) Communications/Server: Maximum 2,000 mm (78-3/4 inches or 45 Rack Units [RU]), per EIA/ECA 310.
      - b) Seismic: Maximum 1,689 mm (66-1/2 inches or 38 RUs, per EIA/ECA 310).
  - c. Heavy Duty Cycle: Maximum 544 kilograms (1,200 pounds) capacity.
  - d. Certification:
    - 1) NRTL (i.e. UL): For communications and server cabinets.
    - 2) Telcordia Technologies: #63-GR-CORE, (2012) for seismic cabinets.
    - 3) Seismic: Provide cabinet OEM constructed to seismic design category.
13. Cabinet Internal Components:
  - a. AC Power:
    - 1) Standard "Quad AC Box":

- a) Power capacity: 20 Ampere, single phase, 120 VAC continuous duty.
  - b) Wire gauge: #12 AWG, solid copper, connected to room's internal AC Power Panel, or as directed by COR.
  - c) Number of AC power outlets: Minimum 4 receptacles.
  - d) Enclosure: Fully self-contained, metal 102 mm (4 inch) x 102 mm (4 inches) x 64 mm (2-1/2 inches) with cover
  - e) Connection: Minimum 25.4 mm (1 inch) conduit connected to room's AC Power Panel, or as directed by COR
  - f) Number of boxes: One.
  - g) Compliance: NRTL (i.e. UL); NPFA - 70 (NEC).
- b. AC Outlet Strips:
- 1) Power Capacity: 15 Ampere, single phase, 120 VAC continuous duty.
  - 2) Wire Gauge: Minimum #12 AWG, solid copper.
  - 3) Number of AC Power Outlets: Minimum 10 "U" grounded.
  - 4) Enclosure: Fully self-contained; typically metal.
  - 5) Connecting Wire: Minimum 2 m (6 feet) long, with three prong self-grounding AC plug connected to cabinet's internal AC "Quad" box.
  - 6) Number of Strips: 2.
  - 7) Certification: NRTL (i.e. UL).
- c. AC Power Line Surge Protector and Filter Construction:
- 1) Input Voltage Range: 120 VAC + 15 percent at 50/60 Hz, single phase.
  - 2) Power Service Capacity: 20 AMP, 120 VAC.
  - 3) Voltage Output Regulation: +5.0 percent, instantaneous of input.
  - 4) Circuit Breaker: 15 AMP; may be self-contained.
  - 5) AC Outlets: Minimum four duplex grounded NEMA 5-20R.
  - 6) Response Time: 5.0 nanosecond.
  - 7) Suppression: Isolate and filter any noise, surge spikes
    - a) Surge: Minimum 20,000 AMP.
    - b) Noise:



- 1) Common: -40 dB.
  - 2) Differential: -45 dB.
  - 8) Clamping Voltage: Minimum 300 V.
  - 9) Enclosure: One; self-contained.
  - 10) Mounting: Internal to cabinet floor or on internal mounting rail shelf, allowing two plugs from two plug strips.
  - 11) AC Power Cord: Required; minimum 1,628 mm (6 feet), three wire (green ground); minimum #14 AWG stranded.
  - 12) Compliance: NRTL (i.e. UL60950-1).
- d. Uninterruptible Power Supply (UPS): Provide each cabinet with an internal UPS which may be combined with surge protector and filter if system's 50 percent expansion requirement is met. Provide at least one hour continuous full load // two hours if working with a //critical// emergency // safety // police// system// uninterruptible system primary AC Power, with a 50 percent // 30 min // 1.0 hour// respectively // reserve capacity, in the event of facility primary or emergency AC power failure.
- 1) UPS to include:
    - a) On-Off Switch: This function is required to be a part of system's electronic supervision requirements.
    - b) First/Fast Charge Unit: Must provide clean predicable charge voltage/current. Function is required to be a part of system's electronic supervision requirements.
    - c) Over Voltage/Current Protect: Cannot short circuit AC power line at any time. This function is required to be a part of system's electronic supervision requirements.
    - d) Trickle Charge Unit: Must be capable of maintaining a suitable internal battery charge without damaging batteries.
    - e) Mounting: Provide per OEM's direction.
    - f) Proper Ventilation: Do not override cabinets' ventilation system.

- g) Power Change from AC Input: Accomplish change without interruption to communications link or subsystem being protected. Generate visual and aural alarms in electrical supervision system, local and remote, to annunciating panels via direct connection for trouble indication.
- 2) Specific requirements for current and surge protection to include:
  - a) Voltage Protection: Threshold, line to neutral, starts at maximum 200 Volts peak. Transient voltage cannot exceed 330 Volts peak. Furnish documentation on peak clamping Voltage as a function of transient waveform.
  - b) Peak Power Dissipation: Minimum 35 Joules per phase, as measured for 1.0 millisecond at sub branch panels, 100 Joules per phase at branch panels and 300 Joules per phase at service entrance panels. Typically, power dissipation is 12,000 Watts (W) for 1.0 mS (or 12 Joules). Provide explanation of how ratings were measured or empirically derived.
  - c) Surge Protector (may be combined with On-Off switch of UPS): Must not short circuit AC power line at any time.
    - 1) Components must be minimum silicon semi-conductors.
    - 2) Secondary stages, if used, may include other types of rugged devices.
    - 3) Indicators: Provide visual device indicating surge suppression component is functioning.
    - 4) Electrical Supervision: Required; must be audible and visual, local and remote to annunciating panels via direct connection for trouble indication.
  - d) Provide current and surge protection on ancillary equipment.
  - e) Equip each cabinet with the following:
    - 1) Equipment Mounting Rails (Front & Rear): Fully adjustable internal equipment mounting rails allowing front or rear equipment mounting with pre-drilled EIA/ECA 310-E Standard tapped holes. Support entire

- equipment by supplementary support in addition to face mounting screws on rails.
- 2) Cabinet Ground: Stainless steel adjustable, lug connected to cabinet's main structure providing an internal cabinet ground for all installed equipment properly bolted to rail and with ground wire connected.
  - 3) Grounding Terminals: A separate mounting hole on equipment mounting rail, with stainless steel connecting bolt bonded by minimum #10 AWG copper wire to cabinet's internal grounding lug.
14. Ground Interconnection: Bond cabinet's common grounding lug to room's communications circulating ground busbar with a minimum #4 AWG stranded copper wire.
  15. Blank Panels: Provide at every unused rack space.
    - a. Match cabinet color.
    - b. Provide panels of 3 mm (1/8 inch) thick aluminum with vertical dimensions in increments of one rack unit (RMU) or 45 mm (1-3/4 inch) with mounting holes spaced to correspond to EIA/ECA 310-E Standard 483 mm (19 inch) rack dimensions.
    - c. Fill large unused openings with single standard large panel instead of numerous types.
    - d. Leave one blank rack space (RMU), covered with a blank panel, between each item of equipment, for minimum internal air flow.
    - e. Leave 356 mm (14 inches)(8.0 RMU) open space, covered with blank cover panel, for additional expansion equipment.
    - f. Wire Management: System that connects each item of installed equipment to room wire management system.
    - g. Knock-out Holes: Provide for cable entrance/exits via conduits, cable duct/trays.
  - D. Environmental Cabinet:
    1. Enclosure must fully contain installed equipment, including electronics, in same manner as standard cabinet. Provide climate control for installed equipment as if

- they were in a standalone air handling area, regardless of local area air handling capabilities.
2. Provide an OEM's fully assembled unit enclosure.
  3. If more than two enclosures are required in any system location, provide OEM-assembled enclosures, in a single unit, side-by-side.
  4. Technical Characteristics:
    - a. Environmental Control: Automatic, heating and cooling as required.
    - b. Temperature Conditions (rated at 1,300 W of install equipment heat generation):
      - 1) Internal Range: Maintains 26.67 degree to 37.78 degree C (80 degree to 100 degree f) of internal heat conditions.
      - 2) External Range: Maximum 37.78 degrees + -3.89 degrees C (100 degrees + 25 degrees F).
    - c. Forced Air Unit: Required with non-disposable air filter; unobstructed and uninterruptible.
    - d. Air Conditioning: As required; fully internal mounted.
    - e. Heater: As required; fully internal mounted.
    - f. UPS: Required; fully internal mounted.
    - g. Front Door: Full length, see through, EMI resistant and lockable, keyed alike with 7-pin tubular lock // and Police Service SMS card access // .
    - h. Rear door: Full length, see through, EMI resistant, and lockable keyed alike with 7-pin tubular lock // and Police Service SMS card access // .
    - i. Conduit Wiring Entrance: Top or bottom; fully sealed.
    - j. Input Power: Minimum 2 each; maximum 120 VAC at 20A, independent circuit, conduit for fixed or armored cable for moveable installations.
    - k. Dimensions:
      - 1) Height: Maximum 1980 mm (78 inches).
      - 2) Width: Maximum 635 mm (25 inches).
      - 3) Depth: Maximum 965 mm (38 inches).

- 4) Front Panel Opening: 480 mm (19 inches), w/ EIA/ECA 310 mounting hole spacing.
- l. Trouble Annunciator Panel: Refer to specific requirements in equipment cabinet.
- m. Audio Monitor Panel: Refer to specific requirements in equipment cabinet.
- E. Wall Mounted Distribution or System Interface Cabinet:
  1. Construct of minimum 1.59 mm (16 gauge) cold rolled steel, with top, side and bottom panels.
  2. Provide double-hinged front door and main cabinet body allowing access to all internal equipment and wiring; mount to solid walls or internal studs.
  3. Provide baked-on iron phosphate primer and baked enamel paint finish in a color to be selected by the using FMS Chief or COR.
  4. Provide integral and adjustable EIA/ECA 310 standard predrilled rack mounting rails to allow front panel equipment mounting and access.
  5. After equipment, doors and panels are installed, snap-in-place chrome trim strip covers all front panel screw fasteners.
  6. Provide full-length vertical piano hinge to allow entire front portion of cabinet to “swing out” from wall for access to installed equipment, wires and cable; maintain minimum OSHA Safety clearances and NFPA operational functions.
  7. Provide an OEM’s fully assembled unit enclosure.
  8. Equip these cabinets same as equipment cabinets, except mount UPS on floor below cabinet with AC power connection in conduit to AC service panel.
  9. Technical Characteristics:
    - a. Overall Height: Maximum 1,218 mm (48 inches).
    - b. Overall Depth: Maximum 558 mm (22 inches).
    - c. Overall Width: Maximum 610 mm (24 inches).
    - d. Front Panel Horizontal: Maximum width 483 mm (19 inches).
    - e. Capacity: Maximum 180 kilograms (400 pounds).
    - f. Lockable:
      - 1) Tubular lock with 7-pin security.

- 2) Key cabinets alike.
- 3) Police SMS access card system.

F. Stand Alone Open Equipment Rack:

1. Construct of minimum 1.59 mm (16 gauge) cold rolled steel with manufacturer's standard paint finish, in a color to be selected by COR with concurrence from facility's FMS Service Chief.
2. Floor-mount as directed by COR with concurrence from facility's FMS Service Chief.
3. Equip rack same as equipment cabinet, except mount UPS with additional support for weight and AC power connection in conduit to AC service panel.
4. Provide an OEM fully assembled unit.
5. Technical Characteristics:
  - a. Overall Height: Maximum 2,180 mm (85-7/8 inches).
  - b. Overall Depth: Maximum 650 mm (25-1/2 inches).
  - c. Overall Width: Maximum 535 mm (21-1/16 inches).
  - d. Front Panel Opening: 483 mm (19 inches), EIA/ECA 310 horizontal width.
  - e. Hole Spacing: Per EIA/ECA 310.
  - f. Load Capacity: Maximum 680.4 kg (1,500 lbs).
  - g. Certifications:
    - 1) EIA/ECA: 310-E.
    - 2) NRTL (i.e. UL): OEM specific.

G. Wire Management Equipment:

1. Provide an orderly horizontal and vertical interface between outside and inside wires and cables, distribution and interface wires and cables, interconnection wires and cables and associated equipment, jumper cables, and provide an uniform connection media for system fire-retardant wires and cables and other subsystems.
2. Interface to each cable tray, duct, wireway, or conduit used in the system.
3. Interconnection or distribution wires and cables must enter system at top (or from a wireway in the floor) via overhead protection system and be uniformly routed down

- // either or // both sides at same time, of the frames side protection system, then laterally for termination on rear of each respective terminating assembly.
4. Custom configure to meet 30 percent fill system design and user needs.
    - a. Minimum Height: \_\_\_\_ .
    - b. Minimum Depth: \_\_\_\_ .
    - c. Minimum Width: \_\_\_\_ .
  - H. Vertical Cable Managers:
    1. Use same make, style and size of vertical cable manager on rack/frame or in between racks/frames when more than one cable manager is used on a rack/frame or group of racks/frames.
    2. Match color and cover style of racks/frames and cable managers.
  - I. Horizontal Cable Managers:
    1. Use same make and style of cable manager on rack/frame or racks/frames, when more than one horizontal cable manager is used on a rack/frame or group of racks/frames.
    2. Match color of racks/frames and cable managers.
  - J. Telecommunication Room (TR): In hostile TR locations , where it has been determined (by COR or Facility Chief Engineer) that proper TR climate or external signal radiation cannot be maintained or controlled, provide a minimum of two individual and properly sized self-contained climate controlled equipment cabinet enclosures; one designated for voice, and one designated for dataservice.
  - K. Provide gas protection devices on all circuits and cable pairs serving building distribution frames, located in buildings other than building in which is located, or in any area served by an unprotected distribution system (maintenance hole, manhole, aerial, etc.).
  - L. Provide installation hardware when enclosures or racks are attached to structural floor.
  - M. Provide noise filters and surge protectors for each equipment interface cabinet, switch equipment cabinet, control console, and local and remote active equipment locations to ensure protection from input primary AC power surges so as a consequence noise glitches are not induced into low voltage data circuits.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Coordinate cabinet installation such that doors fully close and lock, with active and passive equipment installed and connected.
- B. Verify equipment dimensions and brackets allow mounting with cabinet doors closed. Front door or rear door of any cabinet that does not close and lock may result in immediate cancellation of inspections or tests.

### **3.2 INSTALLATION**

- A. Equipment Cabinets:
  - 1. Install cabinets in a manner that complies with OEM instructions, requirements of this specification, and in a manner which does not constitute a safety hazard.
  - 2. Provide weatherproof equipment installed outdoors or install in NEMA 3S rated enclosures with hinged doors and locks with two keys.
  - 3. Install equipment indoors in NEMA 4 rated metal cabinets with hinged doors and locks with two keys.
- B. Grounding:
  - 1. Bond equipment, including identified Government furnished equipment, to ground so total ground resistance measures maximum 0.1 Ohm.
    - a. Install lightning arrestors and grounding in accordance with NFPA.
    - b. Install gas protection devices at nearest point of entrance in buildings where protection is required and on same circuits as MDF in telephone switch room.
    - c. Do not use AC neutral, including in power panel or receptacle outlet, for system control, subcarrier or audio reference ground.
    - d. Use of conduit, signal duct or cable trays as system or electrical ground is not permitted.
  - 2. Connect each equipment grounding terminal to a separate mounting hole on equipment mounting rail, to right as one looks at it from rear, with a minimum #12 AWG stranded copper wire with protective green jacket.



3. Extend common ground bus of minimum #10 AWG solid copper wire throughout each equipment cabinet and bond to TGB. Provide a separate isolated ground connection from each equipment cabinet ground bus to system ground. Do not tie equipment ground buses together.
  4. Bond equipment to cabinet bus with copper braid equivalent to #12 AWG. Self-grounding equipment enclosures, racks or cabinets, that provide OEM certified functional ground connections through physical contact with installed equipment, are acceptable alternatives.
  5. Bond cable shields to cabinet ground bus with minimum #12 AWG stranded copper wire at only one end of cable run. Insulate cable shields from each other, faceplates, equipment racks, consoles, enclosures or cabinets, except at system common ground point. Bond coaxial and audio cables only at source; in all cases, keep cable shield ground connections to a minimum.
- c. Equipment Assembly:
1. Cabinets:
    - a. Install and adjust cabinet/frame accessories to position, including thermal management accessories, vertical cable managers, vertical power managers and equipment-mounting rails, using manufacturer's installation instructions prior to baying or placing cabinet for attachment to building and before installing any rack-mount equipment into cabinet. Shelves, horizontal cable managers and filler panels (rack-mount accessories), if used, may be installed after cabinet is placed.
    - b. When used in a multi-cabinet bay, attach cabinets side-by-side using baying kits according to manufacturer's instructions.
    - c. Attach overhead ladder rack or cable tray to ceiling or top of cabinet. Maintain minimum 75 mm (3 inches) clearance between top of cabinet and bottom of ladder rack/cable tray. Position ladder rack/cable tray so that it does not interfere with hot air exhaust through cabinet's top panel. Use radius drops where cable enters or exits ladder rack/cable tray.

- d. In seismic areas, install additional bracing as required by building codes and recommendations of a licensed structural engineer.
- e. Install ladder rack with side stringers facing rack or cabinet so that ladder forms an inverted U-shape and so that welds between stringers (sides) and cross members (middle) face away from cables.
- f. Secure ladder rack to tops of equipment racks or cabinets using manufacturer's recommended supports and appropriate hardware.
- g. Attach bonding conductor sized per TIA-607-B between telecommunications grounding busbar and cabinet. Attach bonding conductor to cabinet using a ground terminal block according to manufacturer's installation instructions.
- h. Provide bonding conductor and other hardware required to make connections between cabinet and telecommunications grounding busbar.
- i. Install rack mounted equipment normally requiring adjustment or observation so operational adjustments can be conveniently made.
- j. Mount heavy equipment with rack slides or rails to allow servicing from front of enclosure. Provide support in addition to front panel mounting screws for heavy equipment.
- k. Provide with cable slack to permit servicing by removal of installed equipment from front of enclosure.
- l. Install color-matched blank panel spacer 44 mm (1.75 inches) high between each piece of active and passive equipment to ensure adequate air circulation for efficient equipment cooling and air ventilation.
- m. Provide quiet fans and non-disposable air filters at each console or cabinet.
- n. Install enclosures and racks plumb and square, permanently attached to building structure and held in place.
- o. Provide 381 mm (15 inches) of front vertical space opening for additional equipment.

- p. Install equipment located indoors in metal racks or enclosures with hinged doors to allow access for maintenance without causing interference to other nearby equipment.
  - q. Cables must enter equipment racks or enclosures in such a manner to allow doors or access panels to open and close without disturbing or damaging cables.
  - r. Mount distribution hardware in a manner that allows access to connections for testing and provides room for doors or access panels to open and close without disturbing the cables.
2. Racks:
- a. Assemble racks according to manufacturer's instructions.
  - b. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching rack to floor.
  - c. Attach assembled racks to floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through raised floor tile and be secured in structural floor below.
  - d. Bond racks to telecommunications grounding busbar using appropriate hardware provided by contractor.
  - e. In seismic areas, install additional bracing as required by building codes and recommendations of a licensed structural engineer.
  - f. Ladder rack may be attached to top of rack to deliver cables to rack. Do not drill rack to attach; use appropriate hardware from rack manufacturer.
  - g. Provide radius drops to guide cable where cable exits or enters side of overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field.
  - h. Evenly distribute equipment load on rack. Place large and heavy equipment towards bottom of rack. Secure equipment to rack with equipment mounting screws. In seismic areas, secure equipment to shelves with additional bracing.
3. Vertical Cable Managers:

- a. Provide vertical managers so number of cables in each manager does not exceed OEM fill capacity.
- b. Attach vertical cable managers to side of rack/frame using manufacturer's installation instructions and hardware.
- c. Attach vertical cable manager to both racks/frames when a single vertical cable manager is used between two racks/frames.
- d. Dress cables through openings in between T-shaped guides on manager so that cables make gradual bends as they exit or enter cable manager into rack-mount space (RMU). Do not twist, coil or make sharp bends in cables.
- e. Attach doors to cable manager in closed position after cabling is complete.
- 4. Horizontal Cable Managers:
  - a. Attach horizontal cable managers to rack/frame with minimum four screws according to manufacturer's installation instructions. Center each cable manager within allocated rack-mount space (RMU).
  - b. Provide horizontal managers located so number of cables each manager supports is less than cable manager's cable fill capacity.
  - c. Dress cables through openings in between T-shaped guides on cable manager so that cables make gradual bends as they exit or enter cable manager into rack-mount space (RMU). Do not twist, coil or make sharp bends in cables.
  - d. Attach covers to cable manager in closed position after cabling is complete.
- D. Labeling: Permanently label each enclosure in accordance with TIA-606-B using laser printers; handwritten labels are not acceptable.
  - 1. Equipment: Label system equipment with contrasting plastic laminate or bakelite material on face of unit corresponding to its source.
  - 2. Conduit, Cable Duct, and/or Cable Tray: Label conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 m (10 feet), identifying system.

--- E N D ---

**SECTION 27 15 00**  
**COMMUNICATIONS STRUCTURED CABLING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies a complete and operating voice and digital structured cabling distribution system and associated equipment and hardware to be installed in VA Out Patient Clinic here-in-after referred to as the “facility”.

**1.2 RELATED WORK**

- A. Wiring devices: Section 26 27 26, WIRING DEVICES.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.
- D. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- E. Low voltage cabling system infrastructure: Section 27 10 00, CONTROL, COMMUNICATION AND SIGNAL WIRING.
- F. Voice communication switching and routing equipment: Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT.
- G. Extension of a voice communication switching and routing system: Section 27 31 31, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT EXTENSION.
- H. Emergency radio equipment: Section 27 32 41, TWO-WAY RADIO EQUIPMENT AND SYSTEMS.
- I. High Definition (HDTV) Master Antenna Television (MATV) system and associated equipment: Section 27 41 31, MASTER ANTENNA TELEVISION EQUIPMENT AND SYSTEMS.
- J. Emergency Service Public Address System (PAS) and associated equipment: Section 27 51 16, PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS.

### **1.3 SUBMITTALS**

- A. In addition to requirements of Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS provide:
  - 1. Pictorial layout drawing of each telecommunications room, showing termination cabinets, each distribution cabinet and rack, as each is expected to be installed and configured.
  - 2. List of test equipment as per 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Certifications:
  - 1. Submit written certification from OEM indicating that proposed supervisor of installation and proposed provider of contract maintenance are authorized representatives of OEM. Include individual's legal name and address and OEM warranty credentials in the certification.
  - 2. Pre-acceptance Certification: Submit in accordance with test procedures.
  - 3. Test system cables and certify to COR before proof of performance testing can be conducted. Identify each cable as labeled on as-installed drawings.
  - 4. Provide current and qualified test equipment OEM training certificates and product OEM installation certification for contractor installation, maintenance, and supervisory personnel.
- C. Closeout Submittal: Provide document from OEM certifying that each item of equipment installed conforms to OEM published specifications.

### **1.4 WARRANTY**

- A. Work subject to terms of Article "Warranty of Construction," FAR clause 52.246-21.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE AND DESIGN CRITERIA**

- A. Provide complete system including "punch down" and cross-connector blocks voice and data distribution sub-systems, and associated hardware including telecommunications outlets (TCO); copper and fiber optic distribution cables, connectors, "patch" cables,

“break out” devices and equipment cabinets, interface cabinets, and radio relay equipment rack.

B. Industry Standards:

1. Cable distribution systems provided under this section are connected to systems identified as critical care performing life support functions.
2. Conform to National and Local Life Safety Codes (whichever are more stringent), NFPA, NEC, this section, Joint Commission Life Safety Accreditation requirements, and OEM recommendations, instructions, and guidelines.
3. Provide supplies and materials listed by a nationally recognized testing laboratory where such standards are established for supplies, materials or equipment.
4. Refer to industry standards and minimum requirements of Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and guidelines listed.
5. Active and passive equipment required by system design and approved technical submittal; must conform to each UL standard in effect for equipment, when technical submittal was reviewed and approved by Government or date when COR accepted system equipment to be replaced. Where a UL standard is in existence for equipment to be used in completion of this contract, equipment must bear approved NRTL label.

C. System Performance: Provide complete system to meet or exceed TIA Category 5E or on a case by case basis Category 6A for specialized powered systems’ requirements.

D. Provide continuous inter- and/or intra-facility voice, data, and analog service.

1. Provide voice and data cable distribution system based on a physical “Star” topology.
2. Provide separate cable distribution system for emergency, safety and protection systems (i.e. emergency bypass phones; police emergency voice communications from parking lots and stairwells personal protection, duress alarms and annunciation systems; etc.)
3. Contact SMCS 005OP2H3 (202-462-5310) for specific technical assistance and approvals.

- E. Specific Subsystem Requirements: Provide products necessary for a complete and functional voice, data, analog and videotele communications cabling system, including backbone cabling system, patch panels and cross-connections, horizontal cabling systems, jacks, faceplates, and patch cords.
- F. Coordinate size and type of conduit, pathways and firestopping for maximum 40 percent cable fill with subcontractors.
- G. Terminate all interconnecting twisted pair, fiber-optic or coaxial cables on patch panels or punch blocks. Terminate unused or spare conductors and fiber strands. Do not leave unused or spare twisted pair wire, fiber-optic or coaxial cable unterminated, unconnected, loose or unsecured.
- H. Color code distribution wiring to conform to ANSI/TIA 606-B and construction documents, whichever is more stringent. Label all equipment, conduit, enclosures, jacks, and cables on record drawings, to facilitate installation and maintenance.
- I. In addition to requirements in Section 27 05 11, REQUIREMENTS FOR COMMUNICATION INSTALLATIONS, provide stainless steel faceplates with plastic covers over labels.
- J. Provide cable tray as required (12"W x 4"D minimum) throughout all major corridors. Where cable tray cannot physically be installed, provide j-hooks as required to support cabling. Cable tray shall be Cablofil Wire Basket by Legrand, or equal, length as required. J-hook shall be EATON B series or equal.

## **2.2 EQUIPMENT AND MATERIALS**

- A. Where system connects to an existing or future voice (telephone) system, refer to Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT for specific voice (telephone) equipment and system operational performance standards.
- B. Cable Systems - Twisted Pair, Fiber optic, Coaxial and Analog:
  - 1. General:
    - a. Provide cable (i.e. backbone, outside plant, and horizontal cabling) conforming to accepted industry standards with regards to size, color code, and insulation.



- b. Some areas can be considered “plenum”. Comply with all codes pertaining to plenum environments. It is contractor’s responsibility to review the VA’s cable requirements with COR and OI&T Service prior to installation to confirm type of environment present at each location.
  - c. Provide proper test equipment to confirm that cable pairs meet each OEM’s standard transmission requirements, and ensure cable carries data transmissions at required speeds, frequencies, and fully loaded bandwidth.
- 2. Telecommunications Rooms (TR):
  - a. In TR’s served with UTP and STP fiber optic, coaxial and analog backbone cables, terminate UTP and STP cable on RJ-45, 8-pin connectors of separate 48-port modular patch panels, 110A or equivalent type punch down blocks that are dedicated to voice and data applications.
  - b. Provide 24 port fiber optic modular patch panels with “LC” or OEM specified couplers dedicated for voice, data and FMS applications.
  - c. Provide connecting cables required to extend backbone cables (i.e. patch cords, twenty-five pair, etc.), to ensure complete and operational distribution systems.
  - d. In TR’s, which are only served by a UTP and STP backbone cable, terminate cable on separate modular connecting devices, Type 110A punch down blocks (or equivalent), dedicated to data applications.
- 3. Backbone Copper Cables:
  - a. Riser Cable:
    - 1) Provide communication riser cables listed in NEC Table 800, 154(a) for the purpose and suited for electrical connection to a communication network.
    - 2) Provide STP or Unshielded Twisted Pair (UTP), minimum 24 American Wire Gauge (AWG) solid, thermoplastic insulated conductors for communication (analog RF coaxial cable is not to be provided in riser systems) riser cables with a thermoplastic outer jacket.
    - 3) Label and test complete riser cabling system.
- 4. Horizontal Cable: Installed from TCO jack to the TR patch panel.

- a. Tested to ANSI/TIA-568-C.2 Category 5E requirements including NEXT, ELFEXT (Pair-to-Pair and Power Sum), Insertion Loss (attenuation), Return Loss, and Delay Skew.
  - b. Minimum Transmission Parameters: 250 MHz 500 MHz.
  - c. Provide four pair 0.205 mm<sup>2</sup> (24 AWG) 0.326 mm<sup>2</sup> (22 AWG) cable
  - d. Terminate all four pairs on same port at patch panel in TR.
  - e. Terminate all four pairs on same jack, at work area Telecommunication Outlets (TCO):
    - 1) Jacks: Minimum three eight-pin RJ-45 ANSI/TIA-568-C.2 Category 5E 6A Type jacks at TCO.
      - a) Top Port: RJ-45 jack compatible with RJ-11 plug for voice.
      - b) Bottom Two Ports: Unkeyed RJ-45 jacks for data.
5. Fiber Optics Backbone Cable:
- a. Provide 50/125 62.5/125 (for Bell System Interconnection Compatibility) OM4 multi-mode cable, containing at minimum 18 strands of fiber, unless otherwise specified.
  - b. Provide loose tube cable, which separates individual fibers from the environment, or indoor/outdoor cables, for outdoor runs or any area that includes an outdoor run.
  - c. Provide tight buffered fiber cable or indoor/outdoor cables for indoor runs.
  - d. Terminate multimode fibers at both ends with LC SC type female connectors installed in an appropriate patch or breakout panel and secured with a cable management system. Provide minimum 610 mm (2 ft.) cable loop at each end.
  - e. Provide single mode fiber optic cable 8.3 mm containing at minimum 12 strands of fiber, unless otherwise specified. Terminate single mode fibers at both ends with LC SC type female connectors installed in an appropriate patch or breakout panel and secured with a cable management system. Provide minimum 610 mm (2 feet) cable loop at each end to allow for future movement.

- f. Install fiber optic cables in TR's, Voice (Telephone) Switch Room, and Main Computer Room, in rack mounted fiber optic patch panels. Provide female LC SC couplers in appropriate panel for termination of each strand.
    - g. Test all fiber optic strands' cable transmission performance in accordance with TIA standards. Measure attenuation in accordance with fiber optic test procedures TIA-455-C ('-61', or -53). Provide written results to COR for review and approval.
  - c. Cross-Connect Systems (CCS):
    - 1. Copper Cables: Provide copper CCS sized to connect cables at TR and allow for a minimum of 50 percent anticipated growth.
    - 2. Maximum DC Resistance per Cable Pair: 28.6 Ohms per 305 m (1,000 feet).
    - 3. Fiber Optic Cables:
      - a. Provide fiber CCS sized to connect cables at TR and allow for a minimum of 50 percent anticipated growth.
      - b. Install fiber optic cable slack in protective enclosures.
  - D. Telecommunication Room (TR):
    - 1. Terminate backbone and horizontal, copper, fiber optic, coaxial and analog cables on appropriate cross-connection systems (CCS) containing patch panels, punch blocks, and breakout devices provided in enclosures and tested, regardless of installation method, mounting, termination, or cross-connecting used. Provide cable management system as a part of each CCS.
    - 2. Coordinate location in TR with FMS equipment (i.e. fire alarm, nurse call, code blue, video, public address, radio entertainment, intercom, and radio paging equipment).
  - E. Coaxial and Analog Cables: Bond equipment to ground per TIA standards, such that all grounding systems comply with all applicable National, Regional, and Local Building and Electrical codes.
    - 1. Provide current arrester for each copper or coaxial cable that enters from outside of a building regardless if cable is installed underground or aerial.
    - 2. Provide a gas surge protector/module and bond to earth ground.

- F. Main Cross-connection Subsystem (MCCS): MCCS is common point of distribution for inter- and intra-building copper and fiber optic backbone system cables, and connections to the voice (telephone) and data cable systems.
- G. Voice (or Telephone) Cable Cross-Connection Subsystem:
  - 1. Provide Insulation Displacement Connection (IDC) hardware.
  - 2. Provide the following for each Category 5E (or on a case by case basis Category 6 6A for specialized powered systems technically accepted by SMCS 005OP2H3, (202) 461-5310, OI&T and FMS Services and COR) Cabling System termination; cross-connection wires, RJ-45 patch cord connector to RJ-45 patch cord connector , hybrid modular cord to IDC patch cord connector.
    - a. Provide terminations to be accessible without need for disassembly of IDC wafer. Provide IDC wafers removable from their mounts to facilitate testing on either side of connector.
    - b. Provide removable designation strips or labels to allow for inspection of terminations.
    - c. Provide cable management system as a part of IDC.
  - 3. Provide IDC connectors capable of re-terminations, without damage, a minimum of 200 IDC insertions or withdrawals on either side of connector panel.
  - 4. Install using only non-impact terminating tool having both a tactile and an audible feedback to indicate proper termination.
  - 5. Provide inputs from PBX, FTS, Local Voice (Telephone) System, or diverse routed voice distribution systems on left side of IDC (110A blocks with RJ45 connections are acceptable alternates to IDC) of MCCS.
  - 6. Provide system outputs from MCCS to voice backbone cable distribution system on the right side of same IDC (or 110A blocks) of MCCS.
  - 7. Do not split pairs within cables between different jacks or connections.
  - 8. Provide UTP cross connect wire to connect each pair of terminals plus an additional 50 percent spare.
- H. Data Cross-Connection Subsystems:

1. Provide patch panels with modular RJ45 female to 110 connectors for cross-connection of copper data cable terminations and system ground with cable management system.
2. Provide patch panels conforming to EIA/ECA 310-E dimensions and suitable for mounting in standard equipment racks, with 48 RJ45 jacks aligned in two horizontal rows per panel. Provide RJ45 jacks of modular design and capable of accepting and functioning with other modular (i.e. RJ11) plugs without damaging jack.
  - a. Provide system inputs from servers, data LAN, bridge, or interface distribution systems on top row of jacks of appropriate patch panel.
  - b. Provide backbone cable connections on bottom row of jacks of same patch panel.
  - c. Provide patch cords for each system pair of connection jacks with modular RJ45 connectors provided on each end to match panel's modular RJ45 female jack's being provided.
- I. Fiber-Optic Cross-Connection Subsystems: Provide rack mounted patch or distribution panels installed inside a lockable cabinet or "breakout enclosure" that accommodate minimum 12 strands multimode fiber and 12 strand single mode fiber - these counts do not include 50 percent spare requirement. Provide cable management system for each panel.
  1. Provide panels for minimum 24 female LC SC connectors, able to accommodate splices and field mountable connectors and have capacity for additional connectors to be added up to OEM's maximum standard panel size for this type of use. Protect patch panel sides, including front and back, by a cabinet or enclosure.
  2. Provide panels that conform to EIA/ECA 310-E dimensions suitable for installation in standard racks, cabinets, and enclosures. Provide panels for system grounding where armored cables are installed.
  3. Provide patch panels with highest OEM approved density of fiber LC SC termination's (maximum of 72 each), while maintaining a high level of

manageability. Provide proper LC SC couplers installed for each pair of fiber optic cable LC SC connectors.

- a. Provide system inputs from interface equipment or distribution systems on top row of connectors of appropriate patch panel.
  - b. Provide backbone cable connections on bottom row of connectors of same patch panel.
  - c. Provide patch cords for each pair of fiber optic strands with connector to match couplers.
4. Provide field installable connectors that are pre-polished.
    - a. Terminate every fiber cable with appropriate connector, and test to ensure compliance to specifications and industry standards for fiber optic LC SC female connector terminated with a fiber optic cable.
    - b. Install a terminating cap for each unused LC SC connector.
- J. Copper Outside Plant Cable: Minimum of STP or UTP, 22 AWG solid conductors, solid PVC insulation, and filled core (flex gel - waterproof Rural Electric Association (REA) listed PE 39 code) between outer armor or jacket and inner conductors protective lining.
1. Provide copper cable system as a Star \_\_\_\_\_ Topology.
- K. Horizontal Cabling (HC):
1. Horizontal cable length to farthest system outlet to be maximum of 90 m (295 ft).
  2. Splitting of pairs within a cable between different jacks is not permitted.
- L. Air Blown Fiber: Alternative fiber optic cable installation method.
1. Air blown fiber installation process (also referred to as air blown cable, air assisted cable, high pressure air blowing, cable jetting, and referred to as air blown fiber herein) typically uses separate optical fiber cables along with separate flexible protective microducts installed where optical fiber cables can be blown in using specific equipment, trained installation personnel and practices.
  2. Indoor Microducts:
    - a. Provide empty bundled microducts comprising an inner layer of microducts optimized for air blown fiber system and an outer jacket layer of plenum riser

general purpose rated material with product identification and sequential length marking on outer layer at minimum one-meter (three feet) intervals.

- b. Provide microduct allowing multiple fibers to be installed simultaneously into each microduct using air blown fiber installation technique and fibers to also be removed from microduct using same technique.
  - c. Size each microduct for 50 percent unoccupied microducts after initial fiber bundle installation.
  - d. Furnish microducts that maintain minimum bend radius of 20 times cable diameter.
  - e. Provide quantity of plugs or end-caps so all unoccupied microducts are plugged on both ends per manufacturer's specifications. Provide plugs or end-caps that can be easily installed or removed from duct connectors as needed over the lifetime of the installation.
3. Outside Microducts:
- a. Provide outdoor-rated bundled microducts consisting of a number of empty microducts comprising an inner layer of microducts optimized for air blown fiber system and covered by a rated jacketing material with product identification and sequential length marking on outer layer at one-meter (three feet) minimum intervals.
  - b. Provide microducts with rodent protection at direct buried applications.
  - c. Protect outdoor-rated bundled microducts either by utilizing a moisture barrier and an outer jacket outerlayer of jacketed, galvanized steel armored (underground), direct buried, or outdoor tray or rack locations UV resistant for aerial, outdoor rack or tray applications jacketed, galvanized steel armored for aerial, outdoor rack or tray locations or by utilizing an HDPE jacket (with optional steel-tape wrapped between outer jacket and inner microducts) that has been treated with rodent deterrent.
  - d. Water-blocking must be accomplished by utilizing a moisture barrier within the bundled microduct assembly or by utilizing water-blocked fiber cable.

- e. Provide microduct allowing multiple fibers to be installed simultaneously into each microduct using air blown fiber installation technique and fibers to also be removed from microduct using same technique.
  - f. For future capacity, size each microduct provided for 50 percent unoccupied microducts after initial fiber bundle installation.
  - g. Furnish microducts to maintain minimum bend radius twenty times cable diameter.
  - h. Provide quantity of plugs or end-caps so unoccupied microducts are plugged on both ends per manufacturer's specifications, to prevent ingress of contaminants including water.
4. Microduct Couplers: Provide plastic-bodied pneumatic connector to join microducts of same size.
- a. Provide straight connectors constructed of a transparent plastic material permitting a visual verification of fiber population.
  - b. Provide tee connectors with additional port allowing for gas-blocking in internal/external situations, or provide gas-blocking couplers as needed to protect and isolate classified areas from non-classified areas or provide close-down connectors if needed for midspan assisted blows in long runs
5. Microduct Distribution Units: Provide NEMA-rated enclosure, suited for site environmental conditions provided for microduct distribution, routing, and termination.
- a. Provide unit capable of wall mounting to provide proper geometry for distribution wherever several microducts enter same location or where microduct type transitions take place.
  - b. Size based on number of microducts to enter unit.
6. Outdoor Enclosure/Splice Case: Provide outdoor NEMA-rated enclosure, or splice case suitable for site environmental conditions of outside plant microduct distribution and routing.



- a. Splice Cases: Water-tight, and air-tight re-enterable splice cases that do not require re-entry kits.
- b. Material: Stainless steel.
- c. Select enclosure/splice case hardware to meet site conditions.
  - 1) Provide NEMA-4 and 4X enclosures or splice cases in areas where hosing and splashing environmental conditions exist.
  - 2) Provide NEMA-6 and 6P enclosures splice cases in areas where temporary or long term flooded environmental conditions exist.
- 7. Fiber Termination Units: Provide at locations where fiber is to be terminated.
  - a. Provide for strain relief of incoming microducts.
  - b. Provide connector panels and connector couplings adequate to accommodate the number of fibers to be terminated.
  - c. Incorporate radius control mechanisms to limit bending of fibers to manufacturer's recommended minimum or 76 mm (3 inches), whichever is larger.
  - d. Where rack-mount fiber termination hardware is required, provide wall-mount microduct distribution unit near rack and provide individual microducts to route and connect fiber bundle passing through microduct distribution units to fiber termination hardware.
  - e. Provide LC SC connectors mounted on a coupler panel that snaps into patch panel housing assembly.
- 8. Fiber Bundles or Cables:
  - a. Provide fiber bundles or cables designed and manufactured to facilitate:
    - 1) Rapid installation of fiber using air blown fiber installation process without risk or damage to fibers.
    - 2) Re-installation without degradation of the optical specifications and performance of fiber.
    - 3) Transition points from indoor to outdoor environments without splices.

- b. Provide jacketed optical fibers manufactured so that the jacketed fiber strands meet GR409 and meet either UL 1666 for riser rated cables or UL 910 for plenum rated cables and are specific to the purpose of being blown throughout the bundled microduct system.
- c. Provide fiber designed to be stripped and terminated with standard tools.
- d. Provide fiber designed to be terminated with standard fiber optic connectors.
- e. Provide maximum 72 strands of fiber to be blown within each microduct; if fiber counts higher than 72 strands are required, provide microcore fiber with counts to 432 strands in larger size microducts.

## **2.3 DISTRIBUTION EQUIPMENT AND SYSTEMS**

### **A. Telecommunication Outlet:**

- 1. TCO consists of minimum one voice (telephone) RJ45 jack and two data RJ45 jacks, and one single mode fiber optic , and one multimode fiber optic jacks mounted in a separate steel outlet box 100 mm (4 inches) x 100 mm (4 inches) x 63 mm (2-1/2 inches) minimum with a labeled stainless steel faceplate. Where shown on drawings, provide a second steel outlet box minimum 100 mm (4 inches) x 100 mm (4 inches) x 63 mm (2-1/2 inches), with a labeled faceplate, adjacent to first box to ensure system connections and expandability requirements are met.
- 2. Provide RJ-45/11 compatible female type voice (telephone) multi-pin connections. Provide RJ-45 female type data multi-pin connections. Provide LC SC ceramic stainless steel ferrule female type fiber optic connectors.
- 3. Provide wall outlet with a stainless steel face plate and sufficient ports to fit voice (telephone) multi-pin jack, data multi- pin jacks , fiber optic jacks , analog jacks and plastic covers for labels when mounted on outlet box provided (minimum 100mm (4 inches) x 100mm (4 inches) for single and 100mm (4 inches) x 200mm (8 inches) for dual outlet box applications. Install stainless steel face plate, for prefabricated bedside patient unit installations.

4. Interface fiber optic LC SC jacks to appropriate patch panels in associated TR, but do not cross-connect fiber optic cables fiber optic equipment or install fiber optic equipment.

B. Backbone Distribution Cables:

1. Meet TIA transmission performance requirements of Voice Grade Category 3 5E 6 6A.
2. Provide cable listed for environments where it is installed.
3. Technical Characteristics:
  - a. Length: As required, in minimum 1 kilometer (3,000 ft.) reels.
  - b. Size:
    - 1) Minimum 0.326 mm<sup>2</sup> (22 AWG) outside plant installation.
    - 2) Minimum 0.205 mm<sup>2</sup> (24 AWG) interior installations.
  - c. Color Coding: American Telephone and Telegraph Company Standard; Bell System Practices Outside Plant Construction and Maintenance Section G50.607.3, Issue 2 February, 1959.
  - d. Minimum Bend Radius: 10X cable outside diameter.
  - e. Impedance: 120 Ohms + 15 percent.
  - f. DC Resistance: Maximum 8.00 ohms/100 m
  - g. Shield Coverage: As required by drawing notes single shield tape design dual shield tape design flat shield bonded to cable jacket .
  - h. Maximum attenuation for 100m at 20° C:

Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
.772	2.2	-	-	-
1	2.6	2.0	2.0	2.1
4	5.6	4.1	3.8	3.8
8	8.5	5.8	5.3	5.3

Frequency (MHz)	Category 3 (dB)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
10	9.7	6.5	6.0	5.9
16	13.1	8.2	7.6	7.5
20		9.3	8.5	8.4
25		10.4	9.5	9.4
31.25		11.7	10.7	10.5
62.5		17.0	15.4	15.0
100		22.0	19.8	19.1
200			29.0	27.6
250			32.8	31.1
300				34.3
400				40.1
500				45.3

4. Data Multi-Conductor:

- a. Unshielded F/UTP cable with solid conductors.
- b. Able to handle the power and voltage used over the distance required.
- c. Meets TIA transmission performance requirements of Category 5E 6 6A .
- d. Technical Characteristics:
  - 1) 0.205 mm<sup>2</sup> (24 AWG) - 0.326 mm<sup>2</sup> (22 AWG) cable
  - 2) Working Shield: 350 V.
  - 3) Bend Radius: 10 times cable outside diameter.
  - 4) Impedance: 100 Ohms + 15%, BAL.
  - 5) Bandwidth: 250 MHz 500 MHz .
  - 6) DC Resistance: Maximum 9.38 Ohms/100m (328 ft.) at 20 degrees C.
  - 7) Maximum Mutual Capacitance: 5.6 nF per 100 m (328 ft.).

- 8) Shield Coverage:
- a) Overall Outside (if OEM specified): 100 percent.
  - b) Individual Pairs (if OEM specified): 100 percent.
- 9) Maximum attenuation for 100m (328 ft.) at 20° C:

Frequency (MHz)	Category 5e (dB)	Category 6 (dB)	Category 6A (dB)
1	2.0	2.0	2.1
4	4.1	3.8	3.8
8	5.8	5.3	5.3
10	6.5	6.0	5.9
16	8.2	7.6	7.5
20	9.3	8.5	8.4
25	10.4	9.5	9.4
31.25	11.7	10.7	10.5
62.5	17.0	15.4	15.0
100	22.0	19.8	19.1
200		29.0	27.6
250		32.8	31.1
300			34.3
400			40.1
500			45.3

5. Fiber Optic:
- a. Multimode Fiber:
    - 1) Provide OM4 OM2 Type general purpose multimode fiber optic cable installed in conduit for system locations with load-bearing support braid surrounding inner tube for strength during cable installation.

2) Technical Characteristics:

- a) Bend Radius: Minimum 152 mm (6 inches); outer jacket as required.
- b) Fiber Diameter: 50 62.5 for Bell System Interconnection Standard requirements microns.
- c) Cladding: 125 microns.
- d) Attenuation:
  - 1) 850 nanometer: Maximum 4.0 dB per kilometer.
  - 2) 1,300 nanometer: Maximum 2.0 dB per kilometer.
- e) Bandwidth:
  - 1) 850 nanometer: Minimum 160 MHz.
  - 2) 1,300 nanometer: Minimum 500 MHz.
- f) Connectors: Stainless steel.

b. Single mode Fiber:

- 1) Provide OS1 Type general purpose single mode fiber optic cable installed in conduit for all system locations with load-bearing support braid surrounding inner tube for strength during cable installation.
- 2) Technical Characteristics:
  - a) Bend Radius: Minimum 100 mm (4 inches).
  - b) Outer Jacket: PVC.
  - c) Fiber Diameter: 8.7 microns.
  - d) Cladding: 125 microns.
  - e) Attenuation at 850 nanometer: 1.0 dBm per kilometer.
  - f) Connectors: Ceramic.

c. Outlet Connection Cables:

1. Voice (Telephone):

- a. Provide a connection cable for each TCO voice (telephone) jack in system with 10 percent spares able to connect voice (telephone) connection cable from voice (telephone) instrument to TCO voice (telephone) jack. Do not provide voice (telephone) instruments or equipment.

- b. Technical Characteristics:
  - 1) Length: Minimum 1.8 m (6 feet).
  - 2) Cable: Voice Grade.
  - 3) Connector: RJ-11/45 compatible male on each end.
  - 4) Size: Minimum 24 AWG.
  - 5) Color Coding: Required, telephone industry standard.
- 2. Data:
  - a. Provide a connection cable for each TCO data jack in system with 10 percent spares to connect a data instrument to TCO data jack. Do not provide data terminals/equipment.
  - b. Technical Characteristics:
    - 1) Length: Minimum 1.8 m (6 feet).
    - 2) Cable: Data grade Category 5E or on a case-by-case basis Category 6 6A for specialized powered systems accepted by SMCS 005OP2H3 (202) 461-5310, IT and FMS Services and COR.
    - 3) Connector: RJ-45 male on each end.
    - 4) Color Coding: Required, data industry standard.
    - 5) Size: Minimum 24 AWG.
- 3. Fiber Optic:
  - a. Provide a connection cable for each TCO fiber optic connector in system with 10 percent spares. Provide data connection cable to connect a fiber optic instrument to TCO fiber optic jack. Do not provide fiber optic instruments/equipment.
  - b. Technical Characteristics:
    - 1) Length: Minimum 1.8 m (6 feet).
    - 2) Cable: Flexible single conductor with jacket.
    - 3) Connector: LC SC male on each end.
    - 4) Size: To fit OM1 single mode or OM4 multimode cable.
- d. System Connectors:

1. Modular (RJ-45/11 and RJ-45): Provide voice and high speed data transmission applications type modular plugs compatible with voice (telephone) instruments, computer terminals, and other type devices requiring linking through modular telecommunications outlet to the system compatible with UTP F/UTP cables.
  - a. Technical Characteristics:
    - 1) Number of Pins:
      - a) RJ-45: Eight.
      - b) RJ-11/45: Compatible with RJ-45.
    - 2) Dielectric: Surge.
    - 3) Voltage: Minimum 1,000V RMS, 60 Hz at one minute.
    - 4) Current: 2.2A RMS at 30 minutes or 7.0A RMS at 5.0 seconds.
    - 5) Leakage: Maximum 100  $\mu$ A.
    - 6) Connections:
      - a) Initial contact resistance: Maximum 20 milli-Ohms.
      - b) Insulation displacement: Maximum 10 milli-Ohms.
      - c) Interface: Must interface with modular jacks from a variety of OEMs. RJ-11/45 plugs provide connection when used in RJ-45 jacks.
      - d) Durability: Minimum 200 insertions/withdrawals.
  - E. Fiber Optic Terminators:
    1. Pre-polished crimp on type that has proper ferrule to terminate fiber optic cable.
    2. Technical Characteristics:
      - a. Frequency: Light wave.
      - b. Power Blocking: As required.
      - c. Return Loss: 25 dB.
      - d. Connectors: LC SC .
      - e. Construction: Ceramic.
  - F. Conduit and Signal Ducts:
    1. Conduit:



- a. Provide conduit or sleeves for cables penetrating walls, ceilings, floors, interstitial space, fire barriers, etc.
- b. Minimum Conduit Size: 19 mm (3/4 inch).
- c. Provide separate conduit and signal ducts for each cable type installation.
- d. When metal (plastic covered, flexible cable protective armor, etc.) systems are authorized to be provided for use in system, follow installation guidelines and standard specified in Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS and NEC.
- e. Maximum 40 percent conduit fill for cable installation.
2. Signal Duct, Cable Duct, or Cable Tray: Use existing signal duct, cable duct, and cable tray, when identified and accepted by COR.
- G. Cable tray shall be Cablofil Wire Basket by Legrand, or equal, length as required.
- H. J-hook shall be EATON B series or equal.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install for ease of operation, maintenance, and testing.
- B. Install system to comply with NFPA 70 National Electrical Code, NFPA 99 Health Care Facilities, NFPA 101 Life Safety Code, Joint Commission Manual for Health Care Facilities, and original equipment manufacturers' (OEM) installation instructions.
- C. Cable Systems Installation:
  1. Install system cables in cable duct, cable tray, cable runway, conduit or when specifically approved, flexible NEC Article 800 communications raceway. Confirm drawings show sufficient quantity and size of cable pathways. If flexible communications raceway is used, install in same manner as conduit.
  2. Coordinate outside plant and backbone cables to furnish number of cable pairs for system requirements and obtain approval of COR and IT Service prior to installation.
  3. Bond to ground metallic cable sheaths, etc. (i.e. risers, underground, horizontal, etc.).

4. Install temporary cable to not present a pedestrian safety hazard and be responsible for all work associated with removal. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and accepted by COR, IT Service, FMS and SMCS 005OP2H3 (202-461-5310) prior to installation.

D. Labeling:

1. Industry Standard: Provide labeling in accordance with ANSI/TIA-606-B.
2. Print lettering of labels with laser printers thermal ink transfer process \_\_\_\_\_ ; handwritten labels are not acceptable.
3. Label both ends of all cables in accordance with industry standard. Provide permanent Labels in contrasting colors and identify according to system "Record Wiring Diagrams".
4. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and record on "Record Wiring Diagrams".

### 3.2 FIELD QUALITY CONTROL

A. Interim Inspection:

1. Verify that equipment provided adheres to installation requirements of this section. Interim inspection must be conducted by a factory-certified representative and witnessed by COR.
2. Check each item of installed equipment to ensure appropriate NRTL label.
3. Verify cabling terminations in telecommunications rooms and at workstations adhere to color code for T568B T568A pin assignments and cabling connections comply with TIA standards.
4. Visually confirm marking of cables, faceplates, patch panel connectors and patch cords.
5. Perform fiber optical field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

6. Notify COR of the estimated date the contractor expects to be ready for interim inspection, at least 20 working days before requested inspection date, so interim inspection does not affect systems' completion date.
  7. Provide results of interim inspection to COR. If major or multiple deficiencies are discovered, COR can require a second interim inspection before permitting contractor to continue with system installation.
  8. Do not proceed with installation until COR determines if an additional inspection is required. In either case, re-inspection of deficiencies noted during interim inspections must be part of the proof of performance test.
- B. Pretesting:
1. Pretest entire system upon completion of system installation.
  2. Verify during system pretest, utilizing the accepted equipment, that system is fully operational and meets system performance requirements of this section.
  3. Provide COR four copies of recorded system pretest measurements and the written certification that system is ready for formal acceptance test.
- C. Microduct Tests:
1. Furnish COR, obstruction and pressure test data for each microduct installed. Complete pressure and obstruction tests per manufacturer's recommended procedures prior to installing fiber, and ensure 100 percent of all microducts are compliant with manufacturer.
  2. Complete microduct pressure testing before proceeding with end-to-end microduct obstruction testing.
  3. Notify COR at least one week in advance of test date so that Government and design professional may be present to witness testing.
  4. Maintain close contact with chosen and technically-approved OEM and SMCS 005OP2H3 throughout installation, testing and certification process.
- D. Acceptance Test:

1. After system has been pretested and the contractor has submitted pretest results and certification to COR, then schedule an acceptance test date and give COR 30 days' written notice prior to date acceptance test is expected to begin.
  2. Test only in presence of a COR.
  3. Test utilizing approved test equipment to certify proof of performance.
  4. Verify that total system meets the requirements of this section.
  5. Include expected duration of test time, with notification of the acceptance test.
- E. Verification Tests:
1. Test UTP STP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has an overall shield. Test cables after termination and prior to cross-connection.
  2. Multi-mode Fiber Optic Cable: Perform end-to-end attenuation tests in accordance with TIA-568-B.3 and TIA-526-14A using Method A, Optical Power Meter and Light Source and Method B, OTDR . Perform verification acceptance test.
  3. Single mode Fiber Optic Cable: Perform end-to-end attenuation tests in accordance with TIA-568-B.3 and TIA-526-7 using Method A, Optical Power Meter and Light Source and Method B, OTDR . Perform verification acceptance test.
- F. Performance Testing:
1. Perform Category 5E (or on a case by case basis Category 6 6A for specialized powered systems accepted by SMCS 005OP2H3, (202) 461-5310, IT and FMS Services and COR) tests in accordance with TIA-568-B.1 and TIA-568-B.2. Include the following tests - wire map, length, insertion loss, return loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, propagation delay and delay skew.
  2. Fiber Optic Links: Perform end-to-end fiber optic cable link tests in accordance with TIA-568-B.3.
- G. Total System Acceptance Test: Perform verification tests for UTP STP copper cabling systems and multi-mode and single mode fiber optic cabling systems after complete telecommunication distribution system and workstation outlet are installed.

### 3.3 MAINTENANCE

- A. Accomplish the following minimum requirements during one year warranty period:
1. Respond and correct on-site trouble calls, during standard work week:
    - a. A routine trouble call within one working day of its report. A routine trouble is considered a trouble which causes a system outlet, station, or patch cord to be inoperable.
    - b. Standard work week is considered 8:00 A.M. to 5:00 P.M., Monday through Friday exclusive of Federal holidays.
  2. Respond to an emergency trouble call within six hours of its report. An emergency trouble is considered a trouble which causes a subsystem or distribution point to be inoperable at any time.
  3. Respond on-site to a catastrophic trouble call within four hours of its report. A catastrophic trouble call is considered total system failure.
    - a. If a system failure cannot be corrected within four hours (exclusive of standard work time limits), provide alternate equipment, or cables within four hours after four hour trouble shooting time.
    - b. Routine or emergency trouble calls in critical emergency health care facilities (i.e., cardiac arrest, intensive care units, etc.) are also be deemed as a catastrophic trouble.
  4. Provide COR written report itemizing each deficiency found and the corrective action performed during each official reported trouble call. Provide COR with sample copies of reports for review and approval at beginning of total system acceptance test.

--- E N D ---

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

**PART 1 - GENERAL**

**1.1 SECTION SUMMARY**

- A. Work covered by this document includes design, engineering, labor, material and products, equipment warranty and system warranty, training and services for, and incidental to, the complete installation of new and fully operating National Fire Protection Association (NFPA) – Life Safety Code 101.3-2 (a) Labeled and (b) Listed, Emergency Service Nurse-Call and/or Life Safety listed Code Blue Communication System and associated equipment (here-in-after referred to as the System) provided in approved locations indicated on the contract drawings. These items shall be tested and certified capable of receiving, distributing, interconnecting and supporting Nurse-Call and/or Code Blue communications signals generated local and remotely as detailed herein.
- B. Work shall be complete, Occupational Safety and Health Administration (OSHA), National Recognized Testing Laboratory (NRTL – i.e. Underwriters Laboratory [UL]) Listed and Labeled; and VA Central Office (VACO), Telecommunications Voice Engineering (TVE 005OP3B) tested, certified and ready for operation.
- C. The System shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be designed, engineered and installed for ease of operation, maintenance, and testing.
- D. The term “provide”, as used herein, shall be defined as: designed, engineered, furnished, installed, certified, tested, and warranty by the Contractor.
- E. Specification Order of Precedence: In the event of a conflict between the text of this document and the Project’s Contract Drawings outlined and/or cited herein; **THE TEXT OF THIS DOCUMENT TAKES PRECEDENCE. HOWEVER, NOTHING IN THIS DOCUMENT WILL SUPERSEDE APPLICABLE EMERGENCY LAWS AND REGULATIONS, SPECIFICALLY NATIONAL AND/OR LOCAL LIFE AND PUBLIC SAFETY CODES.** The Local Fire Marshall and/or VA Public Safety Officer are the only authorities that may modify this document’s

EMERGENCY CODE COMPLIANCE REQUIREMENTS, on a case by case basis, in writing and confirmed by VA's Project Manager (PM), Resident Engineer (RE) and TVE-005OP3B.

The VA PM is the only approving authority for other amendments to this document that may be granted, on a case by case basis, in writing with technical concurrences by VA's PM, RE, TVE-005OP3B and identified Facility Project Personnel.

- F. The Original Equipment Manufacturer (OEM) and Contractor shall ensure that all management, sales, engineering and installation personnel have read and understand the requirements of this specification before the system is designed, engineered, delivered and provided. The Contractor shall furnish a written statement stating this requirement as a part of the technical submittal that includes each name and certification, including the OEMs. The Contractor is cautioned to obtain in writing, all approvals for system changes relating to the published contract specifications and drawings, from the PM and/or the RE before proceeding with the change.

## **1.2 RELATED SECTIONS**

- A. 01 33 23 – Shop Drawings, Product Data and Samples.
- B. 07 84 00 – Firestopping.
- C. 26 05 21 – Low – Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- D. 26 41 00 – Facility Lightning Protection.
- E. 27 05 11 – Requirements for Communications Installations.
- F. 27 05 26 – Grounding and Bonding for Communications Systems.
- G. 27 05 33 – Raceways and Boxes for Communications Systems.
- H. 27 10 00 – CONTROL, COMMUNICATION AND SIGNAL WIRING.
- I. 27 11 00 – TIP Communications Interface and Equipment Rooms Fittings.
- J. 27 15 00 – TIP Communications Horizontal and Vertical Cabling.

## **1.3 DEFINITION**

- A. Provide: Design, engineer, furnish, install, connect complete, test, certify and warranty.
- B. Work: Materials furnished and completely installed.
- C. Review of contract drawings: A service by the engineer to reduce the possibility of materials being ordered which do not comply with contract documents. The engineer's

review shall not relieve the Contractor of responsibility for dimensions or compliance with the contract documents. The reviewer's failure to detect an error does not constitute permission for the Contractor to proceed in error.

- D. Headquarters (aka VACO) Technical Review, for National and VA Communications and Security, Codes, Frequency Licensing Standards, Guidelines and Compliance:

Office of Telecommunications

Special Communications Team (07A2)

202-461-5301, 202-461-5311

- E. Engineer:

- F. Owner:

- G. General Contractor (GC):

- H. Contractor: Systems Contractor; you; successful bidder.

#### **1.4 REFERENCES**

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

1. United States Federal Law:

- a. Departments of:

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

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



- b) Chapter XXIII, National Telecommunications and Information Administration (NTIA – aka ‘Red Book’) Chapter 7.8 / 9; CFR, Title 47 Federal communications Commission (FCC) Part 15, Radio Frequency Restriction of Use and Compliance in “Safety of Life” Functions & Locations.
- 2) FCC - Communications Act of 1934, as amended, CFR, Title 47 – Telecommunications, in addition to Part 15 – Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/ Locations (also see CFR, Title 15 – Department of Commerce, Chapter XXIII – NTIA):
  - a) Part 15 – Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/Locations.
  - b) Part 58 – Television Broadcast Service.
  - c) Part 90 – Rules and Regulations, Appendix C.
- 3) Health, (Public Law 96-88), CFR, Title 42, Chapter IV Health & Human Services, CFR, Title 46, Subpart 1395(a)(b) JCAHO “a hospital that meets JCAHO accreditation is deemed to meet the Medicare conditions of Participation by meeting Federal Directives:”
  - a) All guidelines for Life, Personal and Public Safety; and, Essential and Emergency Communications.
- 4) Labor, CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standard:
  - a) Subpart 7 - Definition and requirements (for a NRTL – 15 Laboratory’s, for complete list, contact [http://www.osha.gov/dts/otpca/nrtl/faq\\_nrtl.html](http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.html)):
    - 1) UL:
      - a) 44-02 – Standard for Thermoset-Insulated Wires and Cables.

- b) 65 – Standard for Wired Cabinets.
- c) 83-03 – Standard for Thermoplastic-Insulated Wires and Cables.
- d) 467-01 – Standard for Electrical Grounding and Bonding Equipment
- e) 468 – Standard for Grounding and Bonding Equipment.
- f) 486A-01 – Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors
- g) 486C-02 – Standard for Splicing Wire Connectors.
- h) 486D-02 – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
- i) 486E-00 – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
- j) 493-01 – Standard for Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable.
- k) 514B-02 – Standard for Fittings for Cable and Conduit.
- l) 1069 – Hospital Signaling and Nurse Call Equipment.
- m) 1449 – Standard for Transient Voltage Surge Suppressors.
- n) 1479-03 – Standard for Fire Tests of Through-Penetration Fire Stops.
- o) 1666 – Standard for Wire/Cable Vertical (Riser) Tray Flame Tests.
- p) 1863 – Standard for Safety, Communications Circuits Accessories.
- q) 2024 – Standard for Optical Fiber Raceways.

- r) 60950-1/2 – Information Technology Equipment – Safety.
- 2) Canadian Standards Association (CSA): same tests as for UL.
- 3) Communications Certifications Laboratory (CCL): same tests as for UL.
- 4) Intertek Testing Services NA, Inc. (ITSNA formerly Edison Testing Laboratory [ETL]): same tests as for UL.
- b) Subpart 35 – Compliance with NFPA 101 – Life Safety Code.
- c) Subpart 36 - Design and construction requirements for exit routes.
- d) Subpart 268 - Telecommunications.
- e) Subpart 305 - Wiring methods, components, and equipment for general use.
- 5) Department of Transportation, CFR, Title 49 (Public Law 89-670), Part 1, Subpart C – Federal Aviation Administration (FAA):
  - a) Standards AC 110/460-ID & AC 707 / 460-2E – Advisory Circulars for Construction of Antenna Towers.
  - b) Forms 7450 and 7460-2 – Antenna Construction Registration.
- 6) Veterans Affairs (Public Law No. 100-527), CFR, Title 38, Volumes I & II:
  - a) Office of Telecommunications:
    - 1) Handbook 6100 – Telecommunications.
      - a) Spectrum Management FCC & NTIA Radio Frequency Compliance and Licensing Program.
      - b) Special Communications Proof of Performance Testing, VACO Compliance and Life Safety Certification(s).
  - b) Office of Cyber and Information Security (OCIS):
    - 1) Handbook 6500 - Information Security Program.
    - 2) Wireless and Handheld Device Security Guideline Version

3.2, August 15, 2005.

- c) VA's National Center for Patient Safety – Veterans Health Administration  
Warning System, Failure of Medical Alarm Systems using Paging  
Technology to Notify Clinical Staff, July 2004.
- d) VA's Center for Engineering Occupational Safety and Health, concurrence  
with warning identified in VA Directive 7700.
- e) Office of Construction and Facilities Management (CFM):
  - 1) Master Construction Specifications (PG-18-1).
  - 2) Standard Detail and CAD Standards (PG-18-4).
  - 3) Equipment Guide List (PG-18-5).
  - 4) Electrical Design Manual for VA Facilities (PG 18-10),  
Articles 7 & 8.
  - 5) Minimum Requirements of A/E Submissions (PG 18-15):
    - a) Volume B, Major New Facilities, Major Additions; and  
Major Renovations, Article VI, Paragraph B.
    - b) Volume C - Minor and NRM Projects, Article III,  
Paragraph S.
    - c) Volume E - Request for Proposals Design/Build  
Projects, Article II, Paragraph F.
  - 6) Mission Critical Facilities Design Manual (Final Draft –  
2007).
  - 7) Life Safety Protected Design Manual (Final Draft –  
2007).
  - 8) Solicitation for Offerors (SFO) for Lease Based Clinics  
– (05-2009).
- b. Federal Specifications (Fed. Specs.):
  - 1) A-A-59544-00 - Cable and Wire, Electrical (Power, Fixed Installation).
- 2. National Codes:

- a. American Institute of Architects (AIA): Guidelines for Healthcare Facilities.
- b. American National Standards Institute/Electronic Industries Association/Telecommunications Industry Association (ANSI/EIA/TIA):
  - 1) 568-B - Commercial Building Telecommunications Wiring Standards:
    - a) B-1 – General Requirements.
    - b) B-2 – Balanced twisted-pair cable systems.
    - c) B-3 - Fiber optic cable systems.
  - 2) 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
  - 3) 606 – Administration Standard for the Telecommunications Infrastructure of Communications Buildings.
  - 4) 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.
  - 5) REC 127-49 – Power Supplies.
  - 6) RS 270 – Tools, Crimping, Solderless Wiring Devices, Recommended Procedures for User Certification.
- c. American Society of Mechanical Engineers (ASME):
  - 1) Standard 17.4 – Guide for Emergency Personnel.
  - 2) Standard 17.5 – Elevator & Escalator Equipment (prohibition of installing non-elevator equipment in Elevator Equipment Room / Mechanical Penthouse).
- d. American Society of Testing Material (ASTM):
  - 1) D2301-04 - Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape.
- e. Building Industries Communications Services Installation (BICSI):
  - 1) All standards for smart building wiring, connections and devices for commercial and medical facilities.
  - 2) Structured Building Cable Topologies.
  - 3) In consort with ANSI/EIA/TIA.

- f. Institute of Electrical and Electronics Engineers (IEEE):
  - 1) SO/TR 21730:2007 - Use of mobile wireless communication and computing technology in healthcare facilities - Recommendations for electromagnetic compatibility (management of unintentional electromagnetic interference) with medical devices.
  - 2) 0739-5175/08/©2008 IEEE – Medical Grade – Mission Critical – Wireless Networks.
  - 3) C62.41 – Surge Voltages in Low-Voltage AC Power Circuits.
- g. NFPA:
  - 1) 70 - National Electrical Code (current date of issue) – Articles 517, 645 & 800.
  - 2) 75 - Standard for Protection of Electronic Computer Data-Processing Equipment.
  - 3) 77 – Recommended Practice on Static Electricity.
  - 4) 99 - Healthcare Facilities.
  - 5) 101 - Life Safety Code.
- 3. State Hospital Code(s).
- 4. Local Town, City and/or County Codes.
- 5. Accreditation Organization(s):
  - a. Joint Commission on Accreditation of Hospitals Organization (JCAHO) – Section VI, Part 3a – Operating Features.

## **1.5 QUALIFICATIONS**

- A. The OEM shall have had experience with three (3) or more installations of Nurse Call systems of comparable size and interfacing complexity with regards to type and design as specified herein. Each of these installations shall have performed satisfactorily for at least one (1) year after final acceptance by the user. Include the names, locations and point of contact for these installations as a part of the submittal.
- B. The Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The Contractor shall be authorized by the OEM to pass thru the OEM's warranty of the

installed equipment to VA. In addition, the OEM and Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certifications must be provided in writing as part of the Contractor's Technical submittal.

- C. The Contractor's Communications Technicians assigned to the System shall be fully trained, qualified, and certified by the OEM on the engineering, installation, operation, and testing of the System. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the RE before being allowed to commence work on the System.
- D. The Contractor shall display all applicable national, state and local licenses.
- E. The Contractor shall submit copy (s) of Certificate of successful completion of OEM's installation/training school for installing technicians of the System's Nurse Call and/or Code Blue equipment being proposed.

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

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

#### **1.7 SCHEDULING**

- A. After the award of contract, the Contractor shall prepare a detailed schedule (aka milestone chart) using "Microsoft Project" software or equivalent. The Contractor Project Schedule (CPS) shall indicate detailed activities for the projected life of the project. The CPS shall consist of detailed activities and their restraining relationships. It will also detail manpower usage throughout the project.
- B. It is the responsibility of the Contractor to coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified. The owner will not be liable for any additional costs due to missed dates or poor coordination of the supplying contractor with other trades.

## **1.8 REVIEW OF CONTRACT DRAWINGS AND EQUIPMENT DATA SUBMITTALS (AKA TECHNICAL SUBMITTAL[S])**

(Note: The Contractor is encouraged, but not required, to submit separate technical submittal(s) outlining alternate technical approach(s) to the system requirements stated here-in as long as each alternate technical document(s) is complete, separate, and submitted in precisely the same manner as outlined herein. VA will review and rate each received alternate submittal, which follows this requirement, in exactly the same procedure as outlined herein. Partial, add-on, or addenda type alternates will not be accepted or reviewed.)

- A. Submit at one time within 10 days of contract awarding, drawings and product data on all proposed equipment and system. Check for compliance with contract documents and certify compliance with Contractor's "APPROVED" stamp and signature.
- B. Support all submittals with descriptive materials, i.e., catalog sheets, product data sheets, diagrams, and charts published by the manufacturer. These materials shall show conformance to specification and drawing requirements.
- C. Where multiple products are listed on a single cut-sheet, circle or highlight the one that you propose to use. Provide a complete and thorough equipment list of equipment expected to be installed in the system, with spares, as a part of the submittal. Special Communications (TVE-005OP3B) will not review any submittal that does not have this list.
- D. Provide four (4) copies to the PM for technical review. The PM will provide a copy to the offices identified in Paragraph 1.3.C & D, at a minimum for compliance review as described herein where each responsible individual(s) shall respond to the PM within 10 days of receipt of their acceptance or rejection of the submittal(s).
- E. Provide interconnection methods, conduit (where not already installed), junction boxes (J-Boxes), cable, interface fixtures and equipment lists for the: ENR(s) ( aka DMARC), TER, TCR, MCR, MCOR, PCR, ECR, Stacked Telecommunications Rooms (STR), Nurses Stations (NS), Head End Room (HER), Head End Cabinet (HEC), Head End Interface Cabinet (HEIC) and approved TCO locations TIP interface distribution layout drawing, as



they are to be installed and interconnected to teach other (REFER TO APPENDIX B – SUGGESTED TELECOMMUNICATIONS ONE LINE TOPOLOGY pull-out drawing).

- F. Equipment technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.
- G. Engineering drawings of the System, showing calculated of expected signal levels at the headend input and output, each input and output distribution point, and signal level at each telecommunications outlet.
- H. Surveys Required as a Part of The Technical Submittal:
  - 1. The Contractor shall provide the following System surveys that depict various system features and capacities required in addition to the on-site survey requirements described herein (*see Specification Paragraph 2.4.3*). Each survey shall be in writing and contain the following information (the formats are suggestions and may be used for the initial Technical Submittal Survey requirements), as a minimum:
    - a. Nurse Call Cable System Design Plan:
      - 1) An OEM and contractor designed functioning Nurse Call System cable plan **to populate the entire TIP empty conduit/pathway distribution systems provided as a part of Specification 27 11 00** shall be provided as a part of the technical proposal. A specific functioning Nurse Call: cable, interfaces, J-boxes and back boxes shall coincide with the total growth items as described herein. It is the Contractor's responsibility to provide the Systems' entire Nurse Call cable and accessory requirements and engineer a functioning Nurse Call distribution system and equipment requirement plan of the following paragraph(s), at a minimum:
      - 2) The required Nurse Call and/or Code Blue Equipment Locations:

<u>EQUIPPED ITEM</u>	<u>CAPACITY</u>	<u>GROWTH</u>
Master Stations		
Dome Lights		
Room		

<u>EQUIPPED ITEM</u>	<u>CAPACITY</u>	<u>GROWTH</u>
Corridor		
Other		
Patient Stations		
Single		
Dual		
Isolation		
Other		
Emergency Stations		
Bath		
Toilet		
Isolation		
Other		
Staff Stations		
Duty Stations		
Code Blue		
Patient Locations		
Surgical Recovery Locations		
Medical Recovery Locations		
ICU Locations		
SICU		
MICU		
CCU		
Other		
Emergency Room Locations		
Other		
Supervisory Locations		
Nurse Stations		
On-Call Rooms		

<u>EQUIPPED ITEM</u>	<u>CAPACITY</u>	<u>GROWTH</u>
Other		
Remote Locations		
Telephone Operator's Room		
Police Control Room		
Other		
Radio Paging Access <b>(when pre-approved by TVE-005OP3B)</b>		
Audio Paging Access <b>(when pre-approved by TVE-005OP3B)</b>		
Wireless Access <b>(when pre-approved by TVE-005OP3B)</b>		
Maintenance/Programming Console		
Location(s)		
Central Control Cabinet/Equipment		
Location		
Power Supply(s)		
UPS(s)		

3) The required Nurse Call and/or Code Blue Cable Plant/Connections:

The Contractor shall clearly and fully indicate this category for each item identified herein as a part of the technical submittal. For this purpose, the following definitions and sample connections are provided to detail the system's capability:

<u>EQUIPPED ITEM</u>	<u>CAPACITY</u>	<u>GROWTH</u>
Central Control Cabinet/Equipment		
Location		
Power Supply(s)		
UPS(s)		
Essential Electrical Power Panel(s)		
Other		

<u><b>EQUIPPED ITEM</b></u>	<u><b>CAPACITY</b></u>	<u><b>GROWTH</b></u>
Cable Plant		
Supply to Locations Identified in Paragraph 1.8.H.1.a.2)		
Remote Locations		
Telephone Operator Room		
Police Control Room		
Other		
Maintenance/Program Console		
Location(s)		
Other		
LAN (Local Facility) Access/Equipment/Location <b>(when pre-approved by TVE-005OP3B)</b>		
Wireless Access/Equipment/Location <b>(when pre-approved by TVE-005OP3B)</b>		
PA Access/Equipment/Location <b>(when pre-approved by TVE-005OP3B)</b>		
Other		

## 1.9 PROJECT RECORD DOCUMENTS (AS BUILTS)

- A. Throughout progress of the Work, maintain an accurate record of changes in Contract Documents. Upon completion of Work, transfer recorded changes to a set of Project Record Documents.
- B. The floorplans shall be marked in pen to include the following:
  1. Each device specific locations with UL labels affixed.
  2. Conduit locations.
  3. Each interface and equipment specific location.
  4. Head-end equipment and specific location.
  5. Wiring diagram.
  6. Labeling and administration documentation.

- 7. Warranty certificate.
- 8. System test results.

#### **1.10 WARRANTIES / GUARANTY**

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

#### **1.11 USE OF THE SITE**

- A. Use of the site shall be at the GC's direction.
- B. Coordinate with the GC for lay-down areas for product storage and administration areas.
- C. Coordinate work with the GC and their sub-contractors.
- D. Access to buildings wherein the work is performed shall be directed by the GC.

#### **1.12 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft.
- B. Store products in original containers.
- C. Coordinate with the GC for product storage. There may be little or no storage space available on site. Plan to potentially store materials off site.
- D. Do not install damaged products. Remove damaged products from the site and replaced with new product at no cost to the Owner.

#### **1.13 PROJECT CLOSE-OUT**

- A. Prior to final inspection and acceptance of the work, remove all debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from the project site and thoroughly clean your work area.
- B. Before the project closeout date, the Contractor shall submit:

1. OEM Equipment Warranty Certificates.
  2. Evidence of compliance with requirements of governing authorities such as the Low Voltage Certificate of Inspection.
  3. Project record documents.
  4. Instruction manuals and software that is a part of the system.
  5. System Guaranty Certificate.
- C. Contractor shall submit written notice that:
1. Contract Documents have been reviewed.
  2. Project has been inspected for compliance with contract.
  3. Work has been completed in accordance with the contract.

## **PART 2 – PRODUCTS / FUNCTIONAL REQUIREMENTS**

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

- A. Furnish and install a complete and fully functional and operable Nurse Call System for each location shown on the contract drawings and TCOs **WHOSE EMPTY CONDUIT SYSTEM WAS PROVIDED AS A PART OF SPECIFICATION 27 11 00.**
- B. The specific location for each Nurse Call: Central Control Cabinet is OIT Server 171, Power Supply is OIT Server 171, Electrical Supervisor Panel is Electrical Room 170. Reference plans for additional detail.
- C. Coordinate features and select interface components to form an integrated Nurse Call system. Match components and interconnections between the systems for optimum performance of specified functions.
- D. Expansion Capability: The Nurse Call equipment interfaces and cables shall be able to increase number of enunciation points in the future by a minimum of 50 percent (%) above those indicated without adding any internal or external components or main trunk cable conductors.
- E. Equipment: Active electronic type shall use solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied between 110 to 130 VAC, 60 Hz supplied from the Facility's Emergency Electrical Power System.

- F. Meet all FCC requirements regarding equipment listing, low radiation and/or interference of RF signal(s). The system shall be designed to prevent direct pickup of signals from within and outside the building structure.
- G. Weather/Water Proof Equipment: Listed and labeled by an OSHA certified NRTL (i.e. UL) for duty outdoors or in damp locations.

## 2.1 SYSTEM DESCRIPTION

- A. Furnish and install a complete and fully functional and operable Nurse Call and/or Code Blue System **WHOSE EMPTY CONDUIT SYSTEM WAS PROVIDED AS A PART OF SPECIFICATION 27 11 00.**
- B. **The Contractor is responsible for interfacing the nurse call systems with the System.**
- C. The Contractor shall continually employ interfacing methods that are approved by the OEM and VA. At a minimum, an acceptable interfacing method requires not only a physical and mechanical connection, but also a matching of signal, voltage, and processing levels with regard to signal quality and impedance. The interface point must adhere to all standards described herein for the full separation of Critical Care and Life Safety systems.
- D. The System Contractor shall connect the System ensuring that all NFPA and UL Critical Care and Life Safety Circuit and System separation guidelines are satisfied. The System Contractor is not allowed to make any connections to the Telephone System. VA shall arrange for the interconnection between the nurse call Systems with the appropriate responsible parties.
- E. System hardware shall consist of a **standalone (separate)** nurse call patient communications network comprised of nurse consoles, control stations, staff and duty stations, room and corridor dome lights, pillow speakers/call cords, pull cord and/or emergency push button stations, wiring. And, other options such as, **pocket page interfaces**, computer interfaces, printer interfaces, wireless / telephone network interfaces, and nurse locating system interface **(when specifically approved first by TVE 005OP3B)** and as shown on drawings. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications,

shall be supplied and installed to provide a complete and operating nurse call patient communications network.

- F. System firmware shall be the product of a reputable firmware OEM of record with a proven history of product reliability and sole control over all source code. Manufacturer shall provide, free of charge, product firmware/software upgrades for a period of two (2) years from date of acceptance by VA for any product feature enhancements. System configuration programming changes shall not require any exchange of parts and shall be capable of being executed remotely via a modem connection **(when specifically approved first by TVE 005OP3B).**
- G. The Nurse Call Head End Equipment shall be located in Telecommunications Room [171](#).
- H. The System shall utilize microprocessor components for all signaling and programming circuits and functions. Self contained or on board system program memory shall be non-volatile and protected from erasure from power outages for a minimum of 12 hours.
- I. Provide a backup battery or a UPS for the System (including each distribution cabinet/point, CRT and Monitor) to allow normal operation and function (as if there was no AC power failure) in the event of an AC power failure or during input power fluctuations for a minimum of 30 minutes.
- J. The System is defined as Critical Service and the Code Blue functions is defined as Life Safety/Support by NFPA (re Part 1.1.A) and so evaluated by JCAHCO. **Therefore, the system shall have a minimum of two (2) additional remote enunciation points in order to satisfy NFPA's Life Safety Code 101 (the typical secondary locations are Telephone Operators Room, MAS ER Desk, Boiler Plant, etc; AND the primary location is required to be in the SCC Room.**
  - 1. These two (2) additional remote locations shall be fully manned:
    - a. 24/7/365 for certified Hospital.
    - b. As long as other identified VA Medical / Servicing Facilities are open for servicing patients.



- c. At a minimum, Code Blue Functions shall be provided in all Recovery (Medical and Surgical) Rooms, Intensive Care Units (ICU), Cardiac Care Units (CCU), Step Down Room, Life Support / Monitoring Rooms, Oncology / Radiology Procedure Rooms, Dialysis Areas.
  - d. The minimum remote enunciation locations shall be:
    - 1) The Telephone / PBX Operator Room.
    - 2) The Police Control / Operations Room.
    - 3) Other location(s) that is specifically approved by VA Headquarters TVE - 005OP3B DURING THE PROJECT DEVELOPMENT STAGES AND PRIOR TO EQUIPMENT PURCHASE.
- 2. In addition to the two (2) remote locations afore described, the following locations are the minimum required for additional Nurse Call /Code Blue Annunciation:
  - a. "On Call" Rooms.
  - b. Each Nurse Master Station.
  - c. Each Staff Station.
  - d. Each Duty Station.
- 3. The MAXIMUM enunciation time period from placement of the Code Blue Call to enunciation at each remote locations is 10 seconds; and, 15 seconds to the subsequent enunciating media stations (i.e. PA, Radio Paging, Emergency Telephone or Radio Backup, etc.).
- K. Each Code Blue System shall be designed to provide continuous electrical supervision of the complete and entire system (i.e. dome light bulbs [each light will be considered supervised if they use any one or a combination of (UL) approved electrical supervision alternates, as identified in UL-1069, 1992 revision], wires, contact switch connections, circuit boards, data, audio, and communication busses, main and UPS power, etc.). All alarm initiating and signaling circuits shall be supervised for open circuits, short circuits, and system grounds. Main and UPS power circuits shall be supervised for a change in state (i.e. primary to backup, low battery, UPS on line, etc.). When an open, short or

ground occurs in any system circuit, an audible and visual fault alarm signal shall be initiated at the nurse control station and all remote locations.

- L. When the System is approved to connect to a separate communications system (i.e. LAN, WAN, Telephone, Public Address, radio paging, wireless systems, etc) the connection point shall meet the following minimum requirements for each hard wired / wireless connection (note each wireless system connection MUST BE APPROVED PRIOR TO CONTRACT BID BY VA HEADQUARTERS TVE - 005OP3B AND SPECTRUM MANAGEMENT - 005OP2B – hereinafter referred to as SM - 005OP2B):
  - 1. UL 60950-1/2.
  - 2. FIPS 142.
  - 3. FCC Part 15 Listed Radio Equipment restriction compliance approved by SM – 005OP2B.
- M. All passive distribution equipment shall meet or exceed -80 dB radiation shielding (aka RFI) shielding specifications and be provided with connectors specified by the OEM.
- N. All equipment face plates utilized in the system shall be stainless steel, anodized aluminum or UL approved cyclac plastic for the areas where provided.
- O. Noise filters and surge protectors shall be provided for each equipment interface cabinet, headend cabinet, control console and local and remote amplifier locations to insure protection from input primary AC power surges and to insure noise glitches are not induced into low voltage data circuits.
- P. Plug-in connectors shall be provided to connect all equipment, except coaxial cables. Coaxial cable distribution points shall use coaxial cable connections recommended by the cable OEM and approved by the system OEM. Base band cable systems shall utilize barrier terminal screw type connectors, at a minimum. As an alternate, crimp type connectors installed with a ratchet type installation tool are acceptable provided the cable dress, pairs, shielding, grounding, connections and labeling are the same as the barrier terminal strip connectors. Tape of any type, wire nuts or solder type connections are unacceptable and will not be approved.

- R. Audio Level Processing: The control equipment shall consist of audio mixer(s), volume limiter(s) and/or compressor(s), and power amplifier(s) to process, adjust, equalize, isolate, filter, and amplify each audio channel for each sub-zone in the system and distribute them into the System's RF interfacing distribution trunks and amplification circuits. It is acceptable to use identified Telephone System cable pairs designated for Two-Way Radio interface and control use or identified as spare telephone cable pairs by the Facility's Telephone System Contractor. The use of telephone cable to distribute RF signals, carrying system or sub-system AC or DC voltage is not acceptable and will not be approved. Additionally, each control location shall be provided with the equipment required to insure the system can produce its designed audio channel capacity at each speaker identified on the contract drawings. The Contractor shall provide: a spare set of telephone paging modules as recommended by the OEM (as a minimum provide one spare module for each installed module); one spare audio power amplifier, one spare audio mixer, one spare audio volume limiter and/or compressor, and one spare audio automatic gain adjusting device, and minimum RF equipment recommended by the OEM.
- S. Contractor is responsible for pricing all accessories and miscellaneous equipment required to form a complete and operating system. Unless otherwise noted in this Part, equipment quantities shall be as indicated on the drawings.
- R. System Performance:
1. At a minimum, each distribution, interconnection, interface, terminating point and TCO shall be capable of supporting the Facility's Nurse Call and/or Code Blue System voice and data service as follows:
    - a. Shall be compliant with and not degrade the operating parameters of the Public Switched Telephone Network (PSTN) and the Federal Telecommunications System (FTS) at each PSTN and FTS interface (if attachment is permitted by TVE 005OP3B), interconnection and TCO terminating locations detailed on the contract drawings.

- b. The System shall provide the following minimum operational functions:
  - 1) Code Blue calls shall be cancelable at the calling station only. The nurse call master station (s) that a managing Code Blue functions shall not have the ability to cancel Code Blue calls.
  - 2) Each Code Blue system shall be able to receive audio calls from all bedside stations simultaneously.
  - 3) Calls placed from any Code Blue station shall generate Code Blue emergency type audible and visual signals at each associated nurse control and duty station, respective dome lights and all local and remote annunciator panels. Calls placed from a bedside station shall generate emergency type visual signals at the bedside station and associated dome light(s) in addition to the previous stated stations and panels.
  - 4) Activating the silencing device at any location, while a Code Blue call or system fault is occurring shall mute the audible signals at the alarm location.
    - a) The audible alarm shall regenerate at the end of the selected time-out period until the call or fault is corrected.
    - b) The visual signals shall continue until the call is canceled and/or a fault is corrected. When the fault is corrected, all signals generated by the fault shall automatically cease, returning the System to a standby status.
    - c) Audible signals shall be regenerated in any local or remote annunciator panel that is in the silence mode, in the event an additional Code Blue call is placed in any Code Blue system.
    - d) The additional Code Blue call shall also generate visual signals at all annunciators to identify the location of the call.
- 2. Each System Nurse Call location shall generate a minimum of distinct calls:
  - a. Routine: single flashing dome lights & master station color and audio tone,
  - b. Staff Assist: rapid flashing dome lights & master station color and audio tone,
  - c. Emergency: Red flashing dome lights & master station color and audio tone,

- d. Code Blue (if equipped): Blue flashing dome lights and master station color and audio tone,
- e. Each generated call shall be cancelable at ONLY the originating location,
- f. Staff Locator: Green Flashing dome lights & master station color and audio tone, and

## **2.3 MANUFACTURERS**

- A. The products specified shall be new, FCC and UL Listed, labeled and produced by OEM manufacturer of record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
  - 1. Maintains a stock of replacement parts for the item submitted,
  - 2. Maintains engineering drawings, specifications, and operating manuals for the items submitted, and
  - 3. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid.
- B. Specifications contained herein as set forth in this document detail the salient operating and performance characteristics of equipment in order for VA to distinguish acceptable items of equipment from unacceptable items of equipment. When an item of equipment is offered or furnished for which there is a specification contained herein, the item of equipment offered or furnished shall meet or exceed the specification for that item of equipment.
- C. Equipment Standards and Testing:
  - 1. The System has been defined herein as connected to systems identified as Critical Service performing various Emergency and Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.
  - 2. All supplies and materials shall be listed, labeled or certified by UL or a NRTL where such standards have been established for the supplies, materials or equipment.

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

## 2.4 PRODUCTS

### A. General.

1. Contractor is responsible for pricing all accessories and miscellaneous equipment required to form a complete and operating system. The equipment quantities provided herein shall be as indicated on the drawings with the exception of the indicated spare equipment.
2. Contractor Furnished Equipment List (CFEs):
  - a. The Contractor is required to provide a list of the CFE equipment to be furnished. The quantity, make and model number of each item is required. Select the required equipment items quantities that will satisfy the needs of the system as described herein and with the OEM's concurrence applied to the list(s), in writing.

<u>Item</u>	<u>Quantity</u>	<u>Unit</u>
1.	//As required//	Interface Panel(s)
1.a	//As required//	Electrical Supervision Trouble Enunciator
1.a.1	//As required//	Equipment Back Box(s)
1.b	//As required//	Telephone
1.c	//As required//	Public Address

1.d	//As required//	Radio Paging / Equipment
1.e	//As required//	Wireless / Equipment
1.f.	//As required//	Radio Pager / Equipment
1.g	//As required//	Wireless / Equipment
1.f	//As required//	Personal Communicator / Equipment
2.	//As required//	Lightning Arrestor
3.	//As required//	Head End Equipment/Locations
3.a	//As required//	Cabinet(s)
3.a.1	//As required//	AC Power Conditioner & Filter
3.a.2	//As required//	AC Power Strip
3.a.3	//As required//	UPS
3.a.4	//As required//	Interconnecting Wire/Cables
3.a.5	//As required//	Wire / Cable Connector(s)
3.a.6	//As required//	Wire / Cable Terminator(s)
3.b	//As required//	Wire Management System
3.b	//As required//	Head End Function(s)
3.b.1	//As required//	H7 Interface
3.b.2	//As required//	Nurse Locator
3.b.3	//As required//	Staff Locator
4.	//As required//	Master Station(s)
4.a	//As required//	Nurse Locator
4.b	//As required//	Staff Locator
5.	//As required//	Distribution System(s)
5.a	//As required//	Staff Station
5.a.1	//As required//	Equipment Back Box(s)
5.b	//As required//	Duty Station
5.b.1	//As required//	Equipment Back Box(s)
5.c	//As required//	Code Blue Station
5.c.1	//As required//	Equipment Back Box(s)
5.c.2	2 (MIN)	Remote Station(s)
5.d	//As required//	Patient Station(s)
5.d.1	//As required//	Equipment Back Box(s)
5.d.2	//As required//	Bed Interface(s)
5.d.3	//As required//	Pillow Speaker
5.d.4	//As required//	Push Button Cordset
5.d.5	//As required//	Dummy Plugs
5.d.6	//As required//	Bed Integrated Control
5.d.7	//As required//	Lighting Interface Module
5.d.8	//As required//	TV Control Interface
5.d.9	//As required//	TV Control Jack
5.d.10	//As required//	TV Interconnection Cables

5.d.11	//As required//	HDTV Coaxial
5.d.12	//As required//	HDTV/Nurses Call Interface/ Control
5.d.13	//As required//	Auxiliary Mounting Interface
5.e	//As required//	Emergency Station(s)
5.e.1	//As required//	Equipment Back Box(s)
5.e.2	//As required//	Toilet Emergency Station (waterproof)
5.e.3	//As required//	Shower Emergency Station (waterproof)
5.e.4	//As required//	Lavatory Emergency Station (waterproof)
5.f.	//As required//	Room Dome Light
5.f.1	//As required//	Equipment Back Box(s)
5.g	//As required//	Other Dome Light(s)
5.g.1	//As required//	Equipment Back Box(s)
5.g.2	//As required//	Corridor Dome Light
5.g.3	//As required//	Intersectional Dome Light
5.h	//As required//	System Cable(s)
5.h.1	//As required//	Coaxial
5.h.2	//As required//	System Pin
5.h.3	//As required//	Audio
5.h.4	//As required//	Control
5.h.5	//As required//	Video
5.i	//As required//	System Connector(s)
5.i.1	//As required//	Coaxial
5.i.2	//As required//	System Pin
5.i.2	//As required//	Audio
5.i.3	//As required//	Control
5.i.4	//As required//	Video
5.j	//As required//	Wire Management Required as described herein
<b>6.</b>	<b>//As required//</b>	<b>Mental Health Unit</b>
<b>6.a</b>	<b>//As required//</b>	<b>Head End Function(s)</b>
<b>6.a.1</b>	<b>//As required//</b>	<b>H7 Interface</b>
<b>6.a.2</b>	<b>//As required//</b>	<b>Nurse Locator</b>
<b>6.a.3</b>	<b>//As required//</b>	<b>Staff Locator</b>
<b>6.b.</b>	<b>//As required//</b>	<b>Master Station(s)</b>
<b>6.b.1</b>	<b>//As required//</b>	<b>Nurse Locator</b>
<b>6.b.2</b>	<b>//As required//</b>	<b>Staff Locator</b>
<b>6.c</b>	<b>//As required//</b>	<b>Distribution System(s)</b>



6.c.1	//As required//	Staff Station
6.c.1.a	//As required//	Equipment Back Box(s)
6.c.2	//As required//	Duty Station
6.c.2.a	//As required//	Equipment Back Box(s)
6.c.3	//As required//	Patient Station(s)
6.c.3.a	//As required//	Equipment Back Box(s)\
6.c.4	//As required//	Security Room(s)
6.c.4.a	//As required//	Security Station(s)
6.c.4.b	//As required//	Equipment Back Box(s)\
6.c.4.c	//As required//	Overhead Speaker/Microphone
6.c.4.d	//As required//	Equipment Back Box(s)\
6.c.4.e	//As required//	TV Surveillance System
6.c.4.f	//As required//	Equipment Back Box(s)\
6.c.4.g	//As required//	TV Interconnection Cables
6.c.4.h	//As required//	Audio Interconnection Cables
6.c.5	//As required//	Emergency Station(s)
6.c.5.a	//As required//	Equipment Back Box(s)
6.c.5.b	//As required//	Toilet Emergency Station (waterproof)
6.c.5.c	//As required//	Shower Emergency Station (waterproof)
6.c.5.d	//As required//	Lavatory Emergency Station (waterproof)
6.c.6	//As required//	Room Dome Light
6.c.7	//As required//	Other Dome Light(s)
6.c.7.a	//As required//	Equipment Back Box(s)
6.c.7.b	//As required//	Corridor Dome Light
6.c.7.c	//As required//	Intersectional Dome Light
6.c.8	//As required//	System Cable(s)
6.c.8.a	//As required//	Coaxial
6.c.8.b	//As required//	System Pin
6.c.8.c	//As required//	Audio
6.c.8.d	//As required//	Control
6.c.8.e	//As required//	Video
6.c.9	//As required//	System Connector(s)
6.c.9.a	//As required//	Coaxial
6.c.9.b	//As required//	System Pin
6.c.9.c	//As required//	Audio
6.c.9.d	//As required//	Control
6.c.9.e	//As required//	Video
6.c.9.f	//As required//	Wire Management Required as described herein//

7. **On Hand Spares**

**Provide a separate system spares list as indicated in each equipment description.**

B. NS Room(s):

Refer to CFM Physical Security Manual (07-2007) for VA Facilities, Chapters 9.3 & 1) and PG 18-10, EDM, Chapters 7- Table 7-1, 8 & Appendix B, Telecommunications One Line Topology for specific Room and TIP Connection Requirements.

C. TER, SCC, PCR, STR, HER Rooms and Equipment:

Refer to CFM Physical Security Manual (07-2007) for VA Facilities, Chapters 9.3 & 1) and PG 18-10, EDM, Chapters 7- Table 7-1, 8 & Appendix B, Telecommunications One Line Topology for specific Room and TIP Connection Requirements.

D. Telecommunications Room(s) (TR):

1. Locate the Nurse Call and/or Code Blue floor distribution equipment as required by system design and OEM direction. Provide secured and lockable cabinet/rack(s) as required.

2. Head-End Equipment:

- a. Provide all required power supplies, communications hubs, network switches, intelligent controllers and other devices necessary to form a complete system. Head-end components may be rack mounted or wall mounted in an enclosed metal enclosure.
- b. Provide the head end equipment in the closest Telecommunications Room where the System is installed.
- c. Provide the System UPS inside the cabinet or in a separate cabinet adjacent to the head end cabinet that shall maintain a minimum of 30 minute battery back-up to all system components.
- d. Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation

channels and control functions. See Paragraph 2.5.E for the Cabinet's minimum internal items that are in addition to the installed System equipment.

- e. Vertical Equipment Rack, Wall Mounted (to be included inside of the Equipment Cabinet) containing the following minimum items:

- 1) 36" (28RU) internal rack space, welded steel construction, minimum 20" usable depth, adjustable front mounting rails.
- 2) Install the following products in rack provided by same manufacturer or as specified:
  - a) Security screws w/ nylon isolation bushings.
  - b) Textured blank panels.
  - c) Custom mounts for components without rack mount kits.
  - d) Security covers.
  - e) Internal system ground copper buss (may be substituted with a bare #0 AWG copper wire or equivalent size copper mesh strip connected to ONLY THE FACILITY'S SIGNAL GROUNDING SYSTEM.
  - f) Power Sequencer- rack-mounted power conditioner and (provide as-needed) delayed sequencer(s) with (2) unswitched outlets each and contact closure control inputs. Connect the conditioner to one of the dual duplex outlets.
  - g) Two (2) each 120VAC @ 20A dual duplex outlets, connected via conduit to the nearest Electrical Service Panel that is supplied by the Facility's Essential Electrical System.
  - h) One (1) each 120VAC @ 15A Power Distribution Strip(s). Connect each strip to the unstitched outlet on the power conditioner.

3. HL7 Interface:

- a. The system may support downloading and updating of patient data from the hospital admission system (or other database) via the HL7 standard. The data

only has to travel one way, i.e. from the admission system to the nurse-call system.

- b. Coordinate with the Owner the exact fields that will be populated from the admissions system in the nurse-call system.
- c. The Facility's LAN/WAN is not allowed for Nurses Call/Code Blue main wiring / function that must be a "stand alone primary cable infrastructure" as described herein.
- d. Connections to the VA LAN/WAN for functional or operable conditions will be allowed ONLY when the LAN/WAN system has been demonstrated and NFPA (at a minimum by TVE-005OP3B) Certified meeting Life Safety Standards.
- e. Provide one (1) spare HL Interface unit.

E. TIP Cable Systems:

**Connect the system to the TIP system provided as a part of Speciation Section 27 15**

**00.** Provide additional TIP equipment, interfaces and connections as required by System design. Provide secured pathway(s) and lockable cabinet/rack(s) as required.

F. Interface Equipment:

- 1. TCR:
- b. Electrical Supervision Trouble Annunciator Panel:
  - 1) The Electrical Supervision Trouble Annunciation Panel shall be located in the Telephone Operators Room, Police Control Center, associate Nurses Station(s) .
  - 2) The panel(s) shall be compatible with the generated electrical and/or electronic supervising signals to continuously monitor the operating condition for the System head-end processing equipment, master stations, staff stations, patient stations, duty stations, audio power amplifier(s), UPS, power supplies, dome lights and interconnecting trunks. The panels shall generate an audible and visual signal when the System's supervising system detects a system and equipment trouble or trunk-line is malfunctioning.

- 3) Provide one (1) spare panel.

G. Call Initiation, Annunciation and Response:

1. Light and Tones:

- a Calls may be initiated through:

- 1) Patient station.
- 2) Staff station.
- 4) Toilet Emergency Station pull cord / push button.

- b Once a call is initiated, it must be annunciated at the following locations:

- 1) The Corridor, Intersectional and Room dome light associated with the initiating device.
- 2) A local master control station indicating the call location and priority.
- 3) Each duty station.
- 4) Each staff station.
- 5) Each remote location.
- c) All calls must be displayed until they are cleared by the nursing staff **ONLY** from the initiating device location.

2. Voice:

- a Calls may be initiated through:

- 1) Staff station.
- 2) Master Station.

H. Auxiliary Alarm Monitoring:

1. Each patient station must have the ability to connect a separate and isolated auxiliary alarm to it such as an infusion pump or data tracking / recording device (patient life support units ARE NOT allowed to be connected to these units **UNLESS APPROVED BY TVE - 005OP3B DURING THE PROJECT DEVELOPMENT PHASE AS DESCRIBED HEREIN**. The System must support naming the device that is being monitored as well as display its alarms at the master station and via the room / corridor dome light(s).
2. Provide **2** alarm jacks at each patient station.

3. The above requirements may ONLY be allowed when the system has been approved by VA Headquarters TVE - 005OP3B and TVE - 005OP2B and concurred by the appropriate Medical Service(s) indicates it meets the minimum guidelines and requirements of Paragraph 2.8.A.

I. Patient and Staff Assignment:

1. System may provide for transfer of one or more individual or groups of stations from one master station to another without mechanical switches or additional wiring of the stations. The transfer may be initiated manually by the nurse or automatically at certain times of the day.
2. The Facility's LAN/WAN IS NOT ALLOWED for Nurses Call/Code Blue main wiring which must be a "stand alone primary cable infrastructure." **Connections to the VA LAN/WAN will be allowed ONLY when the LAN/WAN system has been demonstrated and certified by TVE - 005OP3B meeting the minimum guidelines and requirements of the Life Safety Code.**

J. Reports:

1. The system's generated reports logging all calls, alarms, response time, bed, and staff assignments may be allowed to transmit these reports to a central archiving entity.
2. Reports function shall be limited by passwords and security tier level access, so that only supervisors may access it when desired.
3. Provide instructions to the owner on how to enable/disable the reporting functions.
4. The Facility's LAN/WAN IS NOT ALLOWED for Nurses Call/Code Blue main wiring that must be a "stand alone primary cable infrastructure." Connections to the VA LAN/WAN will be allowed ONLY when the system has been demonstrated and certified by 005OP2B meeting the minimum guidelines and requirements of the Life Safety Code.

K. System/Management Software:

1. Provide and install system/management software on minimum of three (3) owner-provided computers.
    - a. The management software shall at a minimum provide all historical reporting features of the system as well as real-time monitoring of events.
    - b. The system software shall at a minimum provide the system's operating and functioning parameters and script. The OEM shall provide VA with access to the software's script writing and functions.
  2. Provide two (2) spare CD's with the software installed and operable.
  3. Rights in Data: VA shall have the right to all script and programming language of system management software. If commercial off the shelf (COTS) or a memorandum of understanding (MOU) is required for follow-on maintenance, the Contractor is required to accomplish the COTS Survey document and the RE is required to accomplish the COTS Acquisition document supplied in Part 5 Attachments herein.
- L. System Functional Station:
1. Master Control:
    - a. Simple Tone and Light:
      - 1) A visual / aural (tone only) system shall be provided, protected and located in the Day Hospital, Mental Health & Blind Rehabilitation Areas, OPC where surgery or procedures are not performed. The System shall include a push-button emergency station (pull cord in Day Hospital and pushbutton in Mental Health & Blind Rehabilitation areas) with an associated corridor dome light in each dressing room (OPC) and toilet (OPC, Day Hospital, Mental Health, Blind Rehabilitation.
      - 2) The visual / aural (tone only) system shall also include a power supply and a visual / aural (tone only) display panel in the respective OPC receptionist / secretary's office and the Day Hospital area and as shown on the drawings.

The visual / tone display panel shall generate audible and visual emergency signals to indicate the location of a placed call.

- 3) The Visual Display Panel shall be a digital readout touch screen to visually announce the location of incoming calls placed in the System including room and bed number and priority of the call. Identify each calling station with an individual display, including separate displays for each patient sharing a dual bedside station. If a digital readout touch screen standard is not required or approved by the Facility during the project design phase, an alpha - numeric scheme shall be provided that identifies the: ward, room and bed (i.e. Ward 2a, Room 201, Bed A (or 1) shall read 2A201A -or- 2A201-1. Equivalent readouts are acceptable as long as TVE 005OP3B and the Facility approve the readout).
    - a) Calls placed at emergency stations located in toilets and baths inside bedrooms shall be displayed for the bed closest to the nurse control station. Beds in multi-bed bedrooms shall be identified in a clock-wise pattern upon entering the bedroom.
    - b) It shall display a minimum of four incoming calls. Additional placed calls shall be stored in order of placement and priority.
  - 4) The visual / aural (tone only) system shall be installed according to the same Procedures, guidelines and standards outlined for a regular Nurse Call System for emergency **NOT CODE BLUE OPERATION**.
  - 5) Speakerphone and handset communication.
  - 6) Provide one (1) spare station for each ten (1) stations installed.
- b. Touch Screen:
- 1) Provide a touch screen master station with 15" minimum monitor size.
  - 2) The master station shall have a full control capability over staff assignment to patients and beds as well as pagers and wireless personal communication devices (when specifically approved by 005OP3B on a case by case basis).



- 3) Speakerphone and handset communication.
- 4) Provide one (1) spare station for each ten (1) stations installed.
2. Staff:
  - a. Light and Tine Only.
  - b. Voice Communications Enabled.
  - c. Provide one (1) spare station for each twenty (20) stations installed.
3. Duty:
  - a. Light and Tine Only.
  - b. Voice Communications Enabled.
  - c. Provide one (1) spare station for each twenty (20) stations installed.
4. Patient:
  - a. Single & Dual:
    - 1) Provide each patient station with the following minimum Feature.
      - a) Call button.
      - b) Call answered button.
      - f) Provide one (1) spare station for each twenty (20) stations installed.
5. Installed Base:
  - a. The existing campus contains an installed base throughout different facilities on campus. The following describes the Rauland Responder system that shall be installed in the new facility as required:
    - 1) Four-Button Status Station, Model R4KPB44.
    - 2) Slim Pull Cord Station, Model R4KPC11.
    - 3) Duty Dome Controller, Model DCA214D.
    - 4) Visual 4-Bulb Corridor Light, Model CLV144.
    - 5) Network Interface Model, Model R4KNIM.
    - 6) Power Supply, Model R4KPR400.
    - 7) Wall Mounting Cabinet, Model 351102.

8) Reporting Software Peripheral Interface Port, Model R4KRSPiP.

9) Responder 4000 Reporting Software, Model R4KRsw.

M. Distribution System: Refer to Specification Sections 27 11 00, Structured TIP

Communications Cables; 27 11 00, TIP Communications Interface and Equipment Rooms Fittings and 27 15 00, HORIZONTAL and Vertical TIP Communications Cabling for additional specific TIP wire and cable standards and installation requirements used to install the Facility's TIP network.

1. In addition to the TIP provided under the aforementioned Specification Sections, the contractor shall provide the following additional TIP installation and testing requirements, provide the following minimum additional System TIP requirements, cables & interconnections:

- a. Each wire and cable used in the System shall be specifically OEM certified by tags on each reel and recommended and approved for installation in the Facility.
- b. The Contractor shall provide the RE a 610 mm (2 foot) sample of each wire and/or cable actually employed in the System and each certification tag for approval before continuing with the installation as described herein.
- c. Fiberoptic Cables: Refer to Specification Section 27 15 00, Horizontal and Vertical TIP Communications Cabling; Paragraph 2.4.C12.d. Fiberoptic Cables – for minimum technical standards and requirements for additional System cables.
- d. Copper Cables: Refer to Specification Section 27 15 00, Horizontal and Vertical TIP Communications Cabling; Paragraph 2.4.C12.c. Copper Cables – for minimum technical standards and requirements for additional System voice and data cables.
- e. Line Level Audio and Microphone Cable:
  - 1) Line level audio and microphone cable for inside racks and conduit.
  - 2) Shielded, twisted pair Minimum 22AWG, stranded conductors and 24AWG drain wire with overall jacket.
- f. Speaker Level Audio (70.7Volt RMS):

- 1) For use with 70.7V speaker circuits.
  - 2) 18AWG stranded pair, minimum.
  - g. All cabling shall be plenum rated.
  - h. Provide one (1) spare 1,000 foot roll of approved System (not microphone) cable only.
2. Raceways, Back Boxes and conduit:
- a. In addition to the Raceways, Equipment Room Fittings provided under Specification Sections 27 15 00 TIP Communication Room Fittings and 27 15 00 – TIP Communications Horizontal and Vertical Cabling, provide the following additional TIP raceway and fittings:
  - b. Each raceway that is open top, shall be: UL certified for telecommunications systems, partitioned with metal partitions in order to comply with NEC Parts 517 & 800 to “mechanically separate telecommunications systems of different service, protect the installed cables from falling out when vertically mounted and allow junction boxes to be attached to the side to interface “drop” type conduit cable feeds.
  - c. Intercommunication System cable infrastructure: EMT above accessible ceilings, 24 inches on center.
  - d. Junction boxes shall be not less than 2-1/2 inches deep and 6 inches wide by 6 inches long.
  - e. Flexible metal conduit is prohibited unless specifically approved by 005OP3B.
  - f. System Conduit:
    - 1) The PA system is NFPA listed as Emergency / Public Safety Communication System which requires the entire system to be installed in a separate conduit system.
    - 2) The use of centralized mechanically partitioned wireways may be used to augment main distribution conduit on a case by case basis when specifically approved by VA Headquarters (005OP3B).

3) Conduit Sleeves:

- a) The AE has made a good effort to identify where conduit sleeves through full-height and fire rated walls on the drawings, and has instructed the electrician to provide the sleeves as shown on the drawings.
- b) While the sleeves shown on the drawings will be provided by others, the contractor is responsible for installing conduit sleeves and fire-proofing where necessary. It is often the case, that due to field conditions, the nurse-call cable may have to be installed through an alternate route. Any conduit sleeves required due to field conditions or those omitted by the engineer shall be provided by the cabling contractor.

g. Device Back Boxes:

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

3. UPS:

- a. Provide a backup battery or a UPS for the System to allow normal operation and function (as if there was no AC power failure) in the event of an AC power failure or during input power fluctuations for a minimum of 30 minutes.
- b. As an alternate solution, the telephone system UPS may be utilized to meet this requirement at the headend location, as long as this function is specifically approved by the Telephone Contractor and the RE.
- c. The Nurse Call Contractor shall not make any attachments or connection to the telephone system until specifically directed to do so, in writing, by the RE.
- d. Provide UPS for all active system components including but not limited to:
  - 1) System Amplifiers.
  - 2) Microphone Consoles.

- 3) Telephone Interface Units.
- 4) TER, TR & Headend Equipment Rack(s).

N. Installation Kit:

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

- 11) Power Panels.
  - 12) Connector Panels.
  - 15) Grounding Blocks.
3. Fiberoptic Cable: The fiberoptic cable kit shall include all fiberoptic connectors, cable tying straps, interduct, heat shrink tubing, hangers, clamps, etc. required to accomplish a neat and secure installation.
  4. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tubing, hangers, clamps, etc., required to accomplish a neat and secure installation.
  5. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
  6. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
  7. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
  8. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to completely and correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.
  9. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide the system documentation as required by this document and explained herein.

### **PART 3 - EXECUTION**

#### **3.1 PROJECT MANAGEMENT**

- A. Assign a single project manager to this project who will serve as the point of contact for the Owner, the General Contractor, and the Engineer.
- B. The Contractor shall be proactive in scheduling work at the hospital, specifically the Contractor will initiate and maintain discussion with the general contractor regarding the schedule for ceiling cover up and install cables to meet that schedule.
- C. Contact the Office of Telecommunications, Special Communications Team (07A2) at 202-461-5301/5311 to have a VA Certified Telecommunications COTR assigned to the project for telecommunications review, equipment and system approval and coordination with VA's Spectrum Management and OCIS Teams.

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

- A. Coordinate with the cabling contractor the location of the TV faceplate and the faceplate opening for the nurse call TV control jack.
- B. Coordinate with the cabling contractor the location of TIP equipment in the **TER, TCR, PCR, SCC, ECR, STRs, NSs, and TCOs in order to connect to the TIP cable network that was installed as a part of Section Specification 27 11 00. Contact the RE immediately, in writing, if additional location(s) are discovered to be activated that was not previously provided.**
- C. Before beginning work, verify the location, quantity, size and access for the following:
  - 1. Isolated ground AC power circuits provided for systems.
  - 2. Primary, emergency and extra auxiliary AC power generator requirements.
  - 3. Junction boxes, wall boxes, wire troughs, conduit stubs and other related infrastructure for the systems.
  - 4. System components installed by others.
  - 5. Overhead supports and rigging hardware installed by others.
- D. Immediately notify the Owner, GC and Consultant(s) in writing of any discrepancies.

### **3.3 NEEDS ASSESSMENT**

Provide a one-on-one meeting with the particular nursing manager of each unit affected by the installation of the new nurse call/code blue system. Review the floor plan drawing, educate the nursing manager with the functions of the equipment that is being provided and gather details specific to the individual units; coverage and priorities of calls; staffing patterns; and other pertinent details that will affect system programming and training.

### **3.4 INSTALLATION**

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

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



5. Finishes for any exposed work such as plates, racks, panels, speakers, etc. shall be approved by the Architect, Owner and TVE 005OP3B.
6. Coordinate cover plates with field conditions. Size and install cover plates as necessary to hide joints between back boxes and surrounding wall. Where cover plates are not fitted with connectors, provide grommets in size and quantity required. Do not allow cable to leave or enter boxes without cover plates installed.
7. Active electronic component equipment shall consist of solid state components, be rated for continuous duty service, comply with the requirements of FCC standards for telephone and data equipment, systems, and service.
8. Color code all distribution wiring to conform to the Nurse Call Industry Standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance.
9. Connect the System's primary input AC power to the Facility's Critical Branch of the Emergency AC power distribution system as shown on the plans or if not shown on the plans consult with RE regarding a suitable circuit location prior to bidding.
10. Product Delivery, Storage and Handling:
  - a. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The RE may inventory the cable, patch panels, and related equipment.
  - b. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the RE.
11. Where TCOs are installed adjacent to each other, install one outlet for each instrument.
12. Equipment installed outdoors shall be weatherproof or installed in weatherproof enclosures with hinged doors and locks with two keys.

B. Equipment Racks/Cabinets:

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

C. Distribution Frames.

1. A new stand-alone (i.e., self supporting, free standing) PA rack/frame may be provided in each TR to interconnect the TCR, PCR, SCC, NS, STRs & ECRs.  
Rack/frames shall be wired in accordance with industry standards and shall employ "latest state-of-the-art" modular cross-connect devices. The PA riser cable shall be sized to satisfy all voice/digital requirements plus not less than 50% spare (growth) capacity in each TR which includes a fiber optic backbone.
2. The frames/racks shall be connected to the TER/MCR system ground.

D. Wiring Practice - in addition to the MANDATORY infrastructure requirements outlined in VA Construction Specifications 27 10 00 – TIP Structured Communications Cabling, 27 11 00 – TIP Communications Rooms Fittings and 27 15 00 – TIP Horizontal and Vertical Communicators Cabling, the following additional practices shall be adhered too:

1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
2. Execute all wiring in strict adherence to the National Electrical Code, applicable local building codes and standard industry practices.
3. Wiring shall be classified according to the following low voltage signal types:
  - a. Balanced microphone level audio (below -20dBm) or Balanced line level audio (-20dBm to +30dBm)
  - b. 70V audio speaker level audio.
  - c. Low voltage DC control or power (less than 48VDC)
4. Where raceway is to be EMT (conduit), wiring of differing classifications shall be run in separate conduit. Where raceway is to be an enclosure (rack, tray, wire trough, utility box) wiring of differing classifications which share the same enclosure shall be mechanically partitioned and separated by at least four (4) inches. Where Wiring of differing classifications must cross, they shall cross perpendicular to one another.
5. Do not splice wiring anywhere along the entire length of the run. Make sure cables are fully insulated and shielded from each other and from the raceway for the entire length of the run.
6. Do not pull wire through any enclosure where a change of raceway alignment or direction occurs. Do not bend wires to less than radius recommended by manufacturer.
7. Replace the entire length of the run of any wire or cable that is damaged or abraded during installation. There are no acceptable methods of repairing damaged or abraded wiring.
8. Use wire pulling lubricants and pulling tensions as recommended by the OEM.
9. Use grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.
10. Do not use tape-based or glue-based cable anchors.

11. Ground shields and drain wires to the Facility's signal ground system as indicated by the drawings.
12. Field wiring entering equipment racks shall be terminated as follows:
  - a. Provide OEM directed service loops at harness break-outs and at plates, panels and equipment. Loops should be sufficient to allow plates, panels and equipment to be removed for service and inspection.
  - b. Line level and speaker level wiring may be terminated inside the equipment rack using specified terminal blocks (see "Products.") Provide 15% spare terminals inside each rack. Microphone level wiring may only be terminated at the equipment served.
  - c. If specified terminal blocks are not designed for rack mounting, utilize  $\frac{3}{4}$ " plywood or  $\frac{1}{8}$ " thick aluminum plates/blank panels as a mounting surface. Do not mount on the bottom of the rack.
  - d. Employ permanent strain relief for any cable with an outside diameter of 1" or greater.
13. Use only balanced audio circuits unless noted otherwise directed and indicated on the drawings.
14. Make all connections as follows:
  - a. Make all connections using rosin-core solder or mechanical connectors appropriate to the application.
  - b. For crimp-type connections, use only tools that are specified by the manufacturer for the application.
  - c. Use only insulated spade lugs on screw terminals. Spade lugs shall be sized to fit the wire gauge. Do not exceed two lugs per terminal.
  - d. Wire nuts, electrical tape or "Scotch Lock" connections are not acceptable for any application.
15. Noise filters and surge protectors shall be provided for each equipment interface cabinet, switch equipment cabinet, control console, local, and remote active

equipment locations to ensure protection from input primary AC power surges and noise glitches are not induced into low Voltage data circuits.

16. Wires or cables **previously approved** to be installed outside of conduit, cable trays, wireways, cable duct, etc:
- a Only when specifically authorized as described herein, will wires or cables be identified and approved to be installed outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.
  - b Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.
  - c Closer wire or cable fastening intervals may be required to prevents sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.
  - d Wire or cable runs to system components installed in walls (i.e.: volume attenuators, circuit controllers, signal, or data outlets, etc.) may, when specifically authorized by the RE, be fished through hollow spaces in walls and shall be certified for use in air plenum areas.
  - e Completely test all of the cables after installation and replace any defective cables.
  - f Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra violet protection and be totally waterproof (including all connections). The laying of wires or cables directly on

roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.

E. Cable Installation - Cable Installation - In addition to the **MANDATORY** infrastructure requirements outlined in VA Construction Specifications 27 10 00 – Structured TIP Communications Cabling, 27 11 00 – TIP Communications Rooms and Fittings and 27 15 00 – TIP Communications Horizontal and Vertical Cabling and the following additional practices shall be adhered too:

1. Support cable on maximum 2'-0" centers. Acceptable means of cable support are cable trays. Velcro wrap cable bundles loosely to the means of support with plenum rated Velcro straps. Plastic tie wraps are not acceptable as a means to bundle cables.
2. Run cables parallel to walls.
3. Install maximum of 10 cables in a single row. Provide necessary rows as required by the number of cables.
4. Do not lay cables on top of light fixtures, ceiling tiles, mechanical equipment, or ductwork. Maintain at least 2'-0" clearance from all shielded electrical apparatus.
5. All cables shall be tested after the total installation is fully complete. All test results are to be documented. All cables shall pass acceptable test requirements and levels. Contractor shall remedy any cabling problems or defects in order to pass or comply with testing. This includes the re-pull of new cable as required at no additional cost to the Owner.
6. Ends of cables shall be properly terminated on both ends per industry and OEM's recommendations.
7. Provide proper temporary protection of cable after pulling is complete before final dressing and terminations are complete. Do not leave cable lying on floor. Bundle and tie wrap up off of the floor until you are ready to terminate.
8. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

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

1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams."
2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or Bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
  - a. Clearly, consistently, logically and permanently mark switches, connectors, jacks, relays, receptacles and electronic and other equipment.
  - b. Engrave and paint fill all receptacle panels using 1/8" (minimum) high lettering and contrasting paint.
  - c. For rack-mounted equipment, use engraved Lamacoid labels with white 1/8" (minimum) high lettering on black background. Label the front and back of all rack-mounted equipment.
3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
4. Termination Hardware: The Contractor shall label TCOs and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams."
5. Where multiple pieces of equipment reside in the same rack group, clearly and logically label each indicating to which room, channel, receptacle location, etc. they correspond.
6. Permanently label cables at each end, including intra-rack connections. Labels shall be covered by the same, transparent heat-shrink tubing covering the end of the overall jacket. Alternatively, computer generated labels of the type which include a clear protective wrap may be used.



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

guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.

- d. When "interduct" flexible cable protective systems is specifically authorized to be provided for use in the System, it's installation guidelines and standards shall be as the specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
  - e. Conduit fill (including GFE approved to be used in the system) shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
  - f. Ensure that Critical Care Nurse Call and/or Code Blue Systems (as identified by NEC Section 517) are completely separated and protected from all other systems.
2. Signal Duct, Cable Duct, or Cable Tray:
- a. The Contractor shall use GFE signal duct, cable duct, and/or cable tray, when identified and approved by the RE.
  - b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.
  - c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The RE shall approve width and height dimensions.
  - d. All cable junctions and taps shall be accessible. Provide an 8" X 8" X 4" (minimum) junction box attached to the cable duct or raceway for installation of

distribution system passive equipment. Ensure all equipment and tap junctions are accessible

### **3.5 PROTECTION OF NETWORK DEVICES**

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

### **3.6 CUTTING, CLEANING AND PATCHING**

- A. It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.
- B. It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.
- C. The Contractor shall be responsible for providing any additional cutting, drilling, fitting or patching required that is not indicated as provided by others to complete the Work or to make its parts fit together properly.
- D. The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate Contractor the Contractor's consent to cutting or otherwise altering the Work.
- E. Where coring of existing (previously installed) concrete is specified or required, including coring indicated under unit prices, the location of such coring shall be clearly identified in the field and the location shall be approved by the Project Manager prior to commencement of coring work.

### **3.7 FIREPROOFING**

- A. Where Nurse Call and/or Code Blue wires, cables and conduit penetrate fire rated walls, floors and ceilings, fireproof the opening.
- B. Provide conduit sleeves (if not already provided by electrical contractor) for cables that penetrate fire rated walls and Telecommunications Rooms floors and ceilings. After the cabling installation is complete, install fire proofing material in and around all conduit sleeves and openings. Install fire proofing material thoroughly and neatly. Seal all floor and ceiling penetrations.
- C. Use only materials and methods that preserve the integrity of the fire stopping system and its rating.
- D. Install fireproofing where low voltage cables are installed in the same manholes with high voltage cables; also cover the low voltage cables with arc proof and fireproof tape.
- E. Use approved fireproofing tape of the same type as used for the high voltage cables, and apply the tape in a single layer, one-half lapped or as recommended by the manufacturer. Install the tape with the coated side towards the cable and extend it not less than 25 mm (one inch) into each duct.
- F. Secure the tape in place by a random wrap of glass cloth tape.

### **3.8 GROUNDING**

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

- D. When required, install grounding electrodes as specified in CFM Division 26, Section 26 05 26 –Grounding and Bonding for Electrical Systems.
- E. Do not use “3<sup>rd</sup> or 4<sup>th</sup>” wire internal electrical system conductors for communications signal ground.
- F. Do not connect the signal ground to the building’s external lightning protection system.
- G. Do Not “mix grounds” of different systems.
- H. Insure grounds of different systems are installed as to not violate OSHA Safety and NEC installation requirements for protection of personnel.

#### **PART 4 – TESTING / GUARANTY / TRAINING**

##### **4.0 SYSTEM LISTING**

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

##### **4.1 PROOF OF PERFORMANCE TESTING**

- A. Intermediate Testing:
  - 1. After completion of 30 – 40% of the installation of a head end cabinet(s) and equipment, one master stations, local and remote stations, treatment rooms, and prior to any further work, this portion of the system must be pretested, inspected, and 1certified. Each item of installed equipment shall be checked to ensure appropriate UL Listing and Certification Labels are affixed as required by NFPA -Life Safety Code 101-3.2 (a) & (b), UL Nurse Call Standard 1069 and JCHCO evaluation guidelines, and proper installation practices are followed. The intermediate test shall include a full operational test.
  - 2. All inspections and tests shall be conducted by an OEM-certified contractor representative and witnessed by TVE-005OP3B if there is no local Government Representative that processes OEM and VA approved Credentials to inspect and certify the system. The results of the inspection will be officially recorded by the

Government Representative and maintained on file by the RE, until completion of the entire project. The results will be compared to the Acceptance Test results. An identical inspection may be conducted between the 65 - 75% of the system construction phase, at the direction of the RE.

B. Pretesting:

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

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

C. Acceptance Test:

1. After the Nurse Call and/or Code Blue System has been pretested and the Contractor has submitted the pretest results and certification to the RE, then the Contractor shall schedule an acceptance test date and give the RE 15 working days written notice prior to the date the acceptance test is expected to begin. The System shall be tested in the presence of a TVE 005OP3B and OEM certified representatives. The System shall be tested utilizing the approved test equipment to certify proof of performance and Life Safety / Critical Service compliance. The tests shall verify that the total System meets all the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.
2. The acceptance test shall be performed on a "go-no-go" basis. Only those operator adjustments required to show proof of performance shall be allowed. The test shall demonstrate and verify that the installed System does comply with all requirements of this specification under operating conditions. The System shall be rated as either acceptable or unacceptable at the conclusion of the test. Failure of any part of the

System that precludes completion of system testing, and which cannot be repaired in four (4) hours, shall be cause for terminating the acceptance test of the System.

Repeated failures that result in a cumulative time of eight (8) hours to affect repairs shall cause the entire System to be declared unacceptable.

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

D. Acceptance Test Procedure:

1. Physical and Mechanical Inspection:

- a. The TVE 005OP3B Representative will tour all major areas where the Nurse Call and/or Code Blue System and all sub-systems are completely and properly installed to insure they are operationally ready for proof of performance testing. A system inventory including available spare parts will be taken at this time. Each item of installed equipment shall be checked to ensure appropriate UL certification labels are affixed.
- b. The System diagrams, record drawings, equipment manuals, TIP Auto CAD Disks, intermediate, and pretest results shall be formally inventoried and reviewed.
- c. Failure of the System to meet the installation requirements of this specification shall be grounds for terminating all testing.

2. Operational Test:

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



- c. The distribution system shall be checked at each interface, junction, and distribution point, first, middle, and last intersectional, room, and bed dome light in each leg to verify that the nurse call distribution system meets all system performance standards.
  - d. Each MATV outlet that is controlled by a nurse call pillow speaker shall be functionally tested at the same time utilizing the Contractor's approved hospital grade HDTV receiver and TV remote control cable.
  - e. The RED system and volume stepper switches shall be checked to insure proper operation of the pillow speaker, the volume stepper and the RED system (if installed).
  - f. Additionally, each installed emergency, patient, staff, duty, panic station, intersectional, room, and bed dome light, power supply, code one, and remote annunciator panels shall be checked insuring they meet the requirements of this specification.
  - g. Once these tests have been completed, each installed sub-system function shall be tested as a unified, functioning and fully operating system. The typical functions are: nurse follower, three levels of emergency signaling (i.e. flashing red emergency, flashing white patient emergency, flashing white or combination lights for staff emergency, separate flashing code blue), minimum of 10 minutes of UPS operation, memory saving, minimum of ten station audio paging, canceling emergency calls at each originating station only, and storage and prioritizing of calls.
  - h. Individual Item Test: The TVE 005OP3B Representative will select individual items of equipment for detailed proof of performance testing until 100% of the System has been tested and found to meet the contents of this specification. Each item shall meet or exceed the minimum requirements of this document.
3. Test Conclusion:

- a. At the conclusion of the Acceptance Test, using the generated punch list (or discrepancy list) the VA and the Contractor shall jointly agree to the results of the test, and reschedule testing on deficiencies and shortages with the RE. Any retesting to comply with these specifications will be done at the Contractor's expense.
  - b. If the System is declared unacceptable without conditions, all rescheduled testing expenses will be borne by the Contractor.
- E. Acceptable Test Equipment: The test equipment shall furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:
  1. Spectrum Analyzer.
  2. Signal Level Meter.
  3. Volt-Ohm Meter.
  4. Sound Pressure Level (SPL) Meter.
  5. Oscilloscope.
  6. Pillow Speaker Test Set (Pillow Speaker with appropriate load and cross connections in lieu of the set is acceptable).
  7. Patient Push Button Cord Test Set.
  8. Patient Bed with connecting multiple conductor cord.

#### **4.2 WARRANTY**

- A. Comply with FAR 52.246-21, except that warranty shall be as follows:
- B. Contractor's Responsibility:
  1. The Contractor shall warranty that all provided material and equipment will be free from defects, workmanship and will remain so for a period of one year from date of final acceptance of the System by the VA. The Contractor shall provide OEM's equipment warranty documents, to the RE (or Facility Contracting Officer if the

Facility has taken possession of the building), that certifies each item of equipment installed conforms to OEM published specifications.

2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. This contact capability shall be provided by the Contractor and OEM at no additional cost to the VA.
3. All Contractor maintenance and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
4. Additionally, the Contractor shall accomplish the following minimum requirements during the two year guaranty period:
  - a. Response Time during the Two Year Guaranty Period:
    - 1) The RE (or Facility Contracting Officer if the system has been turned over to the Facility) is the Contractor's ONLY OFFICIAL reporting and contact official for nurse call system trouble calls, during the guaranty period.
    - 2) A standard work week is considered 8:00 A.M. to 5:00 P.M. or as designated by the RE (or Facility Contracting Officer), Monday through Friday exclusive of Federal Holidays.
  - 3) The Contractor shall respond and correct on-site trouble calls, during the standard work week to:
    - a) A routine trouble call within one (1) working day of its report. A routine trouble is considered a trouble which causes a pillow speaker or cordset, one (1) master nurse control station, patient station, emergency station, or dome light to be inoperable.
    - b) Routine trouble calls in critical emergency health care facilities (i.e., cardiac arrest, intensive care units, etc.) shall also be deemed as an

emergency trouble call. The RE (or Facility Contracting Officer) shall notify the Contractor of this type of trouble call.

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

4) If a Nurse Call and/or Code Blue/ component failure cannot be corrected within four (4) hours (exclusive of the standard work time limits), the Contractor shall be responsible for providing alternate nurse call equipment. The alternate equipment/system shall be operational within a maximum of 20 hours after the four (4) hour trouble shooting time and restore the effected location operation to meet the System performance standards. If any sub-system or major system trouble cannot be corrected within one working day, the Contractor shall furnish and install compatible substitute equipment returning the System or sub-system to full operational capability, as described herein, until repairs are complete.

b. Required On-Site Visits during the **Two Year** Guaranty Period

- 1) The Contractor shall visit, on-site, for a minimum of eight (8) hours, once every 12 weeks, during the guaranty period, to perform system preventive maintenance, equipment cleaning, and operational adjustments to maintain the System according the descriptions identified in this document.
- 2) The Contractor shall arrange all Facility visits with the RE (or Facility Contracting Officer) prior to performing the required maintenance visits.
- 3) Preventive maintenance shall be performed by the Contractor in accordance with the OEM's recommended practice and service intervals during non-busy time agreed to by the RE (or Facility Contracting Officer) and Contractor.
- 4) The preventive maintenance schedule, functions and reports shall be provided to and approved by the RE (or Facility Contracting Officer).

- 5) The Contractor shall provide the RE (or Facility Contracting Officer) a type written report itemizing each deficiency found and the corrective action performed during each required visit or official reported trouble call. The Contractor shall provide the RE with sample copies of these reports for review and approval at the beginning of the Acceptance Test. The following reports are the minimum required:
  - a) The Contractor shall provide a monthly summary all equipment and sub-systems serviced during this warranty period to RE (or Facility Contracting Officer) by the fifth (5<sup>th</sup>) working day after the end of each month. The report shall clearly and concisely describe the services rendered, parts replaced and repairs performed. The report shall prescribe anticipated future needs of the equipment and systems for preventive and predictive maintenance.
  - b) The Contractor shall maintain a separate log entry for each item of equipment and each sub-system of the System. The log shall list dates and times of all scheduled, routine, and emergency calls. Each emergency call shall be described with details of the nature and causes of emergency steps taken to rectify the situation and specific recommendations to avoid such conditions in the future.
- 6) The RE (or Facility Contracting Officer) shall convey to the Facility Engineering Officer, two (2) copies of actual reports for evaluation.
  - a) The RE (or Facility Contracting Officer) shall ensure a copy of these reports is entered into the System's official acquisition documents.
  - b) The Facility Chief Engineer shall ensure a copy of these reports is entered into the System's official technical record documents.
- C. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use; accidents; other vendor, contractor, or owner tampering or negligence, for which the Contractor is not directly responsible and does

not control. The Contractor shall immediately notify the RE or Facility Contracting Officer in writing upon the discovery of these incidents. The RE or Facility Contracting Officer will investigate all reported incidents and render

#### **4.3 TRAINING**

- A. Provide thorough training of all nursing staff assigned to those nursing units receiving new networked nurse/patient communications equipment. This training shall be developed and implemented to address two different types of staff. Floor nurses/staff shall receive training from their perspective, and likewise, unit secretaries (or any person whose specific responsibilities include answering patient calls and dispatching staff) shall receive operational training from their perspective. A separate training room will be set up that allows this type of individualized training utilizing in-service training unit, prior to cut over of the new system.
- B. Provide the following minimum training times and durations:
  - 1. **48** hours prior to opening for nursing staff (in 8-hour increments) – split evenly over 3 weeks and day and night shifts. Coordinate schedule with Owner.
  - 2. **32** hours during the opening week for nursing staff – both day and night shifts.
  - 3. **24** hours for supervisors and system administrators.

#### **5.0 ATTACHMENTS (NOT USED)**

--- E N D ---

**SECTION 28 05 00**  
**COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section, Common Work Results for Electronic Safety and Security (ESS), applies to all sections of Division 28.
- B. Furnish and install fully functional electronic safety and security cabling system(s), equipment and approved accessories in accordance with the specification section(s), drawing(s), and referenced publications. Capacities and ratings of cable and other items and arrangements for the specified items are shown on each system's required Bill of Materials (BOM) and verified on the approved system drawing(s). If there is a conflict between contract's specification(s) and drawings(s), the contract's specification requirements shall prevail.
- C. The Contractor shall provide a fully functional and operating ESS, programmed, configured, documented, and tested as required herein and the respective Safety and Security System Specification(s). The Contractor shall provide calculations and analysis to support design and engineering decisions as specified in submittals. The Contractor shall provide and pay all labor, materials, and equipment, sales and gross receipts and other taxes. The Contractor shall secure and pay for plan check fees, permits, other fees, and licenses necessary for the execution of work as applicable for the project. Give required notices; the Contractor will comply with codes, ordinances, regulations, and other legal requirements of public authorities, which bear on the performance of work.
- D. The Contractor shall provide an ESS, installed, programmed, configured, documented, and tested. The security system shall include but not limited to: physical access control, intrusion detection, duress alarms, elevator control interface, video assessment and surveillance, video recording and storage, delayed egress, personal protection system, intercommunication system, fire alarm interface, equipment cabinetry, dedicated photo badging system and associated live camera, report printer, photo badge printer, and

uninterruptible power supplies (UPS) interface. Operator training shall not be required as part of the Security Contractors scope and shall be provided by the Owner. The Security Contractor shall still be required to provide necessary maintenance and troubleshooting manuals as well as submittals as identified herein. The work shall include the procurement and installation of electrical wire and cables, the installation and testing of all system components. Inspection, testing, demonstration, and acceptance of equipment, software, materials, installation, documentation, and workmanship, shall be as specified herein. The Contractor shall provide all associated installation support, including the provision of primary electrical input power circuits.

- E. Repair Service Replacement Parts On-site service during the warranty period shall be provided as specified under "Emergency Service". The Contractor shall guarantee all parts and labor for a term of one (1) year, unless dictated otherwise in this specification from the acceptance date of the system as described in Part 5 of this Specification. The Contractor shall be responsible for all equipment, software, shipping, transportation charges, and expenses associated with the service of the system for one (1) year. The Contractor shall provide 24-hour telephone support for the software program at no additional charge to the owner. Software support shall include all software updates that occur during the warranty period.

F. Section Includes:

1. Description of Work for Electronic Security Systems,
2. Electronic security equipment coordination with relating Divisions,
3. Submittal Requirements for Electronic Security,
4. Miscellaneous Supporting equipment and materials for Electronic Security,
5. Electronic security installation requirements.

## **1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.



- C. Section 08 11 73 - SLIDING METAL FIRE DOORS. Requirements for door installation.
- D. Section 08 35 13.13 - ACCORDIAN FOLDING DOORS. Requirements for door installation.
- E. Section 08 34 59 - VAULT DOORS AND DAY GATES. Requirements for door and gate installation.
- F. Section 08 51 13 - ALUMINUM WINDOWS. Requirements for window installation.
- G. Section 08 71 00 - DOOR HARDWARE. Requirements for door installation.
- H. Section 10 14 00 - SIGNAGE. Requirements for labeling and signs.
- I. Section 14 21 00 - ELECTRIC TRACTION ELEVATORS. Requirements for elevators.
- J. Section 14 24 00 - HYDRAULIC ELEVATORS. Requirements for elevators.
- K. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.
- L. Section 26 05 21 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- M. Section 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Requirements for infrastructure.
- N. Section 26 05 41 - UNDERGROUND ELECTRICAL CONSTRUCTION. Requirements for underground installation of wiring.
- O. Section 26 56 00 - EXTERIOR LIGHTING. Requirements for perimeter lighting.
- P. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for conductors and cables.
- Q. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for grounding of equipment.
- R. Section 28 05 28.33 - CONDUITS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for infrastructure.
- S. Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS. Requirements for Commissioning.
- T. Section 28 13 00 - PHYSICAL ACCESS CONTROL SYSTEMS (PACS). For physical access control integration.

- U. Section 28 13 16 - PHYSICAL ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT. Requirements for control and operation of all security systems.
- V. Section 28 13 53 - SECURITY ACCESS DETECTION. Requirements for screening of personnel and shipments.
- W. Section 28 16 00 - INTRUSION DETECTION SYSTEM (IDS). Requirements for alarm systems.
- X. Section 28 23 00 - VIDEO SURVEILLANCE. Requirements for security camera systems.
- Y. Section 28 26 00 - ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS). Requirements for emergency and interior communications.
- Z. Section 32 31 13 - CHAIN LINK FENCES AND GATES. Requirements for fences.

### 1.3 DEFINITIONS

SPEC WRITER NOTE: Retain abbreviations that remain after this Section has been edited.

- A. AGC: Automatic Gain Control.
- B. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- C. BICSI: Building Industry Consulting Service International.
- D. CCD: Charge-coupled device.
- E. Central Station: A PC with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.
- F. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.
- G. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.
- H. CPU: Central processing unit.
- I. Credential: Data assigned to an entity and used to identify that entity.
- J. DGP: Data Gathering Panel – component of the Physical Access Control System capable to communicate, store and process information received from readers, reader modules, input modules, output modules, and Security Management System.

- K. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.
- L. EMI: Electromagnetic interference.
- M. EMT: Electric Metallic Tubing.
- N. ESS: Electronic Security System.
- O. File Server: A PC in a network that stores the programs and data files shared by users.
- P. GFI: Ground fault interrupter.
- Q. IDC: Insulation displacement connector.
- R. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- S. I/O: Input/Output.
- T. Intrusion Zone: A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between sensors and communication link to central-station control unit.
- U. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- V. LAN: Local area network.
- W. LCD: Liquid-crystal display.
- X. LED: Light-emitting diode.
- Y. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.
- Z. 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.
- AA. M-JPEG: Motion – Joint Photographic Experts Group.

- BB. MPEG: Moving picture experts group.
- CC. NEC: National Electric Code
- DD. NEMA: National Electrical Manufacturers Association
- EE. NFPA: National Fire Protection Association
- FF. NTSC: National Television System Committee.
- GG. NRTL: Nationally Recognized Testing Laboratory.
- HH. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- II. PACS: Physical Access Control System; A system comprised of cards, readers, door controllers, servers and software to control the physical ingress and egress of people within a given space
- JJ. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.
- KK. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).
- LL. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.
- MM. RCDD: Registered Communications Distribution Designer.
- NN. RFI: Radio-frequency interference.
- OO. RIGID: Rigid conduit is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.
- PP. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- QQ. RS-485: An TIA/EIA standard for multipoint communications.
- RR. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

- SS. SMS: Security Management System – A SMS is software that incorporates multiple security subsystems (e.g., physical access control, intrusion detection, closed circuit television, intercom) into a single platform and graphical user interface.
- TT. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- UU. 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.
- VV. UPS: Uninterruptible Power Supply
- WW. UTP: Unshielded Twisted Pair
- XX. Workstation: A PC with software that is configured for specific limited security system functions.

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. 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 Security Management System's (PACS) 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 PACS. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules. 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] <insert number> 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 Resident Engineer 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.
- D. 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 GENERAL ARRANGEMENT OF CONTRACT DOCUMENTS**

- A. The Contract Documents supplement to this specification indicates approximate locations of equipment. The installation and/or locations of the equipment and devices shall be governed by the intent of the design; specification and Contract Documents, with due regard to actual site conditions, recommendations, ambient factors affecting the equipment and operations in the vicinity. The Contract Documents are diagrammatic and do not reveal all offsets, bends, elbows, components, materials, and other specific elements that may be required for proper installation. If any departure from the contract documents is deemed necessary, or in the event of conflicts, the Contractor shall submit details of such departures or conflicts in writing to the owner or owner's representative for his or her comment and/or approval before initiating work.
- B. Anything called for by one of the Contract Documents and not called for by the others shall be of like effect as if required or called by all, except if a provision clearly designed to negate or alter a provision contained in one or more of the other Contract Documents shall have the intended effect. In the event of conflicts among the Contract Documents, the Contract Documents shall take precedence in the following order: the Form of Agreement; the Supplemental General Conditions; the Special Conditions; the Specifications with attachments; and the drawings.

### **1.6 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.

1. Mark the submittals, "SUBMITTED UNDER SECTION \_\_\_\_\_".
  2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  3. Submit each section separately.
- D. The submittals shall include the following:
1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
  2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or piping so that the proposed installation can be properly reviewed.
  3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- E. Submittals shall be in full compliance of the Contract Documents. All submittals shall be provided in accordance with this section. Submittals lacking the breadth or depth these requirements will be considered incomplete and rejected. Submissions are considered multidisciplinary and shall require coordination with applicable divisions to provide a complete and comprehensive submission package. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted. Additional general provisions are as follows:
1. The Contractor shall schedule submittals in order to maintain the project schedule.
- For coordination drawings refer to Specification Section 01 33 10 - Design Submittal



Procedures, which outline basic submittal requirements and coordination. Section 01 33 10 shall be used in conjunction with this section.

2. The Contractor shall identify variations from requirements of Contract Documents and state product and system limitations, which may be detrimental to successful performance of the completed work or system.
3. Each package shall be submitted at one (1) time for each review and include components from applicable disciplines (e.g., electrical work, architectural finishes, door hardware, etc.) which are required to produce an accurate and detailed depiction of the project.
4. Manufacturer's information used for submittal shall have pages with items for approval tagged, items on pages shall be identified, and capacities and performance parameters for review shall be clearly marked through use of an arrow or highlighting. Provide space for Resident Engineer and Contractor review stamps.
5. Technical Data Drawings shall be in the latest version of AutoCAD®, drawn accurately, and in accordance with VA CAD Standards CAD Standard Application Guide, and VA BIM Guide. FREEHAND SKETCHES OR COPIED VERSIONS OF THE CONSTRUCTION DOCUMENTS WILL NOT BE ACCEPTED. The Contractor shall not reproduce Contract Documents or copy standard information as the basis of the Technical Data Drawings. If departures from the technical data drawings are subsequently deemed necessary by the Contractor, details of such departures and the reasons thereof shall be submitted in writing to the Resident Engineer for approval before the initiation of work.
6. Packaging: The Contractor shall organize the submissions according to the following packaging requirements.
  - a. Binders: For each manual, provide heavy duty, commercial quality, durable three (3) ring vinyl covered loose leaf binders, sized to receive 8.5 x 11 in paper, and appropriate capacity to accommodate the contents. Provide a clear plastic sleeve on the spine to hold labels describing the contents. Provide pockets in the covers to receive folded sheets.

- 1) Where two (2) or more binders are necessary to accommodate data; correlate data in each binder into related groupings according to the Project Manual table of contents. Cross-referencing other binders where necessary to provide essential information for communication of proper operation and/or maintenance of the component or system.
  - 2) Identify each binder on the front and spine with printed binder title, Project title or name, and subject matter covered. Indicate the volume number if applicable.
- b. Dividers: Provide heavy paper dividers with celluloid tabs for each Section. Mark each tab to indicate contents.
- c. Protective Plastic Jackets: Provide protective transparent plastic jackets designed to enclose diagnostic software for computerized electronic equipment.
- d. Text Material: Where written material is required as part of the manual use the manufacturer's standard printed material, or if not available, specially prepared data, neatly typewritten on 8.5 inches by 11 inches 20 pound white bond paper.
- e. Drawings: Where drawings and/or diagrams are required as part of the manual, provide reinforced punched binder tabs on the drawings and bind them with the text.
- 1) Where oversized drawings are necessary, fold the drawings to the same size as the text pages and use as a foldout.
  - 2) If drawings are too large to be used practically as a foldout, place the drawing, neatly folded, in the front or rear pocket of the binder. Insert a type written page indicating the drawing title, description of contents and drawing location at the appropriate location of the manual.
  - 3) Drawings shall be sized to ensure details and text is of legible size. Text shall be no less than 1/16" tall.
- f. Manual Content: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

- 1) Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
- 2) Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
- 3) The manuals shall include:
  - a) Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
  - b) A control sequence describing start-up, operation, and shutdown.
  - c) Description of the function of each principal item of equipment.
  - d) Installation and maintenance instructions.
  - e) Safety precautions.
  - f) Diagrams and illustrations.
  - g) Testing methods.
  - h) Performance data.
  - i) Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
  - j) Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

- g. Binder Organization: Organize each manual into separate sections for each piece of related equipment. At a minimum, each manual shall contain a title page, table of contents, copies of Product Data supplemented by drawings and written text, and copies of each warranty, bond, certifications, and service Contract issued. Refer to Group I through V Technical Data Package Submittal requirements for required section content.
- h. Title Page: Provide a title page as the first sheet of each manual to include the following information; project name and address, subject matter covered by the manual, name and address of the Project, date of the submittal, name, address, and telephone number of the Contractor, and cross references to related systems in other operating and/or maintenance manuals.
- i. Table of Contents: After the title page, include a type written table of contents for each volume, arranged systematically according to the Project Manual format. Provide a list of each product included, identified by product name or other appropriate identifying symbols and indexed to the content of the volume. Where more than one (1) volume is required to hold data for a particular system, provide a comprehensive table of contents for all volumes in each volume of the set.
- j. General Information Section: Provide a general information section immediately following the table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the installer and maintenance Contractor. In addition, list a local source for replacement parts and equipment.
- k. Drawings: Provide specially prepared drawings where necessary to supplement the manufacturers printed data to illustrate the relationship between components of equipment or systems, or provide control or flow diagrams. Coordinate these drawings with information contained in Project Record Drawings to assure correct illustration of the completed installation.

- l. Manufacturer's Data: Where manufacturer's standard printed data is included in the manuals, include only those sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where more than one (1) item in tabular format is included, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation and delete references to information which is not applicable.
  - m. Where manufacturer's standard printed data is not available and the information is necessary for proper operation and maintenance of equipment or systems, or it is necessary to provide additional information to supplement the data included in the manual, prepare written text to provide the necessary information. Organize the text in a consistent format under a separate heading for different procedures. Where necessary, provide a logical sequence of instruction for each operating or maintenance procedure. Where similar or more than one product is listed on the submittal the Contractor shall differentiate by highlighting the specific product to be utilized.
  - n. Calculations: Provide a section for circuit and panel calculations.
  - o. Loading Sheets: Provide a section for DGP Loading Sheets.
  - p. Certifications: Provide section for Contractor's manufacturer certifications.
- 7. Contractor Review: Review submittals prior to transmittal. Determine and verify field measurements and field construction criteria. Verify manufacturer's catalog numbers and conformance of submittal with requirements of contract documents. Return non-conforming or incomplete submittals with requirements of the work and contract documents. Apply Contractor's stamp with signature certifying the review and verification of products occurred, and the field dimensions, adjacent construction, and coordination of information is in accordance with the requirements of the contract documents.

8. Resubmission: Revise and resubmit submittals as required within 15 calendar days of return of submittal. Make resubmissions under procedures specified for initial submittals. Identify all changes made since previous submittal.
  9. Product Data: Within 15 calendar days after execution of the contract, the Contractor shall submit for approval a complete list of all of major products proposed for use. The data shall include name of manufacturer, trade name, model number, the associated contract document section number, paragraph number, and the referenced standards for each listed product.
- F. Group 1 Technical Data Package: Group I Technical Data Package shall be one submittal consisting of the following content and organization. Refer to VA Special Conditions Document for drawing format and content requirements. The data package shall include the following:
1. Section I - Drawings:
    - a. General – Drawings shall conform to VA CAD Standards Guide. All text associated with security details shall be 1/8" tall and meet VA text standard for AutoCAD™ drawings.
    - b. Cover Sheet – Cover sheet shall consist of Project Title and Address, Project Number, Area and Vicinity Maps.
    - c. General Information Sheets – General Information Sheets shall consist of General Notes, Abbreviations, Symbols, Wire and Cable Schedule, Project Phasing, and Sheet Index.
    - d. Floor Plans – Floor plans shall be produced from the Architectural backgrounds issued in the Construction Documents. The contractor shall receive floor plans from the prime A/E to develop these drawing sets. Security devices shall be placed on drawings in scale. All text associated with security details shall be 1/8" tall and meet VA text standard for AutoCAD™ drawings. Floor plans shall identify the following:
      - 1) Security devices by symbol,
      - 2) The associated device point number (derived from the loading sheets),

- 3) Wire & cable types and counts
  - 4) Conduit sizing and routing
  - 5) Conduit riser systems
  - 6) Device and area detail call outs
- e. Architectural details – Architectural details shall be produced for each device mounting type (door details for EECS and IDS, Intrusion Detection system (motion sensor, vibration, microwave Motion Sensor and Camera mounting,
  - f. Riser Diagrams – Contractor shall provide a riser diagram indicating riser architecture and distribution of the SMS throughout the facility (or area in scope).
  - g. Block Diagrams – Contractor shall provide a block diagram for the entire system architecture and interconnections with SMS subsystems. Block diagram shall identify SMS subsystem (e.g., electronic entry control, intrusion detection, closed circuit television, intercom, and other associated subsystems) integration; and data transmission and media conversion methodologies.
  - h. Interconnection Diagrams – Contractor shall provide interconnection diagram for each sensor, and device component. Interconnection diagram shall identify termination locations, standard wire detail to include termination schedule. Diagram shall also identify interfaces to other systems such as elevator control, fire alarm systems, and security management systems.
  - i. Security Details:
    - 1) Panel Assembly Detail – For each panel assembly, a panel assembly details shall be provided identifying individual panel component size and content.
    - 2) Panel Details – Provide security panel details identify general arrangement of the security system components, backboard size, wire through size and location, and power circuit requirements.
    - 3) Device Mounting Details – Provide mounting detailed drawing for each security device (physical access control system, intrusion detection, video surveillance and assessment, and intercom systems) for each type of wall and

ceiling configuration in project. Device details shall include device, mounting detail, wiring and conduit routing.

- 4) Details of connections to power supplies and grounding
- 5) Details of surge protection device installation
- 6) Sensor detection patterns – Each system sensor shall have associated detection patterns.
- 7) Equipment Rack Detail – For each equipment rack, provide a scaled detail of the equipment rack location and rack space utilization. Use of BISC wire management standards shall be employed to identify wire management methodology. Transitions between equipment racks shall be shown to include use vertical and horizontal latter rack system.
- 8) Security Control Room – The contractor shall provide a layout plan for the Security Control Room. The layout plan shall identify all equipment and details associated with the installation.
- 9) Operator Console – The contractor shall provide a layout plan for the Operator Console. The layout plan shall identify all equipment and details associated with the installation. Equipment room - the contractor shall provide a layout plan for the equipment room. The layout plan shall identify all equipment and details associated with the installation.
- 10) Equipment Room – Equipment room details shall provide architectural, electrical, mechanical, plumbing, IT/Data and associated equipment and device placements both vertical and horizontally.
- j. Electrical Panel Schedule – Electrical Panel Details shall be provided for all SMS systems electrical power circuits. Panel details shall be provided identifying panel type (Standard, Emergency Power, Emergency/Uninterrupted Power Source, and Uninterrupted Power Source Only), panel location, circuit number, and circuit amperage rating.



- k. Door Schedule – A door schedule shall be developed for each door equipped with electronic security components. At a minimum, the door schedule shall be coordinated with Division 08 work and include the following information:
  - 1) Item Number
  - 2) Door Number (Derived from A/E Drawings)
  - 3) Floor Plan Sheet Number
  - 4) Standard Detail Number
  - 5) Door Description (Derived from Loading Sheets)
  - 6) Data Gathering Panel Input Number
  - 7) Door Position or Monitoring Device Type & Model Number
  - 8) Lock Type, Model Number & Power Input/Draw (standby/active)
  - 9) Card Reader Type & Model Number
  - 10) Shunting Device Type & Model Number
  - 11) Sounder Type & Model Number
  - 12) Manufacturer
  - 13) Misc. devices as required
    - a) Delayed Egress Type & Model Number
    - b) Intercom
    - c) Camera
    - d) Electric Transfer Hinge
    - e) Electric Pass-through device
  - 14) Remarks column indicating special notes or door configurations
- 2. Camera Schedule - A camera schedule shall be developed for each camera. Contractors shall coordinate with the Resident Engineer to determine camera starting numbers and naming conventions. All drawings shall identify wire and cable standardization methodology. Color coding of all wiring conductors and jackets is required and shall be communicated consistently throughout the drawings package submittal. At a minimum, the camera schedule shall include the following information:

- a. Item Number
  - b. Camera Number
  - c. Naming Conventions
  - d. Description of Camera Coverage
  - e. Camera Location
  - f. Floor Plan Sheet Number
  - g. Camera Type
  - h. Mounting Type
  - i. Standard Detail Reference
  - j. Power Input & Draw
  - k. Power Panel Location
  - l. Remarks Column for Camera
3. Section II – Data Gathering Panel Documentation Package
- a. Contractor shall provide Data Gathering Panel (DGP) input and output documentation packages for review at the Shop Drawing submittal stage and also with the as-built documentation package. The documentation packages shall be provided in both printed and magnetic form at both review stages.
  - b. The Contractor shall provide loading sheet documentation package for the associated DGP, including input and output boards for all field panels associated with the project. Documentation shall be provided in current version Microsoft Excel spreadsheets following the format currently utilized by VA. A separate spreadsheet file shall be generated for each DGP and associated field panels.
  - c. The spreadsheet names shall follow a sequence that shall display the spreadsheets in numerical order according to the DGP system number. The spreadsheet shall include the prefix in the file name that uniquely identifies the project site. The spreadsheet shall detail all connected items such as card readers, alarm inputs, and relay output connections. The spreadsheet shall include an individual section (row) for each panel input, output and card reader.

The spreadsheet shall automatically calculate the system numbers for card readers, inputs, and outputs based upon data entered in initialization fields.

- d. All entries must be verified against the field devices. Copies of the floor plans shall be forwarded under separate cover.
- e. The DGP spreadsheet shall include an entry section for the following information:
  - 1) DGP number
  - 2) First Reader Number
  - 3) First Monitor Point Number
  - 4) First Relay Number
  - 5) DGP, input or output Location
  - 6) DGP Chain Number
  - 7) DGP Cabinet Tamper Input Number
  - 8) DGP Power Fail Input Number
  - 9) Number of Monitor Points Reserved For Expansion Boards
  - 10) Number of Control Points (Relays) Reserved For Expansion Boards
- f. The DGP, input module and output module spreadsheets shall automatically calculate the following information based upon the associated entries in the above fields:
  - 1) System Numbers for Card Readers
  - 2) System Numbers for Monitor Point Inputs
  - 3) System Numbers for Control Points (Relays)
  - 4) Next DGP or input module First Monitor Point Number
  - 5) Next DGP or output module First Control Point Number
- g. The DGP spreadsheet shall provide the following information for each card reader:
  - 1) DGP Reader Number
  - 2) System Reader Number
  - 3) Cable ID Number

- 4) Description Field (Room Number)
  - 5) Description Field (Device Type i.e.: In Reader, Out Reader, etc.)
  - 6) Description Field
  - 7) DGP Input Location
  - 8) Date Test
  - 9) Date Passed
  - 10) Cable Type
  - 11) Camera Numbers (of cameras viewing the reader location)
- h. The DGP and input module spreadsheet shall provide the following information for each monitor point (alarm input).
- 1) DGP Monitor Point Input Number
  - 2) System Monitor Point Number
  - 3) Cable ID Number
  - 4) Description Field (Room Number)
  - 5) Description Field (Device Type i.e.: Door Contact, Motion Detector, etc.)
  - 7) DGP or input module Input Location
  - 8) Date Test
  - 9) Date Passed
  - 10) Cable Type
  - 11) Camera Numbers (of associated alarm event preset call-ups)
- i. The DGP and output module spreadsheet shall provide the following information for each control point (output relay).
- 1) DGP Control Point (Relay) Number
  - 2) System (Control Point) Number
  - 3) Cable ID Number
  - 4) Description Field (Room Number)
  - 5) Description Field (Device: Lock Control, Local Sounder, etc.)
  - 6) Description Field
  - 7) DGP or OUTPUT MODULE Output Location

- 8) Date Test
- 9) Date Passed Cable Type
- 10) Camera Number (of associated alarm event preset call-ups)
- j. The DGP, input module and output module spreadsheet shall include the following information or directions in the header and footer:
  - 1) Header
    - a) DGP Input and Output Worksheet
    - b) Enter Beginning Reader, Input, and Output Starting Numbers and Sheet  
Will Automatically Calculate the Remaining System Numbers.
  - 2) Footer
    - a) File Name
    - b) Date Printed
    - c) Page Number
- 4. Section III - Construction Mock-up: In areas with exposed EMT/Conduit Raceways, contractor shall conceal raceway as much as practical and unobtrusively. In addition, historic significance must be considered to determine installation means and methods for approval by the owner.
- 5. Section IV - Manufacturers' Data: The data package shall include manufacturers' data for all materials and equipment, including sensors, local processors and console equipment provided under this specification.
- 6. Section V - System Description and Analysis: The data package shall include system descriptions, analysis, and calculations used in sizing equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance requirements of this specification. The data package shall include the following:
  - a. Central processor memory size; communication speed and protocol description; rigid disk system size and configuration; flexible disk system size and configuration; back-up media size and configuration; alarm response time calculations; command response time calculations; start-up operations;

expansion capability and method of implementation; sample copy of each report specified; and color photographs representative of typical graphics.

- b. Software Data: The data package shall consist of descriptions of the operation and capability of the system, and application software as specified.
  - c. Overall System Reliability Calculations: The data package shall include all manufacturers' reliability data and calculations required to show compliance with the specified reliability.
7. Section VI – Certifications & References: All specified manufacturer's certifications shall be included with the data package. Contractor shall provide Project references as outlined in Paragraph 1.4 "Quality Assurance".

G. Group II Technical Data Package

- 1. The Contractor shall prepare a report of "Current Site Conditions" and submit a report to the Resident Engineer documenting changes to the site, particularly those conditions that affect performance of the system to be installed. The Contractor shall provide specification sheets, or written functional requirements to support the findings, and a cost estimate to correct those site changes or conditions which affect the installation of the system or its performance. The Contractor shall not correct any deficiency without written permission from the COTR.
- 2. System Configuration and Functionality: The contractor shall provide the results of the meeting with VA to develop system requirements and functionality including but not limited to:
  - a. Baseline configuration
  - b. Access levels
  - c. Schedules (intrusion detection, physical access control, holidays, etc.)
  - d. Badge database
  - e. System monitoring and reporting (unit level and central control)
  - f. Naming conventions and descriptors

H. Group III Technical Data Package

1. Development of Test Procedures: The Contractor will prepare performance test procedures for the system testing. The test procedures shall follow the format of the VA Testing procedures and be customized to the contract requirements. The Contractor will deliver the test procedures to the Resident Engineer for approval at least 60 calendar days prior to the requested test date.
- I. Group IV Technical Data Package
  1. Performance Verification Test
    - a. Based on the successful completion of the pre-delivery test, the Contractor shall finalize the test procedures and report forms for the performance verification test (PVT) and the endurance test. The PVT shall follow the format, layout and content of the pre-delivery test. The Contractor shall deliver the PVT and endurance test procedures to the Resident Engineer for approval. The Contractor may schedule the PVT after receiving written approval of the test procedures. The Contractor shall deliver the final PVT and endurance test reports within 14 calendar days from completion of the tests. Refer to Part 3 of this section for System Testing and Acceptance requirements.
  2. Training Documentation
    - a. New Facilities and Major Renovations: Familiarization training shall be provided for new equipment or systems. Training can include site familiarization training for VA technicians and administrative personnel. Training shall include general information on new system layout including closet locations, turnover of the completed system including all documentation, including manuals, software, key systems, and full system administration rights. Lesson plans and training manuals training shall be oriented to type of training to be provided.
    - b. New Unit Control Room:
      - 1) Provide the security personnel with training in the use, operation, and maintenance of the entire control room system (Unit Control and Equipment Rooms). The training documentation must include the operation and maintenance. The first of the training sessions shall take place prior to

system turnover and the second immediately after turnover. Coordinate the training sessions with the Owner. Completed classroom sessions will be witnessed and documented by the Architect/Engineer, and approved by the Resident Engineer. Instruction is not to begin until the system is operational as designed.

- 2) The training documents will cover the operation and the maintenance manuals and the control console operators' manuals and service manuals in detail, stressing all important operational and service diagnostic information necessary for the maintenance and operations personnel to efficiently use and maintain all systems.
- 3) Provide an illustrated control console operator's manual and service manual. The operator's manual shall be written in laymen's language and printed so as to become a permanent reference document for the operators, describing all control panel switch operations, graphic symbol definitions and all indicating functions and a complete explanation of all software.
- 4) The service manual shall be written in laymen's language and printed so as to become a permanent reference document for maintenance personnel, describing how to run internal self diagnostic software programs, troubleshoot head end hardware and field devices with a complete scenario simulation of all possible system malfunctions and the appropriate corrective measures.
- 5) Provide a professional color DVD instructional recording of all the operational procedures described in the operator's manual. All charts used in the training session shall be clearly presented on the video. Any DVD found to be inferior in recording or material content shall be reproduced at no cost until an acceptable DVD is submitted. Provide four copies of the training DVD, one to the architect/engineer and three to the owner.

### 3. System Configuration and Data Entry:



- a. The contractor is responsible for providing all system configuration and data entry for the SMS and subsystems (e.g., video matrix switch, intercom, digital video recorders, network video recorders). All data entry shall be performed per VA standards & guidelines. The Contractor is responsible for participating in all meetings with the client to compile the information needed for data entry. These meetings shall be established at the beginning of the project and incorporated in to the project schedule as a milestone task. The contractor shall be responsible for all data collection, data entry, and system configuration. The contractor shall collect, enter, & program and/or configure the following components:
  - 1) Physical Access control system components,
  - 2) All intrusion detection system components,
  - 3) Video surveillance, control and recording systems,
  - 4) Intercom systems components,
  - 5) All other security subsystems shown in the contract documents.
- b. The Contractor is responsible for compiling the card access database for the VA employees, including programming reader configurations, access shifts, schedules, exceptions, card classes and card enrollment databases.
- c. Refer to Part 3 for system programming requirements and planning guidelines.
4. Graphics: Based on CAD as-built drawings developed for the construction project, create all map sets showing locations of all alarms and field devices. Graphical maps of all alarm points installed under this contract including perimeter and exterior alarm points shall be delivered with the system. The Contractor shall create and install all graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the COTR, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy,

color examples at least 203.2 x 254 mm (8 x 10 in) of each type of graphic to be used for the completed Security system. The graphics examples shall be delivered to the Resident Engineer for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires them.

- J. Group V Technical Data Package: Final copies of the manuals shall be delivered to the Resident Engineer as part of the acceptance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each sub-contractor installing equipment or systems, as well as the nearest service representatives for each item of equipment for each system. The manuals shall include a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Six (6) hard-copies and one (1) soft copy on CD of each item listed below shall be delivered as a part of final systems acceptance.
1. Functional Design Manual: The functional design manual shall identify the operational requirements for the entire system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. Manufacturer developed literature may be used; however, shall be produced to match the project requirements.
  2. Equipment Manual: A manual describing all equipment furnished including:
    - a. General description and specifications; installation and checkout procedures; equipment electrical schematics and layout drawings; system schematics and layout drawings; alignment and calibration procedures; manufacturer's repair list indicating sources of supply; and interface definition.

3. Software Manual: The software manual shall describe the functions of all software and include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
  - a. Definition of terms and functions; use of system and applications software; procedures for system initialization, start-up, and shutdown; alarm reports; reports generation, database format and data entry requirements; directory of all disk files; and description of all communications protocols including data formats, command characters, and a sample of each type of data transfer.
4. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:
  - a. Computers and peripherals; system start-up and shutdown procedures; use of system, command, and applications software; recovery and restart procedures; graphic alarm presentation; use of report generator and generation of reports; data entry; operator commands' alarm messages, and printing formats; and system access requirements.
5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, recommend schedules, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
6. Spare Parts & Components Data: At the conclusion of the Contractor's work, the Contractor shall submit to the Resident Engineer a complete list of the manufacturer's recommended spare parts and components required to satisfactorily maintain and service the systems, as well as unit pricing for those parts and components.
7. Operation, Maintenance & Service Manuals: The Contractor shall provide two (2) complete sets of operating and maintenance manuals in the form of an instructional manual for use by the VA Security Guard Force personnel. The manuals shall be organized into suitable sets of manageable size. Where possible, assemble

- instructions for similar equipment into a single binder. If multiple volumes are required, each volume shall be fully indexed and coordinated.
8. Equipment and Systems Maintenance Manual: The Contractor shall provide the following descriptive information for each piece of equipment, operating system, and electronic system:
- a. Equipment and/or system function.
  - b. Operating characteristics.
  - c. Limiting conditions.
  - d. Performance curves.
  - e. Engineering data and test.
  - f. Complete nomenclature and number of replacement parts.
  - g. Provide operating and maintenance instructions including assembly drawings and diagrams required for maintenance and a list of items recommended to stock as spare parts.
  - h. Provide information detailing essential maintenance procedures including the following: routine operations, trouble shooting guide, disassembly, repair and re-assembly, alignment, adjusting, and checking.
  - i. Provide information on equipment and system operating procedures, including the following; start-up procedures, routine and normal operating instructions, regulation and control procedures, instructions on stopping, shut-down and emergency instructions, required sequences for electric and electronic systems, and special operating instructions.
  - j. Manufacturer equipment and systems maintenance manuals are permissible.
9. Project Redlines: During construction, the Contractor shall maintain an up-to-date set of construction redlines detailing current location and configuration of the project components. The redline documents shall be marked with the words 'Master Redlines' on the cover sheet and be maintained by the Contractor in the project office. The Contractor will provide access to redline documents anytime during the project for review and inspection by the Resident Engineer or authorized

- Office of Protection Services representative. Master redlines shall be neatly maintained throughout the project and secured under lock and key in the contractor's onsite project office. Any project component or assembly that is not installed in strict accordance with the drawings shall be so noted on the drawings. Prior to producing Record Construction Documents, the contractor will submit the Master Redline document to the Resident Engineer for review and approval of all changes or modifications to the documents. Each sheet shall have Resident Engineer initials indicating authorization to produce "As Built" documents. Field drawings shall be used for data gathering & field changes. These changes shall be made to the master redline documents daily. Field drawings shall not be considered "master redlines".
10. Record Specifications: The Contractor shall maintain one (1) copy of the Project Specifications, including addenda and modifications issued, for Project Record Documents. The Contractor shall mark the Specifications to indicate the actual installation where the installation varies substantially from that indicated in the Contract Specifications and modifications issued. (Note related Project Record Drawing information where applicable). The Contractor shall pay particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later. Upon completion of the mark ups, the Contractor shall submit record Specifications to the COTR. As with master relines, Contractor shall maintain record specifications for Resident Engineer review and inspection at anytime.
  11. Record Product Data: The Contractor shall maintain one (1) copy of each Product Data submittal for Project Record Document purposes. The Data shall be marked to indicate the actual product installed where the installation varies substantially from that indicated in the Product Data submitted. Significant changes in the product delivered to the site and changes in manufacturer's instructions and recommendations for installation shall be included. Particular attention will be given to information on concealed products and installations that cannot be readily

- identified or recorded later. Note related Change Orders and mark up of Record Construction Documents, where applicable. Upon completion of mark up, submit a complete set of Record Product Data to the COTR.
12. Miscellaneous Records: The Contractor shall maintain one (1) copy of miscellaneous records for Project Record Document purposes. Refer to other Specifications for miscellaneous record-keeping requirements and submittals concerning various construction activities. Before substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Categories of requirements resulting in miscellaneous records include a minimum of the following:
- a. Certificates received instead of labels on bulk products.
  - b. Testing and qualification of tradesmen. ("Contractor's Qualifications")
  - c. Documented qualification of installation firms.
  - d. Load and performance testing.
  - e. Inspections and certifications.
  - f. Final inspection and correction procedures.
  - g. Project schedule
13. Record Construction Documents (Record As-Built)
- a. Upon project completion, the contractor shall submit the project master redlines to the Resident Engineer prior to development of Record construction documents. The Resident Engineer shall be given a minimum of a thirty (30) day review period to determine the adequacy of the master redlines. If the master redlines are found suitable by the Resident Engineer, the Resident Engineer will initial and date each sheet and turn redlines over to the contractor for as built development.
  - b. The Contractor shall provide the Resident Engineer a complete set of "as-built" drawings and original master redlined marked "as-built" blue-line in the latest version of AutoCAD drawings unlocked on CD or DVD. The as-built drawing shall include security device number, security closet connection location, data

gathering panel number, and input or output number as applicable. All corrective notations made by the Contractor shall be legible when submitted to the COTR. If, in the opinion of the COTR, any redlined notation is not legible, it shall be returned to the Contractor for re-submission at no extra cost to the Owner. The Contractor shall organize the Record Drawing sheets into manageable sets bound with durable paper cover sheets with suitable titles, dates, and other identifications printed on the cover. The submitted as built shall be in editable formats and the ownership of the drawings shall be fully relinquished to the owner.

- c. Where feasible, the individual or entity that obtained record data, whether the individual or entity is the installer, sub-contractor, or similar entity, is required to prepare the mark up on Record Drawings. Accurately record the information in a comprehensive drawing technique. Record the data when possible after it has been obtained. For concealed installations, record and check the mark up before concealment. At the time of substantial completion, submit the Record Construction Documents to the COTR. The Contractor shall organize into bound and labeled sets for the COTR's continued usage. Provide device, conduit, and cable lengths on the conduit drawings. Exact in-field conduit placement/routings shall be shown. All conduits shall be illustrated in their entire length from termination in security closets; no arrowed conduit runs shall be shown. Pull box and junction box sizes are to be shown if larger than 100mm (4 inch).

K. FIPS 201 Compliance Certificates

SPEC WRITER NOTES: Delete and add components to the list as required by the project. Check <http://www.fips201.com/> website for list of the approved products.

1. Provide Certificates for all software components and device types utilizing credential verification. Provide certificates for:
  - a. Fingerprint Capture Station
  - b. Card Readers

- c. Facial Image Capturing Camera
  - d. PIV Middleware
  - e. Template Matcher
  - f. Electromagnetically Opaque Sleeve
  - g. Certificate Management
    - 1) CAK Authentication System
    - 2) PIV Authentication System
    - 3) Certificate Validator
    - 4) Cryptographic Module
  - h. <list devices and software>
- L. Approvals will be based on complete submission of manuals together with shop drawings.
- M. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
- 1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
  - 2. Each type of conduit and pathway coupling, bushing and termination fitting.
  - 3. Conduit hangers, clamps and supports.
  - 4. Duct sealing compound.
- N. 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.
- O. In addition to the requirement of SUBMITTALS, the VA reserves the right to request the manufacturer to arrange for a VA representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.



## 1.7 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)/ International Code Council (ICC):  
A117.1 .....Standard on Accessible and Usable Buildings and Facilities
- C. American National Standards Institute (ANSI)/ Security Industry Association (SIA):  
AC-03.....Access Control: Access Control Guideline Dye Sublimation  
Printing Practices for PVC Access Control Cards  
CP-01-00.....Control Panel Standard-Features for False Alarm Reduction  
PIR-01-00.....Passive Infrared Motion Detector Standard - Features for  
Enhancing False Alarm Immunity  
TVAC-01.....CCTV to Access Control Standard - Message Set for System  
Integration
- D. 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
- E. American National Standards Institute (ANSI):  
ANSI S3.2-99.....Method for measuring the Intelligibility of Speech over  
Communications Systems
- F. 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  
C1238-97 (R03) .....Standard Guide for Installation of Walk-Through Metal  
Detectors

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

G. Architectural Barriers Act (ABA), 1968

H. Department of Justice: American Disability Act (ADA)

28 CFR Part 36-2010 ADA Standards for Accessible Design

I. Department of Veterans Affairs:

VHA National CAD Standard Application Guide, 2006

VA BIM Guide, V1.0 10

J. Federal Communications Commission (FCC):

(47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems

K. Federal Information Processing Standards (FIPS):

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

L. Federal Specifications (Fed. Spec.):

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

M. Government Accountability Office (GAO):

GAO-03-8-02 .....Security Responsibilities for Federally Owned and Leased  
Facilities

N. Homeland Security Presidential Directive (HSPD):

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

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

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

802.3af-08 .....Power over Ethernet Standard

802.3at-09 .....Power over Ethernet (PoE) Plus Standard

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

C62.41-02 .....IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

C95.1-05 .....Standards for Safety Levels with Respect to Human Exposure in Radio Frequency Electromagnetic Fields

P. International Organization for Standardization (ISO):

7810 .....Identification cards – Physical characteristics

7811 .....Physical Characteristics for Magnetic Stripe Cards

7816-1 .....Identification cards - Integrated circuit(s) cards with contacts - Part 1: Physical characteristics

7816-2 .....Identification cards - Integrated circuit cards - Part 2: Cards with contacts -Dimensions and location of the contacts

7816-3 .....Identification cards - Integrated circuit cards - Part 3: Cards with contacts - Electrical interface and transmission protocols

7816-4 .....Identification cards - Integrated circuit cards - Part 11: Personal verification through biometric methods

7816-10 .....Identification cards - Integrated circuit cards - Part 4: Organization, security and commands for interchange

14443 .....Identification cards - Contactless integrated circuit cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 inches distance

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

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

Q. National Electrical Contractors Association

303-2005 .....Installing Closed Circuit Television (CCTV) Systems

R. National Electrical Manufacturers Association (NEMA):

- 250-08 .....Enclosures for Electrical Equipment (1000 Volts Maximum)
- 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
- S. National Fire Protection Association (NFPA):
- 70-11 ..... National Electrical Code (NEC)
- 731-08 .....Standards for the Installation of Electric Premises Security  
Systems
- 99-2005 .....Health Care Facilities
- T. National Institute of Justice (NIJ)
- 0601.02-03 .....Standards for Walk-Through Metal Detectors for use in  
Weapons Detection
- 0602.02-03 .....Hand-Held Metal Detectors for Use in Concealed Weapon  
and Contraband Detection
- U. National Institute of Standards and Technology (NIST):
- IR 6887 V2.1 .....Government Smart Card Interoperability Specification  
(GSC-IS)
- Special Pub 800-37 .....Guide for Applying the Risk Management Framework to  
Federal Information Systems
- Special Pub 800-63 .....Electronic Authentication Guideline
- Special Pub 800-73-3 .....Interfaces for Personal Identity Verification (4 Parts)
- .....Pt. 1- End Point PIV Card Application Namespace, Data  
Model & Representation
- .....Pt. 2- PIV Card Application Card Command Interface
- .....Pt. 3- PIV Client Application Programming Interface
- .....Pt. 4- The PIV Transitional Interfaces & Data Model  
Specification
- Special Pub 800-76-1 .....Biometric Data Specification for Personal Identity  
Verification

- Special Pub 800-78-2 .....Cryptographic Algorithms and Key Sizes for Personal  
Identity Verification
- Special Pub 800-79-1 .....Guidelines for the Accreditation of Personal Identity  
Verification Card Issuers
- Special Pub 800-85B-1 .....DRAFTPIV Data Model Test Guidelines
- Special Pub 800-85A-2 .....PIV Card Application and Middleware Interface Test  
Guidelines (SP 800-73-3 compliance)
- Special Pub 800-96.....PIV Card Reader Interoperability Guidelines
- Special Pub 800-104A .....Scheme for PIV Visual Card Topography
- V. Occupational and Safety Health Administration (OSHA):
  - 29 CFR 1910.97 .....Nonionizing radiation
- W. Section 508 of the Rehabilitation Act of 1973
- X. Security Industry Association (SIA):
  - AG-01 .....Security CAD Symbols Standards
- Y. Underwriters Laboratories, Inc. (UL):
  - 1-05 .....Flexible Metal Conduit
  - 5-04 .....Surface Metal Raceway and Fittings
  - 6-07 .....Rigid Metal Conduit
  - 44-05 .....Thermoset-Insulated Wires and Cables
  - 50-07 .....Enclosures for Electrical Equipment
  - 83-08 .....Thermoplastic-Insulated Wires and Cables
  - 294-99 .....The Standard of Safety for Access Control System Units
  - 305-08 .....Standard for Panic Hardware
  - 360-09 .....Liquid-Tight Flexible Steel Conduit
  - 444-08 .....Safety Communications Cables
  - 464-09 .....Audible Signal Appliances
  - 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
514A-04 .....	Metallic Outlet Boxes
514B-04 .....	Fittings for Cable and Conduit
51-05 .....	Schedule 40 and 80 Rigid PVC Conduit
609-96 .....	Local Burglar Alarm Units and Systems
634-07 .....	Standards for Connectors with Burglar-Alarm Systems
636-01 .....	Standard for Holdup Alarm Units and Systems
639-97 .....	Standard for Intrusion-Detection Units
651-05 .....	Schedule 40 and 80 Rigid PVC Conduit
651A-07 .....	Type EB and A Rigid PVC Conduit and HDPE Conduit
752-05 .....	Standard for Bullet-Resisting Equipment
797-07 .....	Electrical Metallic Tubing
827-08 .....	Central Station Alarm Services
1037-09 .....	Standard for Anti-theft Alarms and Devices
1635-10 .....	Digital Alarm Communicator System Units
1076-95 .....	Standards for Proprietary Burglar Alarm Units and Systems
1242-06 .....	Intermediate Metal Conduit
1479-03 .....	Fire Tests of Through-Penetration Fire Stops
1981-03 .....	Central Station Automation System
2058-05 .....	High Security Electronic Locks
60950 .....	Safety of Information Technology Equipment
60950-1 .....	Information Technology Equipment - Safety - Part 1: General Requirements

Z. Uniform Federal Accessibility Standards (UFAS) 1984

AA. United States Department of Commerce:

Special Pub 500-101 .....Care and Handling of Computer Magnetic Storage Media

## **1.8 COORDINATION**

A. Coordinate arrangement, mounting, and support of electronic safety and security 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 electronic safety and security items that are behind finished surfaces or otherwise concealed.

## **1.9 MAINTENANCE & SERVICE**

A. General Requirements

1. The Contractor shall provide all services required and equipment necessary to maintain the entire integrated electronic security system in an operational state as specified for a period of one (1) year after formal written acceptance of the system. The Contractor shall provide all necessary material required for performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. See also General Project Requirements.

B. Description of Work

1. The adjustment and repair of the security system includes all software updates, panel firmware, and the following new items computers equipment,

communications transmission equipment and data transmission media (DTM), local processors, security system sensors, physical access control equipment, facility interface, signal transmission equipment, and video equipment.

C. Personnel

1. Service personnel shall be certified in the maintenance and repair of the selected type of equipment and qualified to accomplish all work promptly and satisfactorily. The Resident Engineer shall be advised in writing of the name of the designated service representative, and of any change in personnel. The Resident Engineer shall be provided copies of system manufacturer certification for the designated service representative.

D. Schedule of Work

1. The work shall be performed during regular working hours, Monday through Friday, excluding federal holidays.

E. System Inspections

1. These inspections shall include:
  - a. The Contractor shall perform two (2) minor inspections at six (6) month intervals or more if required by the manufacturer, and two (2) major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
    - 1) Minor Inspections shall include visual checks and operational tests of all console equipment, peripheral equipment, local processors, sensors, electrical and mechanical controls, and adjustments on printers.
    - 2) Major Inspections shall include all work described for Minor Inspections and the following: clean all system equipment and local processors including interior and exterior surfaces; perform diagnostics on all equipment; operational tests of the CPU, switcher, peripheral equipment, recording devices, monitors, picture quality from each camera; check, walk test, and calibrate each sensor; run all system software diagnostics and correct all problems; and resolve any previous outstanding problems.



F. Emergency Service

1. The owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. The Owner shall have sole authority for determining catastrophic and non-catastrophic system failures within parameters stated in General Project Requirements.
  - a. For catastrophic system failures, the Contractor shall provide same day four (4) hour service response with a defect correction time not to exceed eight (8) hours from [notification] [arrival on site]. Catastrophic system failures are defined as any system failure that the Owner determines will place the facility(s) at increased risk.
  - b. For non-catastrophic failures, the Contractor within eight (8) hours with a defect correction time not to exceed 24 hours from notification.

G. Operation

1. Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable portions of the performance verification test.

H. Records & Logs

1. The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

I. Work Request

1. The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of

service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall deliver a record of the work performed within five (5) working days after the work was completed.

J. System Modifications

1. The Contractor shall make any recommendations for system modification in writing to the Resident Engineer. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the Resident Engineer. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and other documentation affected.

K. Software

1. The Contractor shall provide all software updates when approved by the Owner from the manufacturer during the installation and 12-month warranty period and verify operation of the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the operations and maintenance manuals and software documentation. There shall be at least one (1) scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software. All software changes shall be recorded in a log maintained in the unit control room. An electronic copy of the software update shall be maintained within the log. At a minimum, the contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "SOFTWARE CHANGE LOG".

**1.10 MINIMUM REQUIREMENTS**

- A. References to industry and trade association standards and codes are minimum installation requirement standards.

- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

#### **1.11 DELIVERY, STORAGE, & HANDLING**

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  2. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
  3. Painted surfaces shall be protected with factory installed removable heavy craft paper, sheet vinyl or equal.
  4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.
- B. Central Station, Workstations, and Controllers:
1. Store in temperature and humidity controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 10 to 30 deg C (50 to 85 deg F), and not more than 80 percent relative humidity, non-condensing.
  2. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.
  3. Mark packing list with designations which have been assigned to materials and equipment for recording in the system labeling schedules generated by cable and asset management system.

4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

#### **1.12 PROJECT CONDITIONS**

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  1. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 2 to 50 deg C (36 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 1 enclosure.
  2. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of -18 to 50 deg C (0 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 4X enclosures.
  3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -34 to 50 deg C (-30 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 610 mm (24 in) thick. NEMA 250, Type 4X enclosures.
  4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
  5. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

- B. Security Environment: Use vandal resistant enclosures in high-risk areas where equipment may be subject to damage.
- C. Console: All console equipment shall, unless noted otherwise, be rated for continuous operation under ambient environmental conditions of 15.6 to 29.4 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent.

### **1.13 EQUIPMENT AND MATERIALS**

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

3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

#### **1.14 ELECTRICAL POWER**

- A. Electrical power of 120 Volts Alternating Current (VAC) shall be indicated on the Division 26 drawings. Additional locations requiring primary power required by the security system shall be shown as part of these contract documents. Primary power for the security system shall be configured to switch to emergency backup sources automatically if interrupted without degradation of any critical system function. Alarms shall not be generated as a result of power switching, however, an indication of power switching on (on-line source) shall be provided to the alarm monitor. The Security Contractor shall provide an interface (dry contact closure) between the PACS and the Uninterruptible Power Supply (UPS) system so the UPS trouble signals and main power fail appear on the PACS operator terminal as alarms.
- B. Failure of any on-line battery shall be detected and reported as a fault condition. Battery backed-up power supplies shall be provided sized for [8] <insert hours> hours of operation at actual connected load. Requirements for additional power or locations shall be included with the contract to support equipment and systems offered. The following minimum requirements shall be provided for power sources and equipment.
  1. Emergency Generator
    - a. Report Printers: Unit Control Room
    - b. Video Monitors: Unit Control Room
    - c. Intercom Stations
    - d. Radio System
    - e. Lights: Unit Control Room, Equipment Rooms, & Security Offices
    - f. Outlets: Security Outlets dedicated to security equipment racks or security enclosure assemblies.
    - g. Security Device Power Supplies (DGP, VASS, Card Access, Lock Power, etc.) powered from the security closets or remotely: various locations

- h. Telephone/Radio Recording Equipment: Unit Control Room.
  - i. VASS Camera Power Supplies: Security Closets
  - j. VASS Pan/Tilt Units: Various Locations
  - k. VASS Outdoor Housing Heaters and Blowers: Various Sites
  - l. Intercom Master Control System
  - m. Fiber Optic Receivers/Transmitters
  - n. Security office Weapons Storage
  - o. Outlets that charge handheld radios
2. Uninterruptible Power Supply (UPS) on Emergency Power
- a. The following 120VAC circuits shall be provided by others. The Security Contractor shall coordinate exact locations with the Electrical Contractor:
    - 1) Security System Monitors and Keyboards: Control Room
    - 2) CPU: Control Equipment Room
    - 3) Communications equipment: Control Equipment Room and various sites.
    - 4) VASS Matrix Switcher: Control Equipment Room
    - 5) VASS: Control Equipment Room
    - 6) Digital Video Recorders, encoders & decoders: Control Room
    - 7) All equipment Room racked equipment.
    - 8) Network switches

#### **1.15 TRANSIENT VOLTAGE SUPPRESSION, POWER SURGE SUPPLESION, & GROUNDING**

- A. Transient Voltage Surge Suppression: All cables and conductors extending beyond building façade, except fiber optic cables, which serve as communication, control, or signal lines shall be protected against Transient Voltage surges and have Transient Voltage Surge Suppression (TVSS) protection. The TVSS device shall be UL listed in accordance with Standard TIA 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 914.4 mm (3 ft) of the building cable entrance. Fuses shall not be used for surge protection. The inputs

and outputs shall be tested in both normal mode and common mode to verify there is no interference.

1. A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
2. An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.
3. Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model # TE/FA 10B or TE/FA 20B.
4. Operating Temperature and Humidity: -40 to 85 deg C (-40 to 185 deg F), 0 to 95 percent relative humidity.

B. Grounding and Surge Suppression

1. The Security Contractor shall provide grounding and surge suppression to stabilize the voltage under normal operating conditions. To ensure the operation of over current devices, such as fuses, circuit breakers, and relays, under ground-fault conditions.
2. Security Contractor shall engineer and provide proper grounding and surge suppression as required by local jurisdiction and prevailing codes and standards referenced in this document.
3. Principal grounding components and features. Include main grounding buses and grounding and bonding connections to service equipment.
4. Details of interconnection with other grounding systems. The lightning protection system shall be provided by the Security Contractor.
5. Locations and sizes of grounding conductors and grounding buses in electrical, data, and communication equipment rooms and closets.
6. AC power receptacles are not to be used as a ground reference point.
7. Any cable that is shielded shall require a ground in accordance with the best practices of the trade and manufactures installation instructions.
8. Protection should be provided at both ends of cabling.



## **1.16 COMPONENT ENCLOSURES**

### **A. Construction of Enclosures**

1. Consoles, power supply enclosures, detector control and terminal cabinets, control units, wiring gutters, and other component housings, collectively referred to as enclosures, shall be so formed and assembled as to be sturdy and rigid.
2. Thickness of metal in-cast and sheet metal enclosures of all types shall not be less than those in Tables I and II, UL 611. Sheet steel used in fabrication of enclosures shall be not less than 14 gauge. Consoles shall be 16-gauge.
3. Doors and covers shall be flanged. Enclosures shall not have pre-punched knockouts. Where doors are mounted on hinges with exposed pins, the hinges shall be of the tight pin type or the ends of hinge pins shall be tack welded to prevent removal. Doors having a latch edge length of less than 609.6 mm (24 in) shall be provided with a single construction core. Where the latch edge of a hinged door is more than 609.6 mm (24 in) or more in length, the door shall be provided with a three-point latching device with construction core; or alternatively with two, one located near each end.
4. Any ventilator openings in enclosures and cabinets shall conform to the requirements of UL 611. Unless otherwise indicated, sheet metal enclosures shall be designed for wall mounting with top holes slotted. Mounting holes shall be in positions that remain accessible when all major operating components are in place and the door is open, but shall be inaccessible when the door is closed.
5. Covers of pull and junction boxes provided to facilitate initial installation of the system shall be held in place by tamper proof Torx Center post security screws. Stenciled or painted labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate the box is part of the Electronic Security System (ESS).

### **B. Consoles & Equipment Racks: All consoles and vertical equipment racks shall include a forced air-cooling system to be provided by others.**

1. Vertical Equipment Racks:

- a. The forced air blowers shall be installed in the vented top of each cabinet and shall not reduce usable rack space.
  - b. The forced air fan shall consist of one fan rated at 105 CFM per rack bay and noise level shall not exceed 55 decibels.
  - c. d. Vertical equipment racks are to be provided with full sized clear plastic locking doors and vented top panels as shown on contract drawings.
2. Console racks:
- a. Forced air fans shall be installed in the top rear of each console bay. The forced air fan shall consist of one fan rated at 105 CFM mounted to a 133mm vented blank panel the noise level of each fan shall not exceed 55 decibels. The fans shall be installed so air is pulled from the bottom of the rack or cabinet and exhausted out the top.
  - b. Console racks are to be provided with flush mounted hinged rear doors with recessed locking latch on the bottom and middle sections of the consoles.  
Provide code access to support wiring for devices located on the work surfaces.
- C. Tamper Provisions and Tamper Switches:
- 1. Enclosures, cabinets, housings, boxes and fittings or every product description having hinged doors or removable covers and which contain circuits, or the integrated security system and its power supplies shall be provided with cover operated, corrosion-resistant tamper switches.
  - 2. Tamper switches shall be arranged to initiate an alarm signal that will report to the monitoring station when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. It shall take longer than 1 second to depress or defeat the tamper switch after opening or removing the cover. The enclosure and tamper switch shall function together in such a manner as to prohibit direct line of sight to any internal component before the switch activates.
  - 3. Tamper switches shall be inaccessible until the switch is activated. Have mounting hardware concealed so the location of the switch cannot be observed from the

- exterior of the enclosure. Be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating. Be spring-loaded and held in the closed position by the door or cover and be wired so they break the circuit when the door cover is disturbed. Tamper circuits shall be adjustable type screw sets and shall be adjusted by the contractor to eliminate nuisance alarms associated with incorrectly mounted tamper device shall annunciate prior to the enclosure door opening (within 1/4 " tolerance. The tamper device or its components shall not be visible or accessible with common tools to bypass when the enclosure is in the secured mode.
4. The single gang junction boxes for the portrait alarming and pull boxes with less than 102 square mm will not require tamper switches.
  5. All enclosures over 305 square mm shall be hinged with an enclosure lock.
  6. Control Enclosures: Maintenance/Safety switches on control enclosures, which must be opened to make routing maintenance adjustments to the system and to service the power supplies, shall be push/pull-set automatic reset type.
  7. Provide one (1) enclosure tamper switch for each 609 linear mm of enclosure lock side opening evenly spaced.
  8. All security screws shall be Torx-Post Security Screws.
  9. The contractor shall provide the owner with two (2) torx-post screwdrivers.

#### **1.17 ELECTRONIC COMPONENTS**

- A. All electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL 796. Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. All power-dissipating components shall incorporate safety margins of not less than 25 percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity.

#### **1.18 SUBSTITUTE MATERIALS & EQUIPMENT**

- A. Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited

to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

- B. In addition to this Section the Security Contractor shall also reference Section II, Products and associated divisions. The Resident Engineer shall have final authority on the authorization or refusal of substitutions. If there are no proposed substitutions, a statement in writing from the Contractor shall be submitted to the Resident Engineer stating same. In the preparation of a list of substitutions, the following information shall be included, as a minimum:
1. Identity of the material or devices specified for which there is a proposed substitution.
  2. Description of the segment of the specification where the material or devices are referenced.
  3. Identity of the proposed substitute by manufacturer, brand name, catalog or model number and the manufacturer's product name.
  4. A technical statement of all operational characteristic expressing equivalence to items to be substituted and comparison, feature-by-feature, between specification requirements and the material or devices called for in the specification; and Price differential.
- C. Materials Not Listed: Furnish all necessary hardware, software, programming materials, and supporting equipment required to place the specified major subsystems in full operation. Note that some supporting equipment, materials, and hardware may not be described herein. Depending on the manufacturers selected by the COTR, some equipment, materials and hardware may not be contained in either the Contract Documents or these written specifications, but are required by the manufacturer for complete operation according to the intent of the design and these specifications. In such cases, the Resident Engineer shall be given the opportunity to approve the additional equipment, hardware and materials that shall be fully identified in the bid and in the equipment list submittal. The Resident Engineer shall be consulted in the

event there is any question about which supporting equipment, materials, or hardware is intended to be included.

- D. Response to Specification: The Contractor shall submit a point-by-point statement of compliance with each paragraph of the security specification. The statement of compliance shall list each paragraph by number and indicate "COMPLY" opposite the number for each paragraph where the Contractor fully complies with the specification. Where the proposed system cannot meet the requirements of the paragraph, and does not offer an equivalent solution, the offers shall indicate "DOES NOT COMPLY" opposite the paragraph number. Where the proposed system does not comply with the paragraph as written, but the bidder feels it will accomplish the intent of the paragraph in a manner different from that described, the offers shall indicate "COMPARABLE". The offers shall include a statement fully describing the "comparable" method of satisfying the requirement. Where a full and concise description is not provided, the offered system shall be considered as not complying with the specification. Any submission that does not include a point-by-point statement of compliance, as described above, shall be disqualified. Submittals for products shall be in precise order with the product section of the specification. Submittals not in proper sequence will be rejected.

#### **1.19 LIKE ITEMS**

- A. Where two or more items of equipment performing the same function are required, they shall be exact duplicates produced by one manufacturer. All equipment provided shall be complete, new, and free of any defects.

#### **1.20 WARRANTY**

- A. The Contractor shall, as a condition precedent to the final payment, execute a written guarantee (warranty) to the COTR certifying all contract requirements have been completed according to the final specifications. Contract drawings and the warranty of all materials and equipment furnished under this contract are to remain in satisfactory operating condition (ordinary wear and tear, abuse and causes beyond his control for this work accepted) for one (1) year from the date the Contractor received written notification of final acceptance from the COTR. Demonstration and training shall be

performed prior to system acceptance. All defects or damages due to faulty materials or workmanship shall be repaired or replaced without delay, to the COTR's satisfaction, and at the Contractor's expense. The Contractor shall provide quarterly inspections during the warranty period. The contractor shall provide written documentation to the COTR on conditions and findings of the system and device(s). In addition, the contractor shall provide written documentation of test results and stating what was done to correct any deficiencies. The first inspection shall occur 90 calendar days after the acceptance date. The last inspection shall occur 30 calendar days prior to the end of the warranty. The warranty period shall be extended until the last inspection and associated corrective actions are complete. When equipment and labor covered by the Contractor's warranty, or by a manufacturer's warranty, have been replaced or restored because of it's failure during the warranty period, the warranty period for the replaced or repaired equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work. In the event any manufacturer customarily provides a warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.

#### **1.22 SINGULAR NUMBER**

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

### **PART 2 – PRODUCTS**

#### **2.1 EQUIPMENT AND MATERIALS**

- A. All equipment associated within the Security Control Room, Security Console and Security Equipment Room shall be UL 827, UL 1981, and UL 60950 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.

- B. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of [8] <insert hours> hours of run time in the event of a loss of primary power to the facility.
- C. The system shall be designed, installed, and programmed in a manner that will allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.
- D. All equipment and materials for the system will be compatible to ensure correct operation.

## **2.2 EQUIPMENT ITEMS**

- A. The Security Management System shall provide full interface with all components of the security subsystem as follows:
  - 1. Shall allow for communication between the Physical Access Control System and Database Management and all subordinate work and monitoring stations, enrollment centers for badging and biometric devices as part of the PACS, local annunciation centers, the electronic Security Management System (SMS), and all other VA redundant or backup command center or other workstations locations.
  - 2. Shall provide automatic continuous communication with all systems that are monitored by the SMS, and shall automatically annunciate any communication failures or system alarms to the SMS operator providing identification of the system, nature of the alarm, and location of the alarm.
  - 3. Controlling devices shall be utilized to interface the SMS with all field devices.
  - 4. The Security control room and security console will be supported by an uninterrupted power supply (UPS) or dedicated backup generator power circuit.
  - 5. The Security Equipment room, Security Control Room, and Security Operator Console shall house the following equipment i.e. refer to individual master specifications for each security subsystem's specific requirements:
    - a. Security Console Bays and Equipment Racks

- b. Security Network Server and Workstation
  - c. CCTV Monitoring, Controlling, and Recording Equipment
  - d. PACS Monitoring and Controlling Equipment
  - e. IDS Monitoring and Controlling Equipment
  - f. Security Access Detection Monitoring Equipment
  - g. EPPS Monitoring and Controlling Equipment
  - h. Main Panels for all Security Systems
  - i. Power Supply Units (PSU) for all field devices
  - j. Life safety and power monitoring equipment
  - k. All other building systems deemed necessary by the VA to include, but not limited to, heating, ventilation and air conditioning (HVAC), elevator control, portable radio, fire alarm monitoring, and other potential systems.
  - l. Police two-way radio control consoles/units.
- B. Security Console Bays - shall be EIA 310D compliant and:
- 1. Utilize stand-up, sit-down, and vertical equipment racks in any combination to monitor and control the security subsystems.
  - 2. Shall be wide enough for equipment that requires a minimum 19 inch (47.5 cm) mounting area.
  - 3. Shall be made of metal, furnished with wire ways, a power strip, a thermostatic controlled bottom or top mounted fan units, a hinge mounted rear door, a hinge mounted front door made of Plexiglas, and a louvered top. When possible, pre-fabricated (standard off-the-shelf) security console equipment shall be used in place of customized designed consoles.
  - 4. A wire management system shall be designed and installed so that all cables are mounted in a manner that they do not interfere with day-to-day operations, are labeled for quick identification, and so that high voltage power cables do not cause signal interference with low voltage and data carrying cables.
  - 5. Shall be mounted on lockable casters.



6. Shall be ergonomically designed so that all devices requiring repetitive interaction with by the operator can be easily accessed, observed, and accomplished.
7. Controls and displays shall be located so that they are not obscured during normal operation. Control and display units installed with a work bench shall be a minimum of 3 in. (7.5 cm) from all edges of the work bench area.
8. All security subsystem controls shall be installed within the same operating console bay of their associated equipment.
9. Video monitors shall be mounted above all controls within a console bay and positioned in a manner that minimum strain is placed on the operator viewing them at the console.
10. At least one workbench for every three (3) console bays shall be provided free of control equipment to allow for appropriate operator workspace.
11. All console devices shall be labeled and marked with a minimum of quarter inch bold print.
12. All non-security related equipment that is required to be monitored shall be installed in a console bay separate from the security subsystem equipment and clearing be identified as such.
13. Console bays and related equipment shall be arranged in priority order and sequenced based upon their pre-defined security subsystem operations criticality established by the Contracting Officer.
14. The following minimum console technical characteristics shall be taken into consideration when designing for and installing the security console and equipment racks:

	Stand-Up	Sit-Down	Vertical Equipment Rack
Workstation Height	No Greater than 84 in. (210 cm)	No greater than 72 in. (150 cm)	No greater than 96 in. (240 cm)
Bench board Slope	21 in. (52.5 cm)	25 in. (62.5 cm)	N/A
Bench board Angle	15 degrees	15 degrees	N/A

Depth of Console	24 in. (60 cm)	24 in. (60 cm)	N/A
Leg and Feet Clearance	6 sq. ft. from center of Console Slope front	6 sq. ft. from center of Console Slope front	6 sq. ft. from center of Console Slope front
Distance Between Console Rows	96 in. (240 cm)	96 in. (240 cm)	96 in. (240 cm)
Distance Between Console and Wall	36 in. (90 cm) from the rear and/or side of console or rack	36 in. (90 cm) from the rear and/or side of console or rack	36 in. (90 cm) from the rear and/or side of console or rack

C. Security Console Configuration:

1. The size shall be defined by the number of console bays required to house and operate the security subsystems, as well as any other factors that may influence the overall design of the space. A small Access Control System and Database Management shall contain no more than four (4) security console bays. A large Access Control System and Database Management shall contain no less than five (5) and no more than eight (8) security console bays.
2. Shall meet the following minimum spacing requirements to ensure that a Access Control System and Database Management is provided to house existing and future security subsystems and other equipment listed in paragraph 2.3.C:
  - a. 500 square feet for a large Access Control System and Database Management.
  - b. 300 square feet for a small Access Control System and Database Management.
  - c. If office, training room and conference space, is a processing area as well as holding cell space is to be located adjacent to the Access Control System and Database Management, these space requirements also need to be considered.
3. Shall be located in an area within, at a minimum, the first level/line of security defense defined by the VA. If the Access Control System and Database Management is to be located outside the first level of security, then the area shall be constructed

- or retrofit to meet or exceed those requirements outlined in associated VA Master Specifications.
4. Shall not be located within or near an area with little to no blast mitigation standoff space protection, adjacent to an outside wall exposed to vehicle parking and traffic, within a basement or potential flood zone area, in close approximately to major utility areas, or near an exposed air intake(s).
  5. Access shall meet UFAS and ADA accessibility requirements.
  6. Construction shall be slab to slab and free of windows, with the exception of a service window. All penetrations into the room shall be sealed with fire stopping materials. This material shall apply in accordance with Section 07 84 00, FIRESTOPPING.
  7. A service window shall be installed in the wall next to the main entrance of the Access Control System and Database Management or where it best can be monitored and accessed by the security console operator. The window shall meet all requirements set forth in UL 752, to include at a minimum, Class III ballistic level protection. The windows shall be set in a minimum of four (4) inches (100 mm) solid concrete units to ceiling height with either masonry or gypsum wall board to the underside of the slab above. It shall also contain a service tray constructed in a manner that only objects no larger than 3 inches (7.5 cm) in width may pass through it.
  8. The walls making up or surrounding the Access Control System and Database Management shall be made of materials that at a minimum offer Class III ballistic level protection for the security console operator(s).
  9. There will be a main power cut-off button/switch located inside the Access Control System and Database Management in the event of an electrical fire or related event occurs.
  10. Shall have a fire alarm detection unit that is tied into the main building fire alarm system and have at least two fire extinguishers located within it.

11. Shall utilize a fire suppression system similar to that used by the VA's computer and telecommunications room operating areas.
12. The floor shall be raised a minimum of 4 inches (10 cm) from the concrete floor base. Wire ways shall be utilized under the raised floor for separation of signal and power wires and cables.
13. Access shall be monitored and controlled by the PACS via card reader and fixed camera that utilizes a wide angle lens. A 1 in. (2.5 cm) deadbolt shall be utilized as a mechanical override for the door in the event of electrical failure of the PACS, card reader, or locking mechanism.
14. There shall only be one point of ingress and egress to and from the Security Control Room. The door shall be made of solid core wood or better. If a window is required for the door, then the window shall be ballistic resistant with a Millar covering.
15. A two-way intercom shall be placed at the point of entry into the Security Control Room for access-communication control purposes.
16. A remote push-button door unlocking device shall not be installed for the electronic PACS locking mechanism providing access control into the Security Control Room.
17. All controlling equipment and power supplies that must be wall mounted shall be mounted in a manner that maximizes usability of the Security Control Room wall space. All equipment shall be mounted to three quarter inch fire retardant plywood. The plywood shall be fastened to the wall from slab to slab and fixed to the existing walls supports.

D. Security Control Room Ventilation

1. Shall meet or exceed all requirements laid out in VA Master Specification listed in Division 23, HEATING, VENTILATION, AND AIR CONDITIONING.
2. Controls shall be via a separate air handling system that provides an isolated supply and return system. The Security Control Room shall have a dedicated thermostat control unit and cut-off switch to be able to shut off ventilation to the control room in the event of a chemical, biological, or radiological (CBR) event or other related emergency.

3. There shall be a louver installed in the control room door to assist with ventilation of the room. The louver shall be exactly 12 x 12 inches (30 x 30 cm) and closeable.

E. Security Control Room and Security Console Lighting:

1. The following factors shall be taken into consideration for lighting of the Security Control Room and console area:
  - a. Shadows: To reduce eye strain and fatigue, shadows shall be avoided.
  - b. Glare: The readability of all display panels, labels, and equipment shall not be interfered with or create visibility problems.
2. The following table shall provide guidance on the amount of footcandles required per work area and type of task performed:

Work Area/Type of Task		Footcandles
Main Operating Panels		50
Secondary Display Panels		50
Seated Workstations		100
Reading	Handwriting	100
	Typed Documents	50
	Visual Display Units	10
Logbook Recording		100
Maintenance Area		50
Emergency/Back-up Lighting		10

- F. Remote security console access: For facilities that have a remote, secondary back-up control console or workstation shall apply the following requirements:
1. The secondary stations shall the requirements outlined in Sections 2.2.A-G.
  2. Installation of an intercom station or telephone line shall be installed and provide direct one touch call-up for communications between the primary Security Control Console and secondary Security Control Console.
  3. Secondary stations shall not have priority over a primary Security Control Console.
  4. The primary Access Control System and Database Management shall have the ability to shut off power and a signal to a secondary control station in the event the area has been compromised.

G. Wires and Cables:

1. Shall meet or exceed the manufactures recommendation for power and signals.
2. Shall 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.
3. 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.
4. All conduit, pull boxes, and junction boxes shall be marked with colored permanent tape or paint that will allow it to be distinguished from all other infrastructure conduit.
5. Conduit fills shall not exceed 50 percent unless otherwise documented.
6. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
7. 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.
8. 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 subsystems shall be any cable or sets of cables carrying 30 VDC/VAC or higher.
9. For all equipment that is carrying digital data between the Security Control Room, Security Equipment Room, Security Console, or at a remote monitoring station, it 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.

## **2.3 FIBER OPTIC EQUIPMENT**

- A. 8 Channel Fiber Optic Transceivers (Video&PTZ Control)
  1. The field-located and central-located fiber optic transceivers shall utilize wave division multiplexing to transmit and receive video and data pan-tilt-zoom control signals over two standard 62.5/125 multimode fibers.

2. The units shall be capable of operating over a range of 2 km.
3. The units shall be NTSC color compatible.
4. The units shall support data rates up to 64 Kbps.
5. The units shall be surface or rack mountable.
6. The units shall be UL listed.
7. The units shall meet or exceed the following specifications:
  - a. Video
    - 1) Input/Output: 1 volt pk-pk (75 ohms)
    - 2) Input/Output Channels: 8
    - 3) Bandwidth: 10 Hz - 6.5 MHz per channel
    - 4) Differential Gain: <2%
    - 5) Differential Phase: <0.7°
    - 6) Tilt: <1%
    - 7) Signal to Noise Ratio: 60 dB
  - b. Data (Control)
    - 1) Data Channels: 2
    - 2) Data Format: RS-232, RS-422, 2 wire or 4 wire RS-485 with Tri-State Manchester Bi-Phase and Sensornet
    - 3) Data Rate: DC - 100 kbps (NRZ)
    - 4) Bit Error Rate: < 1 in 10<sup>9</sup> @ Maximum Optical Loss Budget
    - 5) Operating Mode: Simplex or Full-Duplex
    - 6) Wavelength: 1310/1550 nm, Multimode or Singlemode
    - 7) Optical Emitter: Laser Diode
    - 8) Number of Fibers: 1
  - c. Connectors
    - 1) Optical: ST
    - 2) Power and Data: Terminal Block with Screw Clamps
    - 3) Video: BNC (Gold Plated Center-Pin)
  - d. Electrical and Mechanical

- 1) Power: 12 VDC @ 500 mA (stand-alone)
- 3) Current Protection: Automatic Resettable Solid-State Current Limiters

e. Environmental

- 1) MTBF: > 100,000 hours
- 2) Operating Temp: -40 to 74 deg C (-40 to 165 deg F)
- 3) Storage Temp: -40 to 85 deg C (-40 to 185 deg F)
- 4) Relative Humidity: 0% to 95% (non-condensing)

B. Fiber Optic Transmitters: The central-located fiber optic transmitters shall utilize wave division multiplexing to transmit video and signals over standard 62.5/125 multimode fibers.

1. The units shall be capable of operating over a range of 4.8 km.
2. The units shall be NTSC color compatible.
3. The units shall support data rates up to 64 Kbps.
4. The units shall be surface or rack mountable.
5. The units shall be UL listed.
6. The units shall meet or exceed the following specifications:

a. Video

- 1) Input: 1 volt pk-pk (75 ohms)
- 2) Bandwidth: 5HZ - 10 MHZ
- 3) Differential Gain: <5%
- 4) Tilt: <1%
- 5) Signal-Noise: 60db
- 6) Wavelength: 850nm
- 7) Number of Fibers: 1
- 8) Operating Temp: -20 to 70 deg C (-4 to 158 deg F)
- 9) Connectors:
  - a) Power: Female plug with screw clamps
  - b) Video: BNC
  - c) Optical: ST



10) Power: 12 VDC

C. Fiber Optic Receivers: The field-located fiber optic receivers shall utilize wave division multiplexing to receive video signals over standard 62.5/125 multimode fiber.

1. The units shall be capable of operating over a range of 4.8 km.
2. The units shall be NTSC color compatible.
3. The units shall support data rates up to 64 Kbps.
4. The units shall be surface or rack mountable.
5. The units shall be UL listed.
6. The units shall meet or exceed the following specifications:

a. Video

- 1) Output: 1 volt pk-pk (75 ohms)
- 2) Bandwidth: 5H2 - 10 MHZ
- 3) Differential Gain: <5%
- 4) Tilt: <1%
- 5) Signal-Noise: 60dB
- 6) Wavelength: 850nm
- 7) Number of Fibers: 1
- 8) Surface Mount: 106.7 x 88.9 x 25.4 mm (4.2 x 3.5 x 1 in)
- 9) Operating Temp: -20 to 70 deg C (-4 to 158 deg F)
- 10) Connectors:
- 11) Power: Female plug block with screw clamps
- 12) Video: BNC
- 13) Optical: ST
- 14) Power: 12 VAC8 Channel Fiber Optic Transcievers (Video&PTZ Control)

D. Fiber Optic Sub Rack with Power Supply

1. The Card Cage Rack shall provide high-density racking for fiber-optic modules. The unit shall be designed to mount in standard 483 mm (19 in) instrument racks and to accommodate the equivalent of 15 1-inch modules.

a. Specifications

- 1) Card Orientation: Vertical
- 2) Construction: Aluminum
- 3) Current Consumption: 0.99 A
- 4) Humidity: 95.0 % RH
- 5) Input Power: 100-240 VAC, 60/50 Hz
- 6) Mounting: Mounts in standard 483 mm (19 in) rack using four (4) screws  
(optional wall brackets purchased separately)
- 7) Number of Outputs: 1.0
- 8) Number of Slots 15.0
- 9) Operating Temperature: -40 to +75 deg C (-40.0 to 167.0 deg F)
- 10) Output Voltage: 13.5 V
- 11) Output Current 6.0 A
- 12) Power Dissipation: 28.0 W
- 13) Power Factor: 48.0
- 14) Power Supply: (built-in)
- 15) Rack Units: 3RU
- 16) Redundant Capability: Yes
- 17) Weight: 2.43 kg (5.35 lb)
- 18) Width: 483 mm (19.0 in)

## **2.4 TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICES (TVSS) AND SURGE SUPPRESSION**

### **A. Transient Voltage Surge Suppression**

1. All cables and conductors extending beyond building perimeter, except fiber optic cables, which serve as communication, control, or signal lines shall be protected against Transient Voltage surges and have Transient Voltage surge suppression protection (TVSS) UL listed in accordance with Standard 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 915 mm (36 in) of the building cable entrance. Fuses shall not be

used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following waveforms:

- a. A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
- b. An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.
- c. Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model # TE/FA 10B or TE/FA 20B or approved equivalent.
- d. Operating Temperature and Humidity: -40 to + 85 deg C (-40 to 185 deg F), and 0 to 95 percent relative humidity, non-condensing.

B. Physical Access Control Systems

1. Suppressors shall be installed on AC power at the point of service and shall meet the following criteria:
  - a. UL1449 2nd Edition, 2007, listed
  - b. UL1449 S.V.R. of 400 Volts or lower
  - c. Status Indicator Light(s)
  - d. Minimum Surge Current Capacity: 40,000 Amps (8 x 20  $\mu$ sec)
  - e. Maximum Continuous Current: 15 Amps
  - f. MCOV: 125 VAC
  - g. Service Voltage: 110-120 VAC
2. Suppressors shall be installed on the Low Voltage circuit at both the point of entrance and exit of the building. Suppressors shall meet the following criteria:
  - a. UL 497B
  - b. Minimum Surge Current Capacity: 2,000 Amps per pair
  - c. Maximum Continuous Current: 5 Amps
  - d. MCOV: 33 Volts
  - e. Service Voltage: 24Volts

3. Suppressors shall be installed on the communication circuit between the access controller and card reader at both the entrance and exit of the building.

Suppressors shall meet the following criteria:

- a. Conforms with UL497B standards (where applicable)
- b. Clamp level for 12 and 24V power: 18VDC / 38VDC
- c. Clamp level for Data/LED: 6.8VDC
- d. Service Voltage for Power: 12VDC/24VDC
- e. Service Voltage for Data/LED: <5VDC
- f. Clamp level – PoE Access Power: 72V
- g. Clamp level – PoE Access Data: 7.9V
- h. Service Voltage – PoE Access: 48VAC – 54VAC
- i. Service Voltage – PoE Data: <5VDC

#### C. Intercom Systems

1. Suppressors shall be installed on the AC power at the point of service and shall meet the following criteria:
  - a. UL 1449 Listed
  - b. UL 1449 S.V.R. of 400 Volts or lower
  - c. Diagnostic Indicator Light(s)
  - d. Integrated ground terminating post (where case/chassis ground exists)
  - e. Minimum Surge Current Capacity of 13,000 Amps (8 x 20  $\mu$ Sec)
2. Suppressors shall be installed on incoming central office lines and shall meet the following criteria:
  - a. UL 497A Listed
  - b. Multi Stage protection design
  - c. Auto-reset current protection not to exceed 2 Amps per pair
  - d. Minimum Surge Current of 500 Amps per pair (8 x 20  $\mu$ Sec)
3. Suppressors shall be installed on all telephone/intercom circuits that enter or leave separate buildings and shall meet the following criteria:
  - a. UL 497A Listed (where applicable)

- b. UL 497B Listed (horns, strobes, speakers or communication circuits over 300 feet)
  - c. Multi Stage protection design
  - d. Auto-reset over-current protection not to exceed 5 Amps per pair
  - e. Minimum Surge Current of 1000 Amps per pair (8 x 20  $\mu$ Sec)
- D. Intrusion Detection Systems
- 1. Suppressors shall be installed on AC at the point of service and shall meet the following criteria:
    - a. UL 1449, 2nd Edition 2007, listed
    - b. UL 1449 S.V.R. of 400 Volts or lower
    - c. Status Indicator Lights
    - d. Center screw for terminating Class II transformers
    - e. Minimum Surge Current Capacity of 32,000 Amps (8 x 20  $\mu$ Sec)
  - 2. Suppressors shall be installed on all Telephone Communication Interface circuits and shall meet the following criteria:
    - a. UL 497A Listed
    - b. Multi Stage protection design
    - c. Surge Current Capacity: 9,000 Amps (8x20  $\mu$ Sec)
    - d. Clamp Voltage: 130Vrms
    - e. Auto reset current protection not to exceed 150 milliAmps
  - 3. Suppressors shall be installed on all burglar alarm initiating and signaling loops and addressable circuits which enter or leave separate buildings. The following criteria shall be met:
    - a. UL 497B for data communications or annunciation (powered loops)
    - b. Fail-short/fail-safe mode.
    - c. Surge Current Capacity: 9,000 Amps (8x20  $\mu$ Sec)
    - d. Clamp Voltage: 15 Vrms
    - e. Joule Rating: 76 Joules per pair (10x1000  $\mu$ Sec)
    - f. Auto-reset current protection not to exceed 150 milliAmps for UL 497A devices.

E. Video Surveillance System

1. Protectors shall be installed on coaxial cable systems on points of entry and exit from separate buildings. Suppressors shall be installed at each exterior camera location and include protection for 12 and/or 24 volt power, data signal and motor controls (for Pan, Tilt and Zoom systems). SPDs shall protect all modes herein mentioned and contain all modes in a single unit system. Protection for all systems mentioned above shall be incorporated at the head end equipment. Additionally a minimum 450VA battery back up shall be used to protect the DVR or VCR and monitor. Protectors shall meet the following criteria:

a. Head-End Power

- 1) UL 1778, cUL (Battery Back Up)
- 2) Minimum Surge Current Capacity: 65,000 Amps (8x20μsec)
- 3) Minimum of two (2) NEMA 5-15R Receptacles (one (1) AC power only, one (1) with UPS)
- 4) All modes protected (L-N, L-G, N-G)
- 5) EMI/RFI Filtering
- 6) Maximum Continuous Current: 12 Amps

b. Camera Power

- 1) Minimum Surge Current Capacity: 1,000 Amps (8X20μsec); 240 Amps for IP Video/PoE cameras
- 2) Screw Terminal Connection
- 3) All protection modes L-G (all Lines)
- 4) MCOV <40VAC

c. Video And Data

- 1) Surge Current Capacity 1,000 Amps per conductor
- 2) "BNC" Connection (Coax)
- 3) Protection modes: L-G (Data), Center Pin-G, Shield-G (Coax)
- 4) Band Pass 0-2GHz
- 5) Insertion Loss <0.3dB

**F. Grounding and Surge Suppression**

1. The Security Contractor shall provide grounding and surge suppression to stabilize the voltage under normal operating conditions. This is to ensure the operation of over current devices, such as fuses, circuit breakers, and relays, underground-fault conditions.
2. The Contractor shall engineer, provide, and install proper grounding and surge suppression as required by local jurisdiction and prevailing codes and standards, referenced in this document.
3. Principal grounding components and features shall include: main grounding buses, grounding, and bonding connections to service equipment.
4. The Contractor shall provide detail drawings of interconnection with other grounding systems including lightning protection systems.
5. The Contractor shall provide details of locations and sizes of grounding conductors and grounding buses in electrical, data, and communication equipment rooms and closets.
6. AC power receptacles are not to be used as a ground reference point.
7. Any cable that is shielded shall require a ground in accordance with applicable codes, the best practices of the trade, and all manufacturers' installation instructions.

**G. 120 VAC Surge Suppression**

1. Continuous Current: Unlimited (parallel connection)
2. Max Surge Current: 13,500 Amps
3. Protection Modes: L - N, L - G, N - G
4. Warranty: Ten Year Limited Warranty
5. Dimension: 73.7 x 41.1 x 52.1 mm (2.90 x 1.62 x 2.05 in)
6. Weight: 2.88 g (0.18 lbs)
7. Housing: ABS

**2.5 INSTALLATION KIT**

**A. General:**

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



4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
5. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this document.
8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to provide the system documentation as required by this document and explained herein.

### **PART 3 – EXECUTION**

#### **3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION**

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Equipment location shall be as close as practical to locations shown on the drawings.
- G. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  - 2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

### **3.2 FIRESTOPPING**

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section 07 84 00 "Firestopping."

### **3.3 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.

### **3.4 DEMONSTRATION AND TRAINING**

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Resident Engineer at least 30 days prior to the planned training.
- D. Provide services of manufacturer's technical representative for <insert hours> hours to instruct VA personnel in operation and maintenance of units.
- E. Submit training plans and instructor qualifications in accordance with the requirements of Section 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.

### **3.5 WORK PERFORMANCE**

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

### **3.6 SYSTEM PROGRAMMING**

- A. General Programming Requirements
  - 1. This following section shall be used by the contractor to identify the anticipated level of effort (LOE) required setup, program, and configure the Electronic Security System (ESS). The contractor shall be responsible for providing all setup, configuration, and programming to include data entry for the Security Management System (SMS) and subsystems [(e.g., video matrix switch, intercoms, digital video recorders, intrusion devices, including integration of subsystems to the SMS (e.g.,

camera call up, time synchronization, intercoms)). System programming for existing or new SMS servers shall not be conducted at the project site.

B. Level of Effort for Programming

1. The Contractor shall perform and complete system programming (including all data entry) at an offsite location using the Contractor's own copy of the SMS software. The Contractor's copy of the SMS software shall be of the Owners current version. Once system programming has been completed, the Contractor shall deliver the data to the Resident Engineer on data entry forms and an approved electronic medium, utilizing data from the contract documents. The completed forms shall be delivered to the Resident Engineer for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires it. The Contractor shall not upload system programming until the Resident Engineer has provided written approval. The Contractor is responsible for backing up the system prior to uploading new programming data. Additional programming requirements are provided as follows:
  - a. Programming for New SMS Server: The contractor shall provide all other system related programming. The contractor will be responsible for uploading personnel information (e.g., ID Cards backgrounds, names, access privileges, personnel photos, access schedules, personnel groupings) along with coordinating with Resident Engineer for device configurations, standards, and groupings. VA shall provide database to support Contractor's data entry tasks. The contractor shall anticipate a weekly coordination meeting and working with Resident Engineer to ensure data uploading is performed without incident of loss of function or data loss.
  - b. Programming for Existing SMS Servers: The contractor shall perform all related system programming except for personnel data as noted. The contractor will not be responsible for uploading personnel information (e.g., ID Cards backgrounds, names, access privileges, access schedules, personnel groupings). The contractor shall anticipate a weekly coordination meeting and working alongside of

Resident Engineer to ensure data uploading is performed without incident of loss of function or data loss. System programming for SMS servers shall be performed by using the Contractor's own server and software. These servers shall not be connected to existing devices or systems at any time.

2. The Contractor shall identify and request from the Resident Engineer, any additional data needed to provide a complete and operational system as described in the contract documents.
3. Contractor and Resident Engineer coordination on programming requires a high level of coordination to ensure programming is performed in accordance with VA requirements and programming uploads do not disrupt existing systems functionality. The contractor shall anticipate a minimum a weekly coordination meeting. Contractor shall ensure data uploading is performed without incident of loss of function or data loss. The following Level of Effort Chart is provided to communicate the expected level of effort required by contractors on VA ESS projects. Calculations to determine actual levels of effort shall be confirmed by the contractor before project award.

Description of Systems	Description of Tasks						
	Develop System Loading Sheets	Coordination	Initial Set-up Configuration	Graphic Maps	System Programming	Final Checks	Level of Effort (Typical Tasks)

SMS Setup & Confi gurati on	e.g., program monitorin g stations, programm ing netw orks, interconne ctions between CCTV, intercoms, time synchroniz ation	e.g., retrieve IP addresses, naming conventio ns, standard event descriptio ns, programm ing templates, coordinate special system needs	e.g., Load system Operating System and Applicatio n software, general system configurati ons	e.g., develop naming conventi ons, develop file folders, confirmin g accuracy of AutoCAD Floor Plans, convert file into jpeg file	e.g., prog ram moni torin g stati ons, prog ram ming netw orks, inter conn ectio ns betw een CCT V, inter com s, time sync hron izati on	e.g., check all system diagnos tics (e.g., clients, panels)	Load and set-up 4-6 CDs and configure servers (to configure Loading and Configuring software Administrative account, audit log, Keystrokes, mouse clicks, multi-screen configuration
--------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Electronic Entry Control Systems	e.g., setup of device, door groups & schedules, REX, Locks, link graphics	e.g., confirming device configurations, naming conventions, event descriptions and narratives	e.g., enter data from loading sheets; configure components, link events, cameras, and graphics		e.g., setup of device, door groups & schedules, REX, Locks, link graphics	e.g., performing entry testing to confirm correct set-up and configuration	e.g., creating a door, door configuration, adding request to exit, door monitors and relays, door timers, door related events (e.g., access, access denied, forced open, held open), linkages, controlled areas, advanced door monitoring, time zones, sequence of operations
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Intrusion Detection Systems	e.g., enter door groups & schedules, link devices - REX, lock, & graphics	e.g., confirming device configurations, naming conventions, event descriptions and narratives	e.g., enter data from loading sheets; configure components, link events, cameras, and graphics		e.g., enter door groups & schedules, link devices - REX, lock, & graphics	e.g., walk test, device position, and masking	e.g., setting up monitoring and control points (e.g., motion sensors, glassbreaks, vibration sensor, strobes, sounders) creating intrusion zones, creating arm/disarm panel, timed sequences, time zones, icon placements on graphic maps, clearance levels, events (e.g., armed, disarmed, zone violation, device alarm activations), LCD reader messages,
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CCTV Systems	e.g., programming call-ups recording	e.g., confirming device configurations, naming conventions	e.g., enter data from loading sheets; camera naming convention, sequences, configure components)		e.g., programming call-ups recording	e.g., confirm area of coverage, call-up per event generated and recording rates	e.g., setting up cameras points, recording ratios (e.g., normal, alarm event) timed recording, linkages, maps placements, call-ups
Intercoms Systems	e.g., programming events & call-ups	e.g., confirming device configurations, naming conventions, event description and narratives	e.g., enter data from loading sheets; configure components, link events, cameras, and graphics		e.g., programming events & call-ups	e.g., confirm operation, SMS event generation and camera call-up	e.g., setup linkages, events for activations, device troubles, land devices on graphic maps
Console Monitoring Components	N/A	per monitor	per monitor	per graphic map	N/A	per monitor	N/A

Note: Programming tasks are supported through the contractor's development of the Technical Data Package Submittals.	
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**Table 1 Contractor Level of Effort**

### **3.7 TESTING AND ACCEPTANCE**

#### **A. Performance Requirements**

##### **1. General:**

- a. The Contractor shall perform contract field, performance verification, and endurance testing and make adjustments of the completed security system when permitted. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the Resident Engineer at least 60 calendar days prior to the test and after the Contractor has received written approval of the specific test procedures.
  - b. The COTR shall witness all testing and system adjustments during testing. Written permission shall be obtained from the Resident Engineer before proceeding with the next phase of testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the Resident Engineer at the conclusion of each phase of testing and prior to Resident Engineer approval of the test.
2. Test Procedures and Reports: The test procedures, compliant w/ VA standard test procedures, shall explain in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. The test reports shall be used to document results of the tests. The reports shall be delivered to the Resident Engineer within seven (7) calendar days after completion of each test.

#### **B. Pre-Delivery Testing**

1. The purpose of the pre-delivery test is to establish that a system is suitable for installation. As such, pre-delivery test shall be a mock-up of the system as planned in the contract documents. The Contractor shall assemble the Security Test System at the Contractors local project within 50-miles of the project site, and perform tests to demonstrate the performance of the system complies with the contract requirements in accordance with the approved pre-delivery test procedures. The

tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during pre-delivery testing, including results of each test procedure, shall be documented and delivered to the Resident Engineer at the conclusion of pre-delivery testing and prior to Resident Engineer's approval of the test. The test report shall be arranged so all commands, stimuli, and responses are correlated to allow logical interpretation. For Existing System modifications, the contractor shall provide their own server with loaded applicable software to support PDT.

2. Test Setup: The pre-delivery test setup shall include the following:
  - a. All console equipment.
    - 1) At least one of each type of data transmission media (DTM) and associated equipment to provide a fully integrated PACS.
    - 2) The number of local processors shall equal the amount required by the site design.
    - 3) Enough sensor simulators to provide alarm signal inputs to the system equal to the number of sensors required by the design. The alarm signals shall be manually or software generated.
    - 4) Contractor to prove to owner all systems are appropriately sized and configured as sized.
    - 5) Integration of VASS, intercom systems, other subsystems.
3. During the bidding process the contractor shall submit a request for information to the Owner to determine if a pre-delivery test will be required. If a pre-delivery test is not required, the contractor shall provide a written notification that the Pre-delivery Test is not required in their shop drawings submission.

SPEC WRITER NOTE: Delete paragraph C.  
"Intermediate Testing" if not applicable to the project.

C. Intermediate Testing

1. After completion of 30-50 percent of the installation of ESS cabinet(s) and equipment, one local and remote control stations and prior to any further work, this portion of the system must be pretested, inspected, and certified. Each item of installed equipment shall be checked to ensure appropriate FCC listing & UL certification labels are affixed, NFPA, Emergency, Safety, and JCAHCO guidelines are followed, and proper installation practices are followed. The intermediate test shall include a full operational test.
- D. The inspection and test will be conducted by a factory-certified contractor representative and witnessed by a Government Representative. The results of the inspection will be officially recorded by a designated Government Representative and maintained on file by the Resident Engineer (RE), until completion of the entire project. The results will be compared to the Acceptance Test results.
- E. Contractor's Field Testing (CFT)
1. The Contractor shall calibrate and test all equipment, verify DTM operation, place the integrated system in service, and test the integrated system. Ground rods installed by this Contractor within the base of camera poles shall be tested as specified in IEEE STD 142. The Contractor shall test all security systems and equipment, and provide written proof of a 100% operational system before a date is established for the system acceptance test. Documentation package for CFT shall include completed (fully annotated details of test details) for each device and system tested, and annotated loading sheets documenting complete testing to Resident Engineer approval. CFT test documentation package shall conform to submittal requirements outlined in this Section. The Contractor's field testing procedures shall be identical to the Resident Engineer's acceptance testing procedures. The Contractor shall provide the Resident Engineer with a written listing of all equipment and software indicating all equipment and components have been tested and passed. The Contractor shall deliver a written report to the Resident Engineer stating the installed complete system has been calibrated, tested, and is ready to begin performance verification testing; describing the results of the functional tests,

diagnostics, and calibrations; and the report shall also include a copy of the approved acceptance test procedure. Performance verification testing shall not take place until written notice by contractor is received certifying that a contractors field test was successful.

F. Performance Verification Test (PVT)

1. Test team:

a. After the system has been pretested and the Contractor has submitted the pretest results and certification to the Resident Engineer, then the Contractor shall schedule an acceptance test to date and give the Resident Engineer written, notice as described herein, prior to the date the acceptance test is expected to begin. The system shall be tested in the presence of a Government Representative, an OEM certified representative, representative of the Contractor and other approved by the Resident Engineer. The system shall be tested utilizing the approved test equipment to certify proof of performance, FCC, UL and Emergency Service compliance. The test shall verify that the total system meets all the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.

2. The Contractor shall demonstrate the completed Physical Access Control System PACS complies with the contract requirements. In addition, the Contractor shall provide written certification that the system is 100% operational prior to establishing a date for starting PVT. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The PVT will be stopped and aborted as soon as 10 technical deficiencies are found requiring correction. The Contractor shall be responsible for all travel and lodging expenses incurred for out-of-town personnel required to be present for resumption of the PVT. If the acceptance test is aborted, the re-test will commence from the beginning with a retest of components previously tested and accepted.

3. The PVT, as specified, shall not begin until receipt of written certification that the Contractors Field Testing was successful. This shall include certification of successful

- completion of testing as specified in paragraph “Contractor’s Field Testing”, and upon successful completion of testing at any time when the system fails to perform as specified. Upon termination of testing by the Resident Engineer or Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II.
4. Upon successful completion of the acceptance test, the Contractor shall deliver test reports and other documentation, as specified, to the Resident Engineer prior to commencing the endurance test.
  5. Additional Components of the PVT shall include:
    - a. System Inventory
      - 1) All Device equipment
      - 2) All Software
      - 3) All Logon and Passwords
      - 4) All Cabling System Matrices
      - 5) All Cable Testing Documents
      - 6) All System and Cabinet Keys
    - b. Inspection
      - 1) Contractor shall record an inspection punch list noting all system deficiencies. The contractor shall prepare an inspection punch list format for Resident Engineers approval.
      - 2) As a minimum the punch list shall include a listing of punch list items, punch list item location, description of item problem, date noted, date corrected, and details of how item was corrected.
  6. Partial PVT - At the discretion of Resident engineer, the Performance Verification Test may be performed in part should a 100% compliant CFT be performed. In the event that a partial PVT will be performed instead of a complete PVT; the partial PVT shall be performed by testing 10% of the system. The contractor shall perform a test of each procedure on select devices or equipment.

G. Endurance Test

1. The Contractor shall demonstrate the specified probability of detection and false alarm rate requirements of the completed system. The endurance test shall be conducted in phases as specified below. The endurance test shall not be started until the Resident Engineer notifies the Contractor, in writing, that the performance verification test is satisfactorily completed, training as specified has been completed, and correction of all outstanding deficiencies has been satisfactorily completed. VA shall operate the system 24 hours per day, including weekends and holidays, during Phase I and Phase III endurance testing. VA will maintain a log of all system deficiencies. The Resident Engineer may terminate testing at any time the system fails to perform as specified. Upon termination of testing, the Contractor shall commence an assessment period as described for Phase II. During the last day of the test, the Contractor shall verify the appropriate operation of the system. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Resident Engineer prior to acceptance of the system.
2. Phase I (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized in writing by the Resident Engineer. If the system experiences no failures, the Contractor may proceed directly to Phase III testing after receiving written permission from the Resident Engineer.
3. Phase II (Assessment):
  - a. After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Resident Engineer. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed.
  - b. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the



Resident Engineer. The meeting shall not be scheduled earlier than five (5) business days after the Resident Engineer receives the report. As part of this test review meeting, the Contractor shall demonstrate all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Resident Engineer will provide a written determine of either the restart date or require Phase I be repeated.

4. Phase III (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized in writing by the COTR.
5. Phase IV (Assessment):
  1. After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the COTR. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed.
  2. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the COTR. The meeting shall not be scheduled earlier than five (5) business days after receipt of the report by the COTR. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by repeating appropriate portions for the performance verification test. Based on the review meeting the test should not be scheduled earlier than five (5) business days after the Resident Engineer receives the report. As a part of this test review meeting, the Contractor shall demonstrate all failures have been corrected by repeating appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Resident Engineer will provide a written determine of either the restart date or require Phase III be

repeated. After the conclusion of any re-testing which the Resident Engineer may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.

H. Exclusions

1. The Contractor will not be held responsible for failures in system performance resulting from the following:
  - a. An outage of the main power in excess of the capability of any backup power source provided the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the PACS performed as specified.
  - b. Failure of an Owner furnished equipment or communications link, provided the failure was not due to Contractor furnished equipment, installation, or software.
  - c. Failure of existing Owner owned equipment, provided the failure was not due to Contractor furnished equipment, installation, or software.

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

**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 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS. Requirements for commissioning.
- G. 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 Resident Engineer/COTR 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-fiber flashlight] [or] [optical loss test set] <Insert test>.
  - 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 coaxial cables 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.

- A. Support of Open Cabling: NRTL labeled for support of [Category 5e] [Category 6] cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
  - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
  - 2. Lacing bars and spools.
  - 3. Straps and other devices.
- B. Cable Trays:
  - 1. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by [electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick] [hot-dip galvanizing, complying with ASTM A 123/A 123M Grade 0.55, not less than 0.002165 inch (0.055 mm) thick].
  - 2. Basket Cable Trays: [6 inches (150 mm) wide and 2 inches (50 mm) deep] <Insert dimensions>. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
  - 3. Trough Cable Trays: [Nominally 6 inches (150 mm)] <Insert dimension> wide.
  - 4. Ladder Cable Trays: [Nominally 18 inches (455 mm)] <Insert dimension> wide, and a rung spacing of [12 inches (305 mm)] <Insert spacing>.
  - 5. Channel Cable Trays: One-piece construction, [nominally 4 inches (100 mm)] <Insert dimension> wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.
  - 6. Solid-Bottom Cable Trays: One-piece construction, [nominally 12 inches (305 mm)] <Insert dimension> wide. Provide [with] [without] solid covers.
- C. Conduit and Boxes: Comply with requirements in Division 28 Section "Conduits and Backboxes for Electrical Systems." [Flexible metal conduit shall not be used.]
  - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

## **2.2 BACKBOARDS**

- A. Backboards: Plywood, [fire-retardant treated,] 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

### **2.3 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 5e] [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, Riser Rated: Type CMR [; or MPP, CMP, or MPR], complying with UL 1666.
    - d. Communications, Limited Purpose: Type CMX[; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG].
    - e. Multipurpose: Type MP or MPG [; or MPP or MPR].
    - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    - g. Multipurpose, Riser Rated: Type MPR [or MPP], complying with UL 1666.

### **2.4 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 5e] [110-style for Category 6] [66-style for Category 5e]. Provide blocks for the number of cables terminated on the block, plus [25] <Insert percentage> percent spare. Integral with connector bodies, including plugs and jacks where indicated.



## 2.5 OPTICAL FIBER CABLE

- A. Description: Multimode, [50/125] [62.5/125]-micrometer, [24] <Insert number>-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-B] [TIA/EIA-492AAAA-A] for 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.
    - c. Riser Rated, Nonconductive: Type OFNR [or OFNP], complying with UL 1666.
    - d. General Purpose, Conductive: Type OFC or OFCG [, or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP].
    - e. Plenum Rated, Conductive: Type OFCP [, or OFNP], complying with NFPA 262.
    - f. Riser Rated, Conductive: Type OFCR [, or OFNR, OFCP, or OFNP], complying with UL 1666.
  5. Conductive cable shall be [steel] [aluminum] armored type.
  6. Maximum Attenuation: [3.50] <Insert number> dB/km at 850 nm; [1.5] <Insert number> dB/km at 1300 nm.
  7. 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] [Orange for 62.5/125-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).

## **2.6 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] [Type ST] [Type LC] [Type MT-RJ] 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.

## **2.7 COAXIAL CABLE**

- A. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- B. RG-11/U: NFPA 70, Type CATV.
  - 1. No. [14] <Insert size> AWG, solid, copper-covered steel conductor.
  - 2. Gas-injected, foam-PE insulation.
  - 3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
  - 4. Jacketed with sunlight-resistant, black PVC or PE.
  - 5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
- C. RG59/U: NFPA 70, Type CATVR.
  - 1. No. [20] <Insert size> AWG, solid, silver-plated, copper-covered steel conductor.
  - 2. Gas-injected, foam-PE insulation.
  - 3. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
  - 4. Color-coded PVC jacket.
- D. RG-6/U: NFPA 70, Type CATV or CM.

1. No. [16] <Insert size> AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
  2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
  3. Jacketed with black PVC or PE.
  4. Suitable for indoor installations.
- E. RG59/U: NFPA 70, Type CATV.
1. No. [20] <Insert size> AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
  2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
  3. PVC jacket.
- F. RG59/U (Plenum Rated): NFPA 70, Type CMP.
1. No. [20] <Insert size> AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
  2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
  3. Copolymer jacket.
- G. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
1. CATV Cable: Type CATV[, or CATVP or CATVR].
  2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
  3. CATV Riser Rated: Type CATVR[, or CATVP, CATVR, or CATV], complying with UL 1666.
  4. CATV Limited Rating: Type CATVX.

## **2.8 COAXIAL CABLE HARDWARE**

- A. Coaxial-Cable Connectors: Type BNC, 75 ohms.

## **2.9 RS-232 CABLE**

- A. Standard Cable: NFPA 70, Type CM.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Polypropylene insulation.
  - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  - 4. PVC jacket.
  - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  - 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Plastic insulation.
  - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  - 4. Plastic jacket.
  - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  - 6. Flame Resistance: Comply with NFPA 262.

## **2.10 RS-485 CABLE**

- A. Standard Cable: NFPA 70, Type CM[ or CMG].
  - 1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Fluorinated ethylene propylene insulation.

3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

## **2.11 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.

## **2.12 CONTROL-CIRCUIT CONDUCTORS**

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.
- B. Class 2 Control Circuits: Stranded copper, [Type THHN-THWN, in raceway] [power-limited cable, concealed in building finishes] [power-limited tray cable, in cable tray] complying with UL 83.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

## **2.13 FIRE ALARM WIRE AND CABLE**

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, [not less than] [No. 18 AWG] [<Insert wire size> AWG] [size as recommended by system manufacturer].
  - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
  - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
  - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
  - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor[ with outer jacket] with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

## **2.14 IDENTIFICATION PRODUCTS**

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

## **2.15 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.

## **2.16 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.

## **2.17 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 Resident Engineer/COTR.
  - 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. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than [60 inches (1525 mm)] <Insert dimension> apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

M. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [72 inches (1830 mm)] <Insert size> long shall be neatly coiled not less than [12 inches (300 mm)] <Insert size> in diameter below each feed point.

N. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

O. 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 FIRE ALARM WIRING INSTALLATION**

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Division 28 Section CONDUITS AND BACKBOXES FOR ELECTRICAL SYSTEMS."
  1. Install plenum cable in environmental air spaces, including plenum ceilings.
  2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
  1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is[ not] permitted.
  3. Signaling Line Circuits: Power-limited fire alarm cables [may] [shall not] be installed in the same cable or raceway as signaling line circuits.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### **3.3 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.

### **3.4 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 "INTRUSION DETECTION" for connecting, terminating, and identifying wires and cables.
- C. Comply with requirements in Division 28 Section "VIDEO SURVEILLANCE" for connecting, terminating, and identifying wires and cables.
- D. Comply with requirements in Division 28 Section "ELECTRONIC PERSONAL PROTECTION SYSTEMS" for connecting, terminating, and identifying wires and cables.
- E. Comply with requirements in Division 28 Section "FIRE DETECTION AND ALARM" for connecting, terminating, and identifying wires and cables.

### **3.5 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.

### **3.6 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."

### **3.7 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.

### 3.8 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.

5. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System."

- 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.

### **3.9 EXISTING 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.

--- E N D ---

**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 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.
- E. Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS. Requirements for commissioning.

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

#### **1.4 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 for sizes 12 AWG and larger. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm<sup>2</sup> (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 mm<sup>2</sup> (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

### **2.2 GROUND RODS**

- A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance.

### **2.3 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).
- 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. Connection to Building Steel: Exothermic-welded type connectors.
  - 3. Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.
  - 4. Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.

5. 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.
6. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

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

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x 3/4 inch).

## **2.5 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.

## **2.6 SPLICE CASE GROUND ACCESSORIES**

- A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm<sup>2</sup> (6 AWG) insulated ground wire with shield bonding connectors.

## **2.7 COMPUTER ROOM GROUND**

- A. Provide 50mm<sup>2</sup> (1/0 AWG) bare copper grounding conductors bolted at mesh intersections to form an equipotential grounding grid. The equipotential grounding grid shall form a 600mm (24 inch) mesh pattern. The grid shall be bonded to each of the access floor pedestals.

## **2.8 SECURITY CONTROL ROOM GROUND**

- A. Provide 50mm<sup>2</sup> (1/0 AWG) stranded copper grounding conductor(s) color coded with a green jacket, bolted at the Room's Communications System Grounding Electrode Cooper Plate and circulate to each equipment rack ground buss bar through the wire management system. Connect each equipment rack, wire management system's cable tray, ladder, etc. to the circulating ground wire with a minimum 25mm<sup>2</sup> (4AWG) stranded Cooper Wire, color coded with a green jacket.

1. Connect each equipment rack ground buss bar to the circulating ground wire a indicated in 2.9.A, and
2. Connect each additional room item to the circulating ground wire as indicated in 2.9.A.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.
- B. System Grounding:
  1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
  2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
  3. A green insulated ground wire shall be installed in all raceways.
- C. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

### **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 COMPUTER ROOM/SECURITY EQUIPMENT ROOM GROUNDING**

- A. Conduit: Ground and bond metallic conduit systems as follows:
  - 1. Ground metallic service conduit and any pipes entering or being routed within the computer room at each end using 16 mm<sup>2</sup> (6AWG) bonding jumpers.
  - 2. Bond at all intermediate metallic enclosures and across all joints using 16 mm<sup>2</sup> (6 AWG) bonding jumpers.

### **3.6 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 mm<sup>2</sup> (6 AWG) bonding jumper at all intermediate metallic enclosures and across all section junctions.
  - 2. Install insulated 16 mm<sup>2</sup> (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 mm<sup>2</sup> (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 mm<sup>2</sup> (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 meters.

### **3.7 LIGHTNING PROTECTION SYSTEM**

- A. Bond the lightning protection system to earth ground externally to the building. Under no condition shall the electrical system's third or fourth ground electrode system, or the telecommunications system circulating ground system be connected to the lightning protection system. The Facility's structural steel may be used to connected the lightning

protection system at the direction of the Resident Engineer certified by an independent certified grounding contractor.

### **3.8 EXTERIOR LIGHT/CAMERA POLES**

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

### **3.9 GROUND RESISTANCE**

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.
- D. Below-grade connections shall be visually inspected by the COTR prior to backfilling. The contractor shall notify the COTR 24 hours before the connections are ready for inspection.

### **3.10 GROUND ROD INSTALLATION**

- A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

### **3.11 GROUNDING FOR RF/EMI CONTROL**

- A. Install bonding jumpers to bond all conduit, cable trays, sleeves and equipment for low voltage signaling and data communications circuits. Bonding jumpers shall consist of 100 mm (4 inches) wide copper strip or two 6 mm<sup>2</sup> (10 AWG) copper conductors spaced minimum 100 mm (4 inches) apart. Use 16 mm<sup>2</sup> (6 AWG) copper where exposed and subject to damage.
- B. Comply with the following when shielded cable is used for data circuits.
  - 1. Shields shall be continuous throughout each circuit.
  - 2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
  - 3. Do not connect shields from different circuits together.
  - 4. Shield shall be connected at one end only. Connect shield to signal reference at the origin of the circuit. Consult with equipment manufacturer to determine signal reference.

### **3.12 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 and at the grounding electrode conductor where exposed.
  - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

### **3.13 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.

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



**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 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.  
Requirements for commissioning - systems readiness checklists, and training.
- J. 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 Resident Engineer/COTR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.
- D. 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.
- E. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- F. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
1. Custom enclosures and cabinets.
  2. 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.
- G. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Structural members in the paths of conduit groups with common supports.
  2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- H. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components,

will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified [and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event]."
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- I. 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.
- C. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
- D. 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.
- E. Flexible galvanized steel conduit: Shall Conform to UL 1.
- F. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
- G. 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.
- C. 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.
- D. Flexible steel conduit fittings:

1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
2. Clamp type, with insulated throat.
- E. 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.
- F. Direct burial plastic conduit fittings:
  1. Fittings shall meet the requirements of UL 514C and NEMA TC3.
  2. As recommended by the conduit manufacturer.
- G. Surface metal raceway fittings: As recommended by the raceway manufacturer.
- H. 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.
    - I. Conduit sizes 2" and smaller shall utilize compression type fittings. Conduit sizes 2" and larger are permitted to utilize set screw type fittings.

## **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. Metal Floor Boxes: Cast or sheet metal, semi-adjustable, rectangular.
- E. Sheet metal boxes: Galvanized steel, except where otherwise shown.
- F. 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. <Insert legend.>
  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 (2 inches wide by 24 inches long) <Insert dimensions> 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.
- C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of [polymer concrete] [reinforced concrete] [cast iron] [hot-dip galvanized-steel diamond plate] [fiberglass].

## **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] [NBR] <Insert sealing element> 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: [Plastic] [Carbon steel] [Stainless steel]. Include two for each sealing element.
  - 3. Connecting Bolts and Nuts: [Carbon steel with corrosion-resistant coating] [Stainless steel] 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 Resident Engineer/COTR 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 Resident Engineer/COTR 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. Aluminum conduits are not permitted.
  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 Resident Engineer/COTR.
- D. Fire Alarm:
1. Fire alarm conduit shall be painted red (a red "top-coated" conduit from the conduit manufacturer may be used in lieu of painted conduit) in accordance with the requirements of Section 28 31 00, "FIRE DETECTION AND ALARM".

### **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 Resident Engineer/COTR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
  4. Installation of conduit in concrete that is less than 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.
  2. Conduit for conductors 600 volts and below:
    - a. Rigid steel, IMC, 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, 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 Section 09 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.
- D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

**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. Label all covers of electrical boxes with the panel name and circuits contained in the box. For example, "L2S-15,17,19".
- H. For boxes installed in metal stud construction, use rigid support metal bar hangers or metal bar fasteners attached to (2) studs. Screwing boxes directly to joists or studs is not acceptable.

### **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 Trade Size	Radius of Conduit Bends mm, Inches
$\frac{3}{4}$	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

- 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).

### **3.9 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.

--- E N D ---

**SECTION 28 13 00**  
**PHYSICAL ACCESS CONTROL SYSTEM**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the finishing, installation, connection, testing and certification of a complete and fully operating Physical Access Control System, hereinafter referred to as the PACS.
- B. This Section includes a Physical Access Control System consisting of a system server, [one or more networked workstation computers,] operating system and application software, and field-installed Controllers connected by a high-speed electronic data transmission network. The PACS shall have the following:
  - 1. Physical Access Control:
    - a. Regulating access through doors [, gates] [, traffic-control bollards] <List other access-control devices>
    - b. Anti-passback
    - c. Visitor assignment
    - d. Surge and tamper protection
    - e. Secondary alarm annunciator
    - f. Credential cards and readers
    - g. Biometric identity verification equipment
    - h. Push-button switches
    - i. RS-232 ASCII interface
    - j. Credential creation and credential holder database and management
    - k. Monitoring of field-installed devices
    - l. Interface with HVACsystems.
    - m. Reporting
  - 2. Security:
    - a. Real-time guard tour.
    - b. Time and attendance.

- c. Key tracking.
  - d. Video and camera control.
  - e. Time and attendance
  - f. <Insert name of system.>
- C. System Architecture:
  - 1. Criticality, operational requirements, and/or limiting points of failure may dictate the development of an enterprise and regional server architecture as opposed to system capacity. Provide server and workstation configurations with all necessary connectors, interfaces and accessories as shown.
- D. PACS shall provide secure and reliable identification of Federal employees and contractors by utilizing credential authentication per FIPS-201.
- E. Physical Access Control System (PACS) shall consist of:
  - 1. Head-End equipment server,
  - 2. One or more networked PC-based workstations,
  - 3. Physical Access Control System and Database Management Software,
  - 4. Credential validation software/hardware,
  - 5. Field installed controllers,
  - 6. PIV Middleware,
  - 7. Card readers,
  - 8. Biometric identification devices,
  - 9. PIV cards,
  - 10. Supportive information system,
  - 11. Door locks and sensors,
  - 12. Power supplies,
  - 13. Interfaces with:
    - a. Video Surveillance and Assessment System,
    - b. Gate, turnstile, and traffic arm controls,
    - c. Automatic door operators,
    - d. Intrusion Detection System,

- e. Intercommunication System
  - f. Fire Protection System,
  - g. HVAC,
  - h. Building Management System,
  - i. Elevator Controls,
  - j. <list interfaced systems>.
14. <list system components>.
- F. Head-End equipment server, workstations and controllers shall be connected by a high-speed electronic data transmission network.
- G. Information system supporting PACS , Head-End equipment server, workstations, network switches, routers and controllers shall comply with FIPS 200 requirements (Minimum Security Requirements for Federal Information and Information Systems)and NIST Special Publication 800-53 (Recommended Security Controls for Federal Information Systems).
- H. PACS system shall support:
- 1. Multiple credential authentication modes,
  - 2. Bidirectional communication with the reader,
  - 3. Incident response policy implementation capability; system shall have capability to automatically change access privileges for certain user groups to high security areas in case of incident/emergency.
  - 4. Visitor management,
- I. All security relevant decisions shall be made on “secure side of the door”. Secure side processing shall include;
- 1. Challenge/response management,
  - 2. PKI path discovery and validation,
  - 3. Credential identifier processing,
  - 4. Authorization decisions.
- J. For locations where secure side processing is not applicable the tamper switches and certified cryptographic processing shall be provided per FIPS-140-2.

- K. System Software: Based on <Insert name of operating system> central-station, workstation operating system, server operating system, and application software.
- L. Software and controllers shall be capable of matching full 56 bit FASC-N plus minimum of 32 bits of public key certificate data.
- M. Software shall have the following capabilities:
  - 1. Multiuser multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.
  - 2. Support authentication and enrolment;
    - a. PIV verification,
    - b. Expiration date check,
    - c. Biometric check,
    - d. Digital photo display/check,
    - e. Validate digital signatures of data objects (Objects are signed by the Trusted Authority
    - f. Private key challenge (CAK & PAK to verify private key public key pairs exist and card is not a clone)
  - 3. Support CRL validation via OCSP or SCVP on a scheduled basis and automatically deny access to any revoked credential in the system.
  - 4. Graphical user interface to show pull-down menus and a menu tree format that complies with interface guidelines of Microsoft Windows operating system.
  - 5. System license shall be for the entire system and shall include capability for future additions that are within the indicated system size limits specified in this Section.
  - 6. System shall have open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with <insert operating system> operating system.
  - 7. Operator login and access shall be utilized via integrated smart card reader and password protection.
- N. Systems Networks:

1. A standalone system network shall interconnect all components of the system. This network shall include communications between a central station and any peer or subordinate workstations, enrollment stations, local annunciation stations, portal control stations or redundant central stations.

O. Security Management System Server Redundancy:

1. The SMS shall support multiple levels of fault tolerance and SMS redundancy listed and described below:
  - a. Hot Standby Servers
  - b. Clustering
  - c. Disk Mirroring
  - d. RAID Level 10
  - e. Distributed Intelligence

P. Number of points:

1. PACS shall support multiple autonomous regional servers that can connect to a master command and controller server.
2. Unlimited number of access control readers, unlimited number of inputs or outputs, unlimited number of client workstations, unlimited number of cardholders.
3. Total system solution to enable enterprise-wide, networked, multi-user access to all system resources via a wide range of options for connectivity with the customer's existing LAN and WAN.

Q. Console Network:

1. Console network, if required, shall provide communication between a central station and any subordinate or separate stations of the system. Where redundant central or parallel stations are required, the console network shall allow the configuration of stations as master and slave. The console network may be a part of the field device network or may be separate depending upon the manufacturer's system configuration.

- R. Network(s) connecting PCs and Controllers shall comply with NIST Special Publication 800-53 (Recommended Security Controls for Federal Information Systems) and consist of one or more of the following:
1. Local area, IEEE 802.3 Fast Ethernet [10 BASE-T] [100 BASE-TX], star topology network based on TCP/IP.
  2. Direct-connected, RS-232 cable from the COM port of the Central Station to the first Controller, then RS-485 to interconnect the remainder of the Controllers at that Location.

## **1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- C. Section 08 11 73 - SLIDING METAL FIRE DOORS. Requirements for door installation.
- D. Section 08 34 59 - VAULT DOORS AND DAY GATES. Requirements for door and gate installation.
- E. Section 08 35 13.13 - ACCORDIAN FOLDING DOORS. Requirements for door installation.
- F. Section 08 71 00 - DOOR HARDWARE. Requirements for door installation.
- G. Section 10 14 00 - SIGNAGE. Requirements for labeling and signs.
- H. Section 14 21 00 ELECTRIC TRACTION ELEVATORS. Requirements for elevators.
- I. Section 14 24 00 - HYDRAULIC ELEVATORS. Requirements for elevators.
- J. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.
- K. Section 26 05 21 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- L. Section 26 05 33 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS. Requirements for infrastructure.
- M. Section 26 05 41 - UNDERGROUND ELECTRICAL CONSTRUCTION. Requirements for underground installation of wiring.
- N. Section 26 56 00 - EXTERIOR LIGHTING. Requirements for perimeter lighting.



- O. Section 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.  
For general requirements that are common to more than one section in Division 28.
- P. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY.  
Requirements for conductors and cables.
- Q. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY.  
Requirements for grounding of equipment.
- R. Section 28 05 28.33 - CONDUITS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY.  
Requirements for infrastructure.
- S. Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY. For  
requirements for commissioning, systems readiness checklists, and training.
- T. Section 28 13 16 - ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.  
Requirements for control and operation of all security systems.
- U. Section 28 13 53 - SECURITY ACCESS DETECTION. Requirements for screening of  
personnel and shipments.
- V. Section 28 16 00 - INTRUSION DETECTION SYSTEM (IDS). Requirements for alarm  
systems.
- W. Section 28 23 00 - VIDEO SURVEILLANCE. Requirements for security camera systems.
- X. Section 28 26 00 - ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS). Requirements  
for emergency and interior communications.
- Y. Section 28 31 00 - FIRE DETECTION AND ALARM. Requirements for integration with fire  
detection and alarm system.

### **1.3 QUALITY ASSURANCE**

- A. Refer to 25 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY,  
Part 1
- A. The Contractor shall be responsible for providing, installing, and the operation of the  
PACS as shown. The Contractor shall also provide certification as required.
- B. The security system will 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. 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.
- D. Product Qualifications:
  - 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.
- E. Contractor Qualifications:
  - 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 Security Management System's (PACS) 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 PACS. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules. 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 Resident Engineer reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.
- a. The Contractor shall provide proof project superintendent with BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.
  - b. 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.
- F. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

#### **1.4 SUBMITTALS**

- A. Refer to 25 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, Section 02 41 00, DEMOLITION, and Section 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- B. Provide certificates of compliance with Section 1.3, Quality Assurance.
- C. Provide a complete and thorough pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.

D. Shop drawing 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 complete 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 individual 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 detailed device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
  - a. Include a title block as defined above.
  - b. Clearly 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 detailed 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 detailed system drawing for each applicable security system shall:
  - a. Clearly 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 detailed 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 PACS, provide the door ID, door type (e.g. wood or metal), locking mechanism (e.g. strike or electromagnetic lock) and control device (e.g. card reader or biometrics).
6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall go through a full review process conducted 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 Section 01 00 00, GENERAL REQUIREMENTS, and Section 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- H. 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.
- I. General: Submittals shall be in full compliance of the Contract Documents. All submittals shall be provided in accordance with this section. Submittals lacking the breath or depth these requirements will be considered incomplete and rejected. Submissions are considered multidisciplinary and shall require coordination with applicable divisions to provide a complete and comprehensive submission package. Additional general provisions are as follows:
1. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination drawings refer to Specification Section 01 33 10 - DESIGN SUBMITTAL PROCEDURES, which outline basic submittal requirements and coordination. Section 01 33 10 shall be used in conjunction with this section.
  2. The Contractor shall identify variations from requirements of Contract Documents and state product and system limitations, which may be detrimental to successful performance of the completed work or system.
  3. Each package shall be submitted at one (1) time for each review and include components from applicable disciplines (e.g., electrical work, architectural finishes,

door hardware, etc.) which are required to produce an accurate and detailed depiction of the project.

4. Manufacturer's information used for submittal shall have pages with items for approval tagged, items on pages shall be identified, and capacities and performance parameters for review shall be clearly marked through use of an arrow or highlighting. Provide space for Resident Engineer and Contractor review stamps.
5. Technical Data Drawings shall be in the latest version of AutoCAD®, drawn accurately, and in accordance with VA CAD Standards. FREEHAND SKETCHES OR COPIED VERSIONS OF THE CONSTRUCTION DOCUMENTS WILL NOT BE ACCEPTED. The Contractor shall not reproduce Contract Documents or copy standard information as the basis of the Technical Data Drawings. If departures from the technical data drawings are subsequently deemed necessary by the Contractor, details of such departures and the reasons thereof shall be submitted in writing to the Resident Engineer for approval before the initiation of work.
6. Packaging: The Contractor shall organize the submissions according to the following packaging requirements.
  - a. Binders: For each manual, provide heavy duty, commercial quality, durable three (3) ring vinyl covered loose leaf binders, sized to receive 8.5 x 11 in paper, and appropriate capacity to accommodate the contents. Provide a clear plastic sleeve on the spine to hold labels describing the contents. Provide pockets in the covers to receive folded sheets.
    - 1) Where two (2) or more binders are necessary to accommodate data, correlate data in each binder into related groupings according to the Project Manual table of contents. Cross-referencing other binders where necessary to provide essential information for communication of proper operation and or maintenance of the component or system.
    - 2) Identify each binder on the front and spine with printed binder title, Project title or name, and subject matter covered. Indicate the volume number if applicable.

- b. Dividers: Provide heavy paper dividers with celluloid tabs for each Section.  
Mark each tab to indicate contents.
- c. Protective Plastic Jackets: Provide protective transparent plastic jackets designed to enclose diagnostic software for computerized electronic equipment.
- d. Text Material: Where written material is required as part of the manual use the manufacturer's standard printed material, or if not available, specially prepared data, neatly typewritten on 8.5 inches by 11 inches 20 pound white bond paper.
- e. Drawings: Where drawings and/or diagrams are required as part of the manual, provide reinforced punched binder tabs on the drawings and bind them with the text.
  - 1) Where oversized drawings are necessary, fold the drawings to the same size as the text pages and use as a foldout.
  - 2) If drawings are too large to be used practically as a foldout, place the drawing, neatly folded, in the front or rear pocket of the binder. Insert a type written page indicating the drawing title, description of contents and drawing location at the appropriate location of the manual.
  - 3) Drawings shall be sized to ensure details and text is of legible size. Text shall be no less than 1/16" tall.
- f. Manual Content: In each manual include information specified in the individual Specification section, and the following information for each major component of building equipment and controls:
  - 1) General system or equipment description.
  - 2) Design factors and assumptions.
  - 3) Copies of applicable Shop Drawings and Product Data.
  - 4) System or equipment identification including: manufacturer, model and serial numbers of each component, operating instructions, emergency instructions, wiring diagrams, inspection and test procedures, maintenance procedures and schedules, precautions against improper use and



maintenance, repair instructions, sources of required maintenance materials and related services, and a manual index.

- g. Binder Organization: Organize each manual into separate sections for each piece of related equipment. At a minimum, each manual shall contain a title page, table of contents, copies of Product Data supplemented by drawings and written text, and copies of each warranty, bond, certifications, and service Contract issued. Refer to Group I through V Technical Data Package Submittal requirements for required section content.
- h. Title Page: Provide a title page as the first sheet of each manual to include the following information; project name and address, subject matter covered by the manual, name and address of the Project, date of the submittal, name, address, and telephone number of the Contractor, and cross references to related systems in other operating and/or maintenance manuals.
- i. Table of Contents: After the title page, include a type written table of contents for each volume, arranged systematically according to the Project Manual format. Provide a list of each product included, identified by product name or other appropriate identifying symbols and indexed to the content of the volume. Where more than one (1) volume is required to hold data for a particular system, provide a comprehensive table of contents for all volumes in each volume of the set.
- j. General Information Section: Provide a general information section immediately following the table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the installer and maintenance Contractor. In addition, list a local source for replacement parts and equipment.
- k. Drawings: Provide specially prepared drawings where necessary to supplement the manufacturers printed data to illustrate the relationship between components of equipment or systems, or provide control or flow diagrams.

Coordinate these drawings with information contained in Project Record Drawings to assure correct illustration of the completed installation.

- I. Manufacturer's Data: Where manufacturer's standard printed data is included in the manuals, include only those sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where more than one (1) item in tabular format is included, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation and delete references to information which is not applicable.
  - m. Where manufacturer's standard printed data is not available and the information is necessary for proper operation and maintenance of equipment or systems, or it is necessary to provide additional information to supplement the data included in the manual, prepare written text to provide the necessary information. Organize the text in a consistent format under a separate heading for different procedures. Where necessary, provide a logical sequence of instruction for each operating or maintenance procedure. Where similar or more than one product is listed on the submittal the Contractor shall differentiate by highlighting the specific product to be utilized.
  - n. Calculations: Provide a section for circuit and panel calculations.
  - o. Loading Sheets: Provide a section for DGP Loading Sheets.
  - p. Certifications: Provide section for Contractor's manufacturer certifications.
7. Contractor Review: Review submittals prior to transmittal. Determine and verify field measurements and field construction criteria. Verify manufacturer's catalog numbers and conformance of submittal with requirements of contract documents. Return non-conforming or incomplete submittals with requirements of the work and contract documents. Apply Contractor's stamp with signature certifying the review and verification of products occurred, and the field dimensions, adjacent construction, and coordination of information is in accordance with the requirements of the contract documents.

8. Resubmission: Revise and resubmit submittals as required within 15 calendar days of return of submittal. Make resubmissions under procedures specified for initial submittals. Identify all changes made since previous submittal.
9. Product Data: Within 15 calendar days after execution of the contract, the Contractor shall submit for approval a complete list of all of major products proposed for use. The data shall include name of manufacturer, trade name, model number, the associated contract document section number, paragraph number, and the referenced standards for each listed product.
- J. Group 1 Technical Data Package: Group I Technical Data Package shall be one submittal consisting of the following content and organization. Refer to VA Special Conditions Document for drawing format and content requirements. The data package shall include the following:
  1. Section I - Drawings:
    - a. General – Drawings shall conform to VA Special Conditions and CAD Standards Documents. All text associated with security details shall be 1/8" tall and meet VA text standard for AutoCAD™ drawings.
    - b. Cover Sheet – Cover sheet shall consist of Project Title and Address, Project Number, Area and Vicinity Maps.
    - c. General Information Sheets – General Information Sheets shall consist of General Notes, Abbreviations, Symbols, Wire and Cable Schedule, Project Phasing, and Sheet Index.
    - d. Floor Plans – Floor plans shall be produced from the Architectural backgrounds issued in the Construction Documents. The contractor shall receive floor plans from the prime A/E to develop these drawing sets. Security devices shall be placed on drawings in scale. All text associated with security details shall be 1/8" tall and meet VA text standard for AutoCAD™ drawings. Floor plans shall identify the following:
      - 1) security devices by symbol,
      - 2) the associated device point number (derived from the loading sheets),

- 3) wire & cable types and counts
  - 4) conduit sizing and routing
  - 5) conduit riser systems
  - 6) device and area detail call outs
- e. Architectural details – Architectural details shall be produced for each device mounting type (door details for doors with physical access control, reader pedestals and mounts, security panel and power supply details).
  - f. Riser Diagrams – Contractor shall provide a riser diagram indicating riser architecture and distribution of the physical access control system throughout the facility (or area in scope).
  - g. Block Diagrams – Contractor shall provide a block diagram for the entire system architecture and interconnections with SMS subsystems. Block diagram shall identify SMS subsystem (e.g., physical access control, intrusion detection, closed circuit television, intercom, and other associated subsystems) integration; and data transmission and media conversion methodologies.
  - h. Interconnection Diagrams – Contractor shall provide interconnection diagram for each sensor, and device component. Interconnection diagram shall identify termination locations, standard wire detail to include termination schedule. Diagram shall also identify interfaces to other systems such as elevator control, fire alarm systems, and security management systems.
  - i. Security Details:
    - 1) Panel Assembly Detail – For each panel assembly, a panel assembly details shall be provided identifying individual panel component size and content.
    - 2) Panel Details – Provide security panel details identify general arrangement of the security system components, backboard size, wire through size and location, and power circuit requirements.
    - 3) Device Mounting Details – Provide mounting detailed drawing for each security device (physical access control system, intrusion detection, video surveillance and assessment, and intercom systems) for each type of wall and

ceiling configuration in project. Device details shall include device, mounting detail, wiring and conduit routing.

- 4) Details of connections to power supplies and grounding
- 5) Details of surge protection device installation
- 6) Sensor detection patterns – Each system sensor shall have associated detection patterns.
- 7) Equipment Rack Detail – For each equipment rack, provide a scaled detail of the equipment rack location and rack space utilization. Use of BISC wire management standards shall be employed to identify wire management methodology. Transitions between equipment racks shall be shown to include use vertical and horizontal latter rack system.
- 8) Security Control Room – The contractor shall provide a layout plan for the Security Control Room. The layout plan shall identify all equipment and details associated with the installation.
- 9) Operator Console – The contractor shall provide a layout plan for the Operator Console. The layout plan shall identify all equipment and details associated with the installation. Equipment room - the contractor shall provide a layout plan for the equipment room. The layout plan shall identify all equipment and details associated with the installation.
- 10) Equipment Room – Equipment room details shall provide architectural, electrical, mechanical, plumbing, IT/Data and associated equipment and device placements both vertical and horizontally.
- j. Electrical Panel Schedule – Electrical Panel Details shall be provided for all SMS systems electrical power circuits. Panel details shall be provided identifying panel type (Standard, Emergency Power, Emergency/Uninterrupted Power Source, and Uninterrupted Power Source Only), panel location, circuit number, and circuit amperage rating.

- k. Door Schedule – A door schedule shall be developed for each door equipped with electronic security components. At a minimum, the door schedule shall be coordinated with Division 08 work and include the following information:
- 1) Item Number
  - 2) Door Number (Derived from A/E Drawings)
  - 3) Floor Plan Sheet Number
  - 4) Standard Detail Number
  - 5) Door Description (Derived from Loading Sheets)
  - 6) Data Gathering Panel Input Number
  - 7) Door Position or Monitoring Device Type & Model Number
  - 8) Lock Type, Model Number & Power Input/Draw (standby/active)
  - 9) Card Reader Type & Model Number
  - 10) Shunting Device Type & Model Number
  - 11) Sounder Type & Model Number
  - 12) Manufacturer
  - 13) Misc. devices as required
    - a) Delayed Egress Type & Model Number
    - b) Intercom
    - c) Camera
    - d) Electric Transfer Hinge
    - e) Electric Pass-through device
  - 14) Remarks column indicating special notes or door configurations
2. Camera Schedule - A camera schedule shall be developed for each camera. Contractors shall coordinate with the Resident Engineer to determine camera starting numbers and naming conventions. All drawings shall identify wire and cable standardization methodology. Color coding of all wiring conductors and jackets is required and shall be communicated consistently throughout the drawings package submittal. At a minimum, the camera schedule shall include the following information:

- a. Item Number
  - b. Camera Number
  - c. Naming Conventions
  - d. Description of Camera Coverage
  - e. Camera Location
  - f. Floor Plan Sheet Number
  - g. Camera Type
  - h. Mounting Type
  - i. Standard Detail Reference
  - j. Power Input & Draw
  - k. Power Panel Location
  - l. Remarks Column for Camera
3. Section II – Data Gathering Panel Documentation Package
- a. Contractor shall provide Data Gathering Panel (DGP) input and output documentation packages for review at the Shop Drawing submittal stage and also with the as-built documentation package. The documentation packages shall be provided in both printed and magnetic form at both review stages.
  - b. The Contractor shall provide loading sheet documentation package for the associated DGP, including input and output boards for all field panels associated with the project. Documentation shall be provided in current version Microsoft Excel spreadsheets following the format currently utilized by VA. A separate spreadsheet file shall be generated for each DGP and associated field panels.
  - c. The spreadsheet names shall follow a sequence that shall display the spreadsheets in numerical order according to the DGP system number. The spreadsheet shall include the prefix in the file name that uniquely identifies the project site. The spreadsheet shall detail all connected items such as card readers, alarm inputs, and relay output connections. The spreadsheet shall include an individual section (row) for each panel input, output and card reader.

The spreadsheet shall automatically calculate the system numbers for card readers, inputs, and outputs based upon data entered in initialization fields.

- d. All entries must be verified against the field devices. Copies of the floor plans shall be forwarded under separate cover.
- e. The DGP spreadsheet shall include an entry section for the following information:
  - 1) DGP number
  - 2) First Reader Number
  - 3) First Monitor Point Number
  - 4) First Relay Number
  - 5) DGP, input or output Location
  - 6) DGP Chain Number
  - 7) DGP Cabinet Tamper Input Number
  - 8) DGP Power Fail Input Number
  - 9) Number of Monitor Points Reserved For Expansion Boards
  - 10) Number of Control Points (Relays) Reserved For Expansion Boards
- f. The DGP, input module and output module spreadsheets shall automatically calculate the following information based upon the associated entries in the above fields:
  - 1) System Numbers for Card Readers
  - 2) System Numbers for Monitor Point Inputs
  - 3) System Numbers for Control Points (Relays)
  - 4) Next DGP or input module First Monitor Point Number
  - 5) Next DGP or output module First Control Point Number
- g. The DGP spreadsheet shall provide the following information for each card reader:
  - 1) DGP Reader Number
  - 2) System Reader Number
  - 3) Cable ID Number



- 4) Description Field (Room Number)
  - 5) Description Field (Device Type i.e.: In Reader, Out Reader, etc.)
  - 6) Description Field
  - 7) DGP Input Location
  - 8) Date Test
  - 9) Date Passed
  - 10) Cable Type
  - 11) Camera Numbers (of cameras viewing the reader location)
- h. The DGP and input module spreadsheet shall provide the following information for each monitor point (alarm input).
- 1) DGP Monitor Point Input Number
  - 2) System Monitor Point Number
  - 3) Cable ID Number
  - 4) Description Field (Room Number)
  - 5) Description Field (Device Type i.e.: Door Contact, Motion Detector, etc.)
  - 6) DGP or input module Input Location
  - 7) Date Test
  - 8) Date Passed
  - 9) Cable Type
  - 10) Camera Numbers (of associated alarm event preset call-ups)
- i. The DGP and output module spreadsheet shall provide the following information for each control point (output relay).
- 1) DGP Control Point (Relay) Number
  - 2) System (Control Point) Number
  - 3) Cable ID Number
  - 4) Description Field (Room Number)
  - 5) Description Field (Device: Lock Control, Local Sounder, etc.)
  - 6) Description Field
  - 7) DGP or OUTPUT MODULE Output Location

- 8) Date Test
- 9) Date Passed Cable Type
- 10) Camera Number (of associated alarm event preset call-ups)
- j. The DGP, input module and output module spreadsheet shall include the following information or directions in the header and footer:
  - 1) Header
    - a) DGP Input and Output Worksheet
    - b) Enter Beginning Reader, Input, and Output Starting Numbers and Sheet  
Will Automatically Calculate the Remaining System Numbers.
  - 2) Footer
    - a) File Name
    - b) Date Printed
    - c) Page Number
- 4. Section III - Construction Mock-up: In areas with exposed EMT/Conduit Raceways, contractor shall conceal raceway as much as practical and unobtrusively. In addition, historic significance must be considered to determine installation means and methods for approval by the owner.
- 5. Section IV - Manufacturers' Data: The data package shall include manufacturers' data for all materials and equipment, including sensors, local processors and console equipment provided under this specification.
- 6. Section V - System Description and Analysis: The data package shall include system descriptions, analysis, and calculations used in sizing equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance requirements of this specification. The data package shall include the following:
  - a. Central processor memory size; communication speed and protocol description; rigid disk system size and configuration; flexible disk system size and configuration; back-up media size and configuration; alarm response time calculations; command response time calculations; start-up operations;

expansion capability and method of implementation; sample copy of each report specified; and color photographs representative of typical graphics.

- b. Software Data: The data package shall consist of descriptions of the operation and capability of the system, and application software as specified.
  - c. Overall System Reliability Calculations: The data package shall include all manufacturers' reliability data and calculations required to show compliance with the specified reliability.
7. Section VI – Certifications & References: All specified manufacturer's certifications shall be included with the data package. Contractor shall provide Project references as outlined in Paragraph 1.4 "Quality Assurance".

K. Group II Technical Data Package

- 1. The Contractor shall prepare a report of "Current Site Conditions" and submit a report to the Resident Engineer documenting changes to the site, particularly those conditions that affect performance of the system to be installed. The Contractor shall provide specification sheets, or written functional requirements to support the findings, and a cost estimate to correct those site changes or conditions which affect the installation of the system or its performance. The Contractor shall not correct any deficiency without written permission from the COTR.
- 2. System Configuration and Functionality: The contractor shall provide the results of the meeting with VA to develop system requirements and functionality including but not limited to:
  - a. Baseline configuration
  - b. Access levels
  - c. Schedules (intrusion detection, physical access control, holidays, etc.)
  - d. Badge database
  - e. System monitoring and reporting (unit level and central control)
  - f. Naming conventions and descriptors

L. Group III Technical Data Package

1. Development of Test Procedures: The Contractor will prepare performance test procedures for the system testing. The test procedures shall follow the format of the VA Testing procedures and be customized to the contract requirements. The Contractor will deliver the test procedures to the Resident Engineer for approval at least 60 calendar days prior to the requested test date.

M. Group IV Technical Data Package

1. Performance Verification Test
  - a. Based on the successful completion of the pre-delivery test, the Contractor shall finalize the test procedures and report forms for the performance verification test (PVT) and the endurance test. The PVT shall follow the format, layout and content of the pre-delivery test. The Contractor shall deliver the PVT and endurance test procedures to the Resident Engineer for approval. The Contractor may schedule the PVT after receiving written approval of the test procedures. The Contractor shall deliver the final PVT and endurance test reports within 14 calendar days from completion of the tests. Refer to Part 3 of this section for System Testing and Acceptance requirements.
2. Training Documentation
  - a. New Facilities and Major Renovations: Familiarization training shall be provided for new equipment or systems. Training can include site familiarization training for VA technicians and administrative personnel. Training shall include general information on new system layout including closet locations, turnover of the completed system including all documentation, including manuals, software, key systems, and full system administration rights. Lesson plans and training manuals training shall be oriented to type of training to be provided.
  - b. New Unit Control Room:
    - 1) Provide the security personnel with training in the use, operation, and maintenance of the entire control room system (Unit Control and Equipment Rooms). The training documentation must include the operation and maintenance. The first of the training sessions shall take place prior to

system turnover and the second immediately after turnover. Coordinate the training sessions with the Owner. Completed classroom sessions will be witnessed and documented by the Architect/Engineer, and approved by the Resident Engineer. Instruction is not to begin until the system is operational as designed.

- 2) The training documents will cover the operation and the maintenance manuals and the control console operators' manuals and service manuals in detail, stressing all important operational and service diagnostic information necessary for the maintenance and operations personnel to efficiently use and maintain all systems.
- 3) Provide an illustrated control console operator's manual and service manual. The operator's manual shall be written in laymen's language and printed so as to become a permanent reference document for the operators, describing all control panel switch operations, graphic symbol definitions and all indicating functions and a complete explanation of all software.
- 4) The service manual shall be written in laymen's language and printed so as to become a permanent reference document for maintenance personnel, describing how to run internal self diagnostic software programs, troubleshoot head end hardware and field devices with a complete scenario simulation of all possible system malfunctions and the appropriate corrective measures.
- 5) Provide a professional color DVD instructional recording of all the operational procedures described in the operator's manual. All charts used in the training session shall be clearly presented on the video. Any DVD found to be inferior in recording or material content shall be reproduced at no cost until an acceptable DVD is submitted. Provide four copies of the training DVD, one to the architect/engineer and three to the owner.

### 3. System Configuration and Data Entry:

- a. The contractor is responsible for providing all system configuration and data entry for the SMS and subsystems (e.g., video matrix switch, intercom, digital video recorders, network video recorders). All data entry shall be performed per VA standards & guidelines. The Contractor is responsible for participating in all meetings with the client to compile the information needed for data entry. These meetings shall be established at the beginning of the project and incorporated in to the project schedule as a milestone task. The contractor shall be responsible for all data collection, data entry, and system configuration. The contractor shall collect, enter, & program and/or configure the following components:
  - 1) Physical Access control system components,
  - 2) All intrusion detection system components,
  - 3) Video surveillance, control and recording systems,
  - 4) Intercom systems components,
  - 5) All other security subsystems shown in the contract documents.
- b. The Contractor is responsible for compiling the card access database for the VA employees, including programming reader configurations, access shifts, schedules, exceptions, card classes and card enrollment databases.
- c. Refer to Part 3 for system programming requirements and planning guidelines.
4. Graphics: Based on CAD as-built drawings developed for the construction project, create all map sets showing locations of all alarms and field devices. Graphical maps of all alarm points installed under this contract including perimeter and exterior alarm points shall be delivered with the system. The Contractor shall create and install all graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the COTR, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy,

- color examples at least 203.2 x 254 mm (8 x 10 in) of each type of graphic to be used for the completed Security system. The graphics examples shall be delivered to the Resident Engineer for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires them.
- N. Group V Technical Data Package: Final copies of the manuals shall be delivered to the Resident Engineer as part of the acceptance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each sub-contractor installing equipment or systems, as well as the nearest service representatives for each item of equipment for each system. The manuals shall include a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Six (6) hard-copies and one (1) soft copy on CD of each item listed below shall be delivered as a part of final systems acceptance.
1. Functional Design Manual: The functional design manual shall identify the operational requirements for the entire system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. Manufacturer developed literature may be used; however, shall be produced to match the project requirements.
  2. Equipment Manual: A manual describing all equipment furnished including:
    - a. General description and specifications; installation and checkout procedures; equipment electrical schematics and layout drawings; system schematics and layout drawings; alignment and calibration procedures; manufacturer's repair list indicating sources of supply; and interface definition.

3. Software Manual: The software manual shall describe the functions of all software and include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
  - a. Definition of terms and functions; use of system and applications software; procedures for system initialization, start-up, and shutdown; alarm reports; reports generation, database format and data entry requirements; directory of all disk files; and description of all communications protocols including data formats, command characters, and a sample of each type of data transfer.
4. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:
  - a. Computers and peripherals; system start-up and shutdown procedures; use of system, command, and applications software; recovery and restart procedures; graphic alarm presentation; use of report generator and generation of reports; data entry; operator commands' alarm messages, and printing formats; and system access requirements.
5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, recommend schedules, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
6. Spare Parts & Components Data: At the conclusion of the Contractor's work, the Contractor shall submit to the Resident Engineer a complete list of the manufacturer's recommended spare parts and components required to satisfactorily maintain and service the systems, as well as unit pricing for those parts and components.
7. Operation, Maintenance & Service Manuals: The Contractor shall provide two (2) complete sets of operating and maintenance manuals in the form of an instructional manual for use by the VA Security Guard Force personnel. The manuals shall be organized into suitable sets of manageable size. Where possible, assemble



- instructions for similar equipment into a single binder. If multiple volumes are required, each volume shall be fully indexed and coordinated.
8. Equipment and Systems Maintenance Manual: The Contractor shall provide the following descriptive information for each piece of equipment, operating system, and electronic system:
- a. Equipment and/or system function.
  - b. Operating characteristics.
  - c. Limiting conditions.
  - d. Performance curves.
  - e. Engineering data and test.
  - f. Complete nomenclature and number of replacement parts.
  - g. Provide operating and maintenance instructions including assembly drawings and diagrams required for maintenance and a list of items recommended to stock as spare parts.
  - h. Provide information detailing essential maintenance procedures including the following: routine operations, trouble shooting guide, disassembly, repair and re-assembly, alignment, adjusting, and checking.
  - i. Provide information on equipment and system operating procedures, including the following; start-up procedures, routine and normal operating instructions, regulation and control procedures, instructions on stopping, shut-down and emergency instructions, required sequences for electric and electronic systems, and special operating instructions.
  - j. Manufacturer equipment and systems maintenance manuals are permissible.
9. Project Redlines: During construction, the Contractor shall maintain an up-to-date set of construction redlines detailing current location and configuration of the project components. The redline documents shall be marked with the words 'Master Redlines' on the cover sheet and be maintained by the Contractor in the project office. The Contractor will provide access to redline documents anytime during the project for review and inspection by the Resident Engineer or authorized

- Office of Protection Services representative. Master redlines shall be neatly maintained throughout the project and secured under lock and key in the contractor's onsite project office. Any project component or assembly that is not installed in strict accordance with the drawings shall be so noted on the drawings. Prior to producing Record Construction Documents, the contractor will submit the Master Redline document to the Resident Engineer for review and approval of all changes or modifications to the documents. Each sheet shall have Resident Engineer initials indicating authorization to produce "As Built" documents. Field drawings shall be used for data gathering & field changes. These changes shall be made to the master redline documents daily. Field drawings shall not be considered "master redlines".
10. Record Specifications: The Contractor shall maintain one (1) copy of the Project Specifications, including addenda and modifications issued, for Project Record Documents. The Contractor shall mark the Specifications to indicate the actual installation where the installation varies substantially from that indicated in the Contract Specifications and modifications issued. (Note related Project Record Drawing information where applicable). The Contractor shall pay particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later. Upon completion of the mark ups, the Contractor shall submit record Specifications to the COTR. As with master relines, Contractor shall maintain record specifications for Resident Engineer review and inspection at anytime.
  11. Record Product Data: The Contractor shall maintain one (1) copy of each Product Data submittal for Project Record Document purposes. The Data shall be marked to indicate the actual product installed where the installation varies substantially from that indicated in the Product Data submitted. Significant changes in the product delivered to the site and changes in manufacturer's instructions and recommendations for installation shall be included. Particular attention will be given to information on concealed products and installations that cannot be readily

- identified or recorded later. Note related Change Orders and mark up of Record Construction Documents, where applicable. Upon completion of mark up, submit a complete set of Record Product Data to the COTR.
12. Miscellaneous Records: The Contractor shall maintain one (1) copy of miscellaneous records for Project Record Document purposes. Refer to other Specifications for miscellaneous record-keeping requirements and submittals concerning various construction activities. Before substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Categories of requirements resulting in miscellaneous records include, a minimum of the following:
- a. Certificates received instead of labels on bulk products.
  - b. Testing and qualification of tradesmen. ("Contractor's Qualifications")
  - c. Documented qualification of installation firms.
  - d. Load and performance testing.
  - e. Inspections and certifications.
  - f. Final inspection and correction procedures.
  - g. Project schedule
13. Record Construction Documents (Record As-Built)
- a. Upon project completion, the contractor shall submit the project master redlines to the Resident Engineer prior to development of Record construction documents. The Resident Engineer shall be given a minimum of a thirty (30) day review period to determine the adequacy of the master redlines. If the master redlines are found suitable by the Resident Engineer, the Resident Engineer will initial and date each sheet and turn redlines over to the contractor for as built development.
  - b. The Contractor shall provide the Resident Engineer a complete set of "as-built" drawings and original master redlined marked "as-built" blue-line in the latest version of AutoCAD drawings unlocked on CD or DVD. The as-built drawing shall include security device number, security closet connection location, data

gathering panel number, and input or output number as applicable. All corrective notations made by the Contractor shall be legible when submitted to the COTR. If, in the opinion of the COTR, any redlined notation is not legible, it shall be returned to the Contractor for re-submission at no extra cost to the Owner. The Contractor shall organize the Record Drawing sheets into manageable sets bound with durable paper cover sheets with suitable titles, dates, and other identifications printed on the cover. The submitted as built shall be in editable formats and the ownership of the drawings shall be fully relinquished to the owner.

- c. Where feasible, the individual or entity that obtained record data, whether the individual or entity is the installer, sub-contractor, or similar entity, is required to prepare the mark up on Record Drawings. Accurately record the information in a comprehensive drawing technique. Record the data when possible after it has been obtained. For concealed installations, record and check the mark up before concealment. At the time of substantial completion, submit the Record Construction Documents to the COTR. The Contractor shall organize into bound and labeled sets for the COTR's continued usage. Provide device, conduit, and cable lengths on the conduit drawings. Exact in-field conduit placement/routings shall be shown. All conduits shall be illustrated in their entire length from termination in security closets; no arrowed conduit runs shall be shown. Pull box and junction box sizes are to be shown if larger than 100mm (4 inch).

O. FIPS 201 Compliance Certificates

1. Provide Certificates for all software components and device types utilizing credential verification. Provide certificates for:
  - a. Fingerprint Capture Station
  - b. Card Readers
  - c. Facial Image Capturing Camera
  - d. PIV Middleware
  - e. Template Matcher

- f. Electromagnetically Opaque Sleeve
  - g. Certificate Management
    - 1) CAK Authentication System
    - 2) PIV Authentication System
    - 3) Certificate Validator
    - 4) Cryptographic Module
  - h. <list devices and software>
- P. Approvals will be based on complete submission of manuals together with shop drawings.
- Q. 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.

#### 1.5 APPLICABLE PUBLICATIONS

- A. Refer to 25 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/ Security Industry Association (SIA):
- AC-03.....Access Control: Access Control Guideline Dye Sublimation  
Printing Practices for PVC Access Control Cards
  - TVAC-01.....CCTV to Access Control Standard - Message Set for System  
Integration
- C. American National Standards Institute (ANSI)/ International Code Council (ICC):
- A117.1 .....Standard on Accessible and Usable Buildings and Facilities
- D. Department of Justice American Disability Act (ADA)
- 28 CFR Part 36.....ADA Standards for Accessible Design 2010
- E. Department of Veterans Affairs (VA):

PACS-R: Physical Access Control System (PACS) Requirements

VA Handbook 0730 Security and Law Enforcement

F. Government Accountability Office (GAO):

GAO-03-8-02 Security Responsibilities for Federally Owned and Leased Facilities

G. National Electrical Contractors Association

303-2005 .....Installing Closed Circuit Television (CCTV) Systems

H. National Electrical Manufacturers Association (NEMA):

250-08 .....Enclosures for Electrical Equipment (1000 Volts Maximum)

I. National Fire Protection Association (NFPA):

70-11 ..... National Electrical Code

J. Underwriters Laboratories, Inc. (UL):

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

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

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

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

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

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

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

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

K. Homeland Security Presidential Directive (HSPD):

HSPD-12 .....Policy for a Common Identification Standard for Federal

Employees and Contractors

L. Federal Communications Commission (FCC):

(47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems

M. Federal Information Processing Standards (FIPS):

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

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

IR 6887 V2.1 .....	Government Smart Card Interoperability Specification (GSC-IS)
Special Pub 800-63.....	Electronic Authentication Guideline
Special Pub 800-96.....	PIV Card Reader Interoperability Guidelines
Special Pub 800-73-3 .....	Interfaces for Personal Identity Verification (4 Parts)
.....	Pt. 1- End Point PIV Card Application Namespace, Data Model & Representation
.....	Pt. 2- PIV Card Application Card Command Interface
.....	Pt. 3- PIV Client Application Programming Interface
.....	Pt. 4- The PIV Transitional Interfaces & Data Model Specification
Special Pub 800-76-1 .....	Biometric Data Specification for Personal Identity Verification
Special Pub 800-78-2 .....	Cryptographic Algorithms and Key Sizes for Personal Identity Verification
Special Pub 800-79-1 .....	Guidelines for the Accreditation of Personal Identity Verification Card Issuers
Special Pub 800-85B-1 .....	DRAFTPIV Data Model Test Guidelines
Special Pub 800-85A-2 .....	PIV Card Application and Middleware Interface Test Guidelines (SP 800-73-3 compliance)
Special Pub 800-96.....	PIV Card Reader Interoperability Guidelines
Special Pub 800-37.....	Guide for Applying the Risk Management Framework to Federal Information Systems
Special Pub 800-96.....	PIV Card Reader Interoperability Guidelines
Special Pub 800-96.....	PIV Card Reader Interoperability Guidelines
Special Pub 800-104A .....	Scheme for PIV Visual Card Topography
Special Pub 800-116.....	Recommendation for the Use of PIV Credentials in Physical Access Control Systems (PACS)

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

C62.41 .....IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

P. International Organization for Standardization (ISO):

7810 .....Identification cards – Physical characteristics

7811 .....Physical Characteristics for Magnetic Stripe Cards

7816-1 .....Identification cards - Integrated circuit(s) cards with contacts - Part 1: Physical characteristics

7816-2 .....Identification cards - Integrated circuit cards - Part 2: Cards with contacts -Dimensions and location of the contacts

7816-3 .....Identification cards - Integrated circuit cards - Part 3: Cards with contacts - Electrical interface and transmission protocols

7816-4 .....Identification cards - Integrated circuit cards - Part 11: Personal verification through biometric methods

7816-10 .....Identification cards - Integrated circuit cards - Part 4: Organization, security and commands for interchange

14443 .....Identification cards - Contactless integrated circuit cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 inches distance

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

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

Q. Uniform Federal Accessibility Standards (UFAS) 1984

R. ADA Standards for Accessible Design 2010

S. Section 508 of the Rehabilitation Act of 1973



## 1.6 DEFINITIONS

- A. Refer to 25 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- A. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.
- B. Access Control List: A list of (identifier, permissions) pairs associated with a resource or an asset. As an expression of security policy, a person may perform an operation on a resource or asset if and only if the person's identifier is present in the access control list (explicitly or implicitly), and the permissions in the (identifier, permissions) pair include the permission to perform the requested operation.
- C. Access Control: A function or a system that restricts access to authorized persons only.
- D. API Application Programming Interface
- E. Assurance Level (or E-Authentication Assurance Level): A measure of trust or confidence in an authentication mechanism defined in OMB Memorandum M-04-04 and NIST Special Publication (SP) 800-63, in terms of four levels: [M-04-04]
  - 1. Level 1: LITTLE OR NO confidence
  - 2. Level 2: SOME confidence
  - 3. Level 3: HIGH confidence
  - 4. Level 4: VERY HIGH confidence
- F. Authentication: A process that establishes the origin of information, or determines an entity's identity. In this publication, authentication often means the performance of a PIV authentication mechanism.
- G. Authenticator: A memory, possession, or quality of a person that can serve as proof of identity, when presented to a verifier of the appropriate kind. For example, passwords, cryptographic keys, and fingerprints are authenticators.
- H. Authorization: A process that associates permission to access a resource or asset with a person and the person's identifier(s).
- I. BIO or BIO-A: A FIPS 201 authentication mechanism that is implemented by using a Fingerprint data object sent from the PIV Card to the PACS. Note that the short-hand

“BIO (-A)” is used throughout the document to represent both BIO and BIO-A authentication mechanisms.

- J. Biometric: An authenticator produced from measurable qualities of a living person.
- K. CAC EP – CAC End Point with end point PIV applet
- L. CAC NG – CAC Next Generation with transitional PIV applet
- M. Card Authentication Key (CAK): A PIV authentication mechanism (or the PIV Card key of the same name) that is implemented by an asymmetric or symmetric key challenge/response protocol. The CAK is an optional mechanism defined in NIST SP 800-73. [SP800-73] NIST strongly recommends that every PIV Card contain an asymmetric CAK and corresponding certificate, and that agencies use the asymmetric CAK protocol, rather than a symmetric CAK protocol, whenever the CAK authentication mechanism is used with PACS.
- N. CCTV: Closed-circuit television.
- O. Central Station: A PC with software designated as the main controlling PC of the PACS. Where this term is presented with initial capital letters, this definition applies.
- P. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.
- Q. CPU: Central processing unit.
- R. Credential: Data assigned to an entity and used to identify that entity.
- S. File Server: A PC in a network that stores the programs and data files shared by users.
- T. FIPS Federal Information Processing Standards
- U. FRAC – First Responder Authentication Credential
- V. HSPD Homeland Security Presidential Directive
- W. I/O: Input/Output.
- X. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

- Y. IEC International Electrotechnical Commission
- Z. ISO International Organization for Standardization
- AA. KB Kilobyte
- BB. kbit/s Kilobits / second
- CC. LAN: Local area network.
- DD. LED: Light-emitting diode.
- EE. Legacy CAC – Contact only Common Access Card with v1 and v2 applets
- FF. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.
- GG. NIST: National Institute of Standards and Technology
- HH. PACS: Physical Access Control System
- II. PC/SC: Personal Computer / Smart Card
- JJ. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.
- KK. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).
- LL. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.
- MM. PIV: Personal Identification Verification
- NN. PIV-I – PIV Interoperable credential
- OO. PPS: Protocol and Parameters Selection
- PP. RF: Radio frequency.
- QQ. ROM: Read-only memory. ROM data are maintained through losses of power.
- RR. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

- SS. RS-485: An TIA/EIA standard for multipoint communications.
- TT. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- UU. TPDU: Transport Protocol Data Unit
- VV. TWIC – Transportation Worker Identification Credential
- WW. UPS: Uninterruptible power supply.
- XX. Vcc: Voltage at the Common Collector
- YY. WAN: Wide area network.
- ZZ. WAV: The digital audio format used in Microsoft Windows.
- AAA. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- BBB. Windows: Operating system by Microsoft Corporation.
- CCC. Workstation: A PC with software that is configured for specific limited security system functions.

## **1.7 COORDINATION**

- A. Refer to 25 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- A. Coordinate arrangement, mounting, and support of electronic safety and security 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 electronic safety and security items that are behind finished surfaces or otherwise concealed.

## **1.8 MAINTENANCE & SERVICE**

- A. Refer to 25 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- A. General Requirements
  - 1. The Contractor shall provide all services required and equipment necessary to maintain the entire integrated electronic security system in an operational state as specified for a period of one (1) year after formal written acceptance of the system. The Contractor shall provide all necessary material required for performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. See also General Project Requirements.
- B. Description of Work
  - 1. The adjustment and repair of the security system includes all software updates, panel firmware, and the following new items computers equipment, communications transmission equipment and data transmission media (DTM), local processors, security system sensors, physical access control equipment, facility interface, signal transmission equipment, and video equipment.
- C. Personnel
  - 1. Service personnel shall be certified in the maintenance and repair of the selected type of equipment and qualified to accomplish all work promptly and satisfactorily. The Resident Engineer shall be advised in writing of the name of the designated service representative, and of any change in personnel. The Resident Engineer shall be provided copies of system manufacturer certification for the designated service representative.
- D. Schedule of Work
  - 1. The work shall be performed during regular working ours, Monday through Friday, excluding federal holidays. These inspections shall include:

- a) The Contractor shall perform two (2) minor inspections at six (6) month intervals or more if required by the manufacturer, and two (2) major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
  - 1) Minor Inspections shall include visual checks and operational tests of all console equipment, peripheral equipment, local processors, sensors, electrical and mechanical controls, and adjustments on printers.
  - 2) Major Inspections shall include all work described for Minor Inspections and the following: clean all system equipment and local processors including interior and exterior surfaces; perform diagnostics on all equipment; operational tests of the CPU, switcher, peripheral equipment, recording devices, monitors, picture quality from each camera; check, walk test, and calibrate each sensor; run all system software diagnostics and correct all problems; and resolve any previous outstanding problems.

E. Emergency Service

- 1. The owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. The Owner shall have sole authority for determining catastrophic and non-catastrophic system failures within parameters stated in General Project Requirements.
  - a. For catastrophic system failures, the Contractor shall provide same day four (4) hour service response with a defect correction time not to exceed eight (8) hours from [notification] [arrival on site]. Catastrophic system failures are defined as any system failure that the Owner determines will place the facility(s) at increased risk.
  - b. For non-catastrophic failures, the Contractor within eight (8) hours with a defect correction time not to exceed 24 hours from notification.

F. Operation

1. Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable portions of the performance verification test.

G. Records & Logs

1. The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

H. Work Request

1. The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall deliver a record of the work performed within five (5) working days after the work was completed.

I. System Modifications

1. The Contractor shall make any recommendations for system modification in writing to the COTR. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the COTR. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and other documentation affected.

J. Software

1. The Contractor shall provide all software updates when approved by the Owner from the manufacturer during the installation and 12-month warranty period and verify operation of the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the

operations and maintenance manuals and software documentation. There shall be at least one (1) scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software. All software changes shall be recorded in a log maintained in the unit control room. An electronic copy of the software update shall be maintained within the log. At a minimum, the contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "SOFTWARE CHANGE LOG".

### **1.9 PERFORMANCE REQUIREMENTS**

- A. PACS shall provide support for multiple authentication modes and bidirectional communication with the reader. PACS shall provide implementation capability for enterprise security policy and incident response.
- B. All processing of authentication information must occur on the "safe side" of a door
- C. Physical Access Control System shall provide access to following Security Areas:
  - 1. Controlled
  - 2. Limited
  - 3. Exclusion
- D. PACS shall provide:
  - 1. One authentication factor for access to Controlled security areas
  - 2. Two authentication factors for access to Limited security areas
  - 3. Three authentication factors for access to Exclusion security areas
- E. PACS shall provide Credential Validation and Path Validation per NIST 800-116.
- F. The PACS System shall have an Enterprise Path Validation Module (PVM) component that processes X.509 certification paths composed of X.509 v3 certificates and X.509 v2 CRLs. The PVM component MUST support the following features:
  - 1. Name chaining;



2. Signature chaining;
  3. Certificate validity;
  4. Key usage, basic constraints, and certificate policies certificate extensions;
  5. Full CRLs; and
  6. CRLs segmented on names.
- G. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to Controllers so that each Controller makes access-control decisions for that Location. Do not use intermediate Controllers for physical access control. If communications to Central Station are lost, all Controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Central Station.
- H. Number of Locations: Support unlimited number of separate Locations using a single PC with combinations of direct-connect, dial-up, or TCP/IP LAN connections to each Location.
1. Each Location shall have its own database and history in the Central Station.  
Locations may be combined to share a common database.
- I. Data Capacity:
1. [130] <Insert number> different card-reader formats.
  2. [999] <Insert number> comments.
  3. [16] <Insert number> graphic file types for importing maps.
- J. Location Capacity:
1. [128] <Insert number> reader-controlled doors.
  2. [50,000] <Insert number> total access credentials.
  3. [2048] <Insert number> supervised alarm inputs.
  4. [2048] <Insert number> programmable outputs.
  5. [32,000] <Insert number> custom action messages per Location to instruct operator on action required when alarm is received.

K. System Network Requirements:

1. Interconnect system components and provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response, and shall return to normal after partial or total network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and identify the communication link that has experienced a partial or total failure.
4. Communications Controller may be used as an interface between the Central Station display systems and the field device network. Communications Controller shall provide functions required to attain the specified network communications performance.

L. Central Station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central Station shall control system networks to interconnect all system components, including workstations and field-installed Controllers.

M. Field equipment shall include Controllers, sensors, and controls. Controllers shall serve as an interface between the Central Station and sensors and controls. Data exchange between the Central Station and the Controllers shall include down-line transmission of commands, software, and databases to Controllers. The up-line data exchange from the Controller to the Central Station shall include status data such as intrusion alarms, status reports, and entry-control records. Controllers are classified as alarm-annunciation or entry-control type.

N. System Response to Alarms: Field device network shall provide a system end-to-end response time of [1] <Insert number> second(s) or less for every device connected to the system. Alarms shall be annunciated at the Central Station within 1 second of the alarm occurring at a Controller or device controlled by a local Controller, and within 100 ms if the alarm occurs at the Central Station. Alarm and status changes shall be

displayed within 100 ms after receipt of data by the Central Station. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console.[ This response time shall be maintained during system heavy load.]

- O. False Alarm Reduction: The design of Central Station and Controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.
- P. Error Detection: A cyclic code error detection method shall be used between Controllers and the Central Station, which shall detect single- and double-bit errors, burst errors of eight bits or less, and at least 99 percent of all other multibit and burst error conditions. Interactive or product error detection codes alone will not be acceptable. A message shall be in error if one bit is received incorrectly. System shall retransmit messages with detected errors. A two-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts. When the number of consecutive retransmission attempts equals the assigned quantity, the Central Station shall print a communication failure alarm message. System shall monitor the frequency of data transmission failure for display and logging.
- Q. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.
- R. Door Hardware Interface: Coordinate with Division 08 Sections that specify door hardware required to be monitored or controlled by the PACS. The Controllers in this Section shall have electrical characteristics that match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 Sections to function with the controls and PC-based software and hardware in this Section.
- S. References to industry and trade association standards and codes are minimum installation requirement standards.
- T. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

### **1.10 EQUIPMENT AND MATERIALS**

- A. Refer to 25 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
  - 1. Components of an assembled unit need not be products of the same manufacturer.
  - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  - 3. Components shall be compatible with each other and with the total assembly for the intended service.
  - 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
  - 1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
  - 2. Four copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
  - 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

### **1.11 WARRANTY OF CONSTRUCTION.**

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

### **1.12 GENERAL REQUIREMENTS**

- A. For general requirements that are common to more than one section in Division 28 refer to Section 28 05 00, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.
- B. General requirements applicable to this section include:
  - 1. General Arrangement Of Contract Documents,
  - 2. Delivery, Handling and Storage,
  - 3. Project Conditions,
  - 4. Electrical Power,
  - 5. Lightning, Power Surge Suppression, and Grounding,
  - 6. Electronic Components,
  - 7. Substitute Materials and Equipment, and
  - 8. Like Items.

## **PART 2 – PRODUCTS**

### **2.1 GENERAL**

- A. All equipment and materials for the system will be compatible to ensure correct operation as outlined in FIPS 201, March 2006 and HSPD-12.
- B. The security system characteristics listed in this section will serve as a guide in selection of equipment and materials for the PACS. If updated or more suitable versions are available then the Contracting Officer will approve the acceptance of prior to an installation.
- C. PACS equipment shall meet or exceed all requirements listed below.
- D. A PACS shall be comprised of, but not limited to, the following components:

1. Physical Access Control System
2. Application Software
3. System Database
4. Surge and Tamper Protection
5. Standard Workstation Hardware
6. Communications Workstation
7. Controllers (Data Gathering Panel)
8. Secondary Alarm Annunciator
9. Keypads
10. Card Readers
11. Credential Cards
12. Biometric Identity Verification Equipment
13. Enrolment Center (To be provided in accordance with the VA PIV enrollment and issuance system.)
14. System Sensors and Related Equipment
15. Push Button Switches
16. Interfaces
17. Door and Gate Hardware interface
18. RS-232 ASCII Interface
19. Floor Select Elevator Control
20. After-Hours HVAC Control
21. Real Time Guard Tour
22. Video and Camera Control
23. Cables
24. Transformers

## **2.2 SECURITY MANAGEMENT SYSTEM (SMS)**

- A. Shall allow the configuration of an enrollment and badging, alarm monitoring, administrative, asset management, digital video management, intrusion detection,

visitor enrollment, remote access level management, and integrated client workstations or any combination of all or some.

- B. Shall be expandable to support an unlimited number of individual module or integrated client workstations. All access control field hardware, including Data Gathering Panels(DGP), shall be connected to all physical access control system workstation on the network.
- C. Shall have the ability to compose, file, maintain, update, and print reports for either individuals or the system as follows.
  - 1. Individual reports that consist of an employee's name, office location, phone number or direct extension, and normal hours of operation. The report shall provide a detail listing of the employee's daily events in relation to accessing points within a facility.
  - 2. System reports shall be able to produce information on a daily/weekly/monthly basis for all events, alarms, and any other activity associated with a system user.
- D. All reports shall be in a date/time format and all information shall be clearly presented. Shall be designed to allow it to work with any industry standard network protocol and topology listed below:
  - 1. Transmission Control Protocol (TCP)/IP
  - 2. Novell Netware (IPX/SPX)
  - 3. Banyan VINES
  - 4. IBM LAN Server (NetBEUI)
  - 5. Microsoft LAN Manager (NetBEUI)
  - 6. Network File System (NFS) Networks
  - 7. Remote Access Service (RAS) via ISDN, x.25, and standard phone lines.
- E. Shall provide full interface and control of the PACS to include the following subsystems within the PACS:
  - 1. Public Key Infrastructure
  - 2. Card Management
  - 3. Identity and Access Management

4. Personal Identity Verification
- F. Shall have the following features or compatibilities:
  1. The ability to be operated locally or remotely via a LAN, WAN, internet, or intranet.
  2. Event and Alarm Monitoring
  3. Database Partitioning
  4. Ability to fully integrate with all other security subsystems
  5. Enhanced Monitoring Station with Split Screen Views
  6. Alternate and Extended Shunt by Door
  7. Escort Management
  8. Enhanced IT-based Password Protection
  10. N-man Rule and Occupancy Restrictions
  11. Open Journal Data Format for Enhanced Reporting
  12. Automated Personnel Import
  13. ODBC Support
  14. Windows 2000 Professional, Windows Server 2003, Windows XP Professionals for Servers, Windows 7
  15. Field-Level Audit Trail
  16. Cardholder Access Events

## **2.3 APPLICATION SOFTWARE**

- A. System Software: Based on [32] <Insert number>-bit, [Microsoft Windows] <Insert name of operating system> central-station and workstation operating system and application software. Software shall have the following features:
  1. Multiuser multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
  2. Graphical user interface to show pull-down menus and a menu tree format.
  3. Capability for future additions within the indicated system size limits.
  4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
  5. Password-protected operator and smart card login and access.



- B. Peer Computer Control Software: Shall detect a failure of a central computer, and shall cause the other central computer to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.
- C. Application Software: Interface between the alarm annunciation and entry-control Controllers, to monitor sensors[ and DTS links], operate displays, report alarms, generate reports, and help train system operators. Software shall have the following functions:
  - 1. Resides at the Central Station, workstations, and Controllers as required to perform specified functions.
  - 2. Operate and manage peripheral devices.
  - 3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
  - 4. Import custom icons into graphics views to represent alarms and I/O devices.
  - 5. Globally link I/O so that any I/O can link to any other I/O within the same Location, without requiring interaction with the host PC. This operation shall be at the Controller.
  - 6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host PC. This operation shall be at the Controller.
  - 7. Messages from PC to Controllers and Controllers to Controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
  - 8. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other PC-to-Controller communications methods by changing the polling frequency and the amount of time the system waits for a response.

9. Automatic and encrypted backups for database and history backups shall be automatically stored at [the central control PC] [a selected workstation] and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
10. Operator audit trail for recording and reporting all changes made to database and system software.

D. Workstation Software:

1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

E. Controller Software:

1. Controllers shall operate as an autonomous intelligent processing unit. Controllers shall make decisions about physical access control, alarm monitoring, linking functions, and door locking schedules for its operation, independent of other system components. Controllers shall be part of a fully distributed processing control network. The portion of the database associated with a Controller and consisting of parameters, constraints, and the latest value or status of points connected to that Controller, shall be maintained in the Controller.
2. Functions: The following functions shall be fully implemented and operational within each Controller:
  - a. Monitoring inputs.
  - b. Controlling outputs.
  - c. Automatically reporting alarms to the Central Station.
  - d. Reporting of sensor and output status to Central Station on request.
  - e. Maintaining real time, automatically updated by the Central Station at least once a day.

- f. Communicating with the Central Station.
  - g. Executing Controller resident programs.
  - h. Diagnosing.
  - i. Downloading and uploading data to and from the Central Station.
- 3. Controller Operations at a Location:
  - a. Location: Up to [64] <Insert number> Controllers connected to RS-485 communications loop. Globally operating I/O linking and anti-passback functions between Controllers within the same Location without central-station or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the Central Station or workstations are off line.
  - b. In the event of communications failure between the Central Station and a Location, there shall be no degradation in operations at the Controllers at that Location. The Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
  - c. Buffered events shall be handled in a first-in-first-out mode of operation.
- 4. Individual Controller Operation:
  - a. Controllers shall transmit alarms, status changes, and other data to the Central Station when communications circuits are operable. If communications are not available, Controllers shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the Central Station, shall be stored for later transmission to the Central Station. Storage capacity for the latest 1024 events shall be provided at each Controller.
  - b. Card-reader ports of a Controller shall be custom configurable for at least [120] <Insert number> different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different Controllers or within the same Controller.

- c. Controllers shall provide a response to card-readers or keypad entries in less than 0.25 seconds, regardless of system size.
  - d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
  - e. Initial Startup: When Controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each Controller.
  - f. Failure Mode: On failure for any reason, Controllers shall perform an orderly shutdown and force Controller outputs to a predetermined failure mode state, consistent with the failure modes shown and the associated control device.
  - g. Startup After Power Failure: After power is restored, startup software shall initiate self-test diagnostic routines, after which Controllers shall resume normal operation.
  - h. Startup After Controller Failure: On failure, if the database and application software are no longer resident, Controllers shall not restart, but shall remain in the failure mode until repaired. If database and application programs are resident, Controllers shall immediately resume operation. If not, software shall be restored automatically from the Central Station.
5. Communications Monitoring:
- a. System shall monitor and report status of RS-485 communications loop [TCP/IP communication status] of each Location.
  - b. Communication status window shall display which Controllers are currently communicating, a total count of missed polls since midnight, and which Controller last missed a poll.
  - c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM memory for each Controller.
6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically

synchronized with the Central Station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

F. PC-to-Controller Communications:

1. Central-station or workstation communications shall use the following:
  - a. Direct connection using serial ports of the PC.
  - b. TCP/IP LAN network interface cards.
  - c. Dial-up modems for connections to Locations.
2. Serial Port Configuration: Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only"; or as an ASCII output port.
3. Multiport Communications Board: Use if more than two serial ports are needed.
  - a. Expandable and modular design. Use a 4-, 8-, or 16-serial port configuration that is expandable to 32 or 64 serial ports.
  - b. Connect the first board to an internal PCI bus adapter card.
4. Direct serial, TCP/IP, and dial-up communications shall be alike in the monitoring or control of system, except for the connection that must first be made to a dial-up Location.
5. TCP/IP network interface card shall have an option to set the poll frequency and message response time-out settings.
6. PC-to-Controller and Controller-to-Controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications shall be verified and buffered and retransmitted if not acknowledged.

G. Direct Serial or TCP/IP PC-to-Controller Communications:

1. Communication software on the PC shall supervise the PC-to-Controller communications link.

2. Loss of communications to any Controller shall result in an alarm at all PCs running the communications software.
3. When communications are restored, all buffered events shall automatically upload to the PC, and any database changes shall be automatically sent to the Controller.

H. Dial-up Modem PC-to-Controller Communications:

1. Communication software on the PC shall supervise the PC-to-Controller communications link during dial-up modem connect times.
2. Communication software shall be programmable to routinely poll each of the remote dial-up modem Locations, collecting event logs and verifying phone lines at time intervals that are operator selectable for each Location.
3. System shall be programmable for dialing and connecting to all dial-up modem Locations and for retrieving the accrued history transactions on an automatic basis as often as once every [10] <Insert number> minutes and up to once every [9999] <Insert number> minutes.
4. Failure to communicate to a dial-up Location three times in a row shall result in an alarm at the PC.
5. Time offset capabilities shall be present so that Locations in a different geographical time zone than the host PC will be set to, and maintained at, the proper local time. This feature shall allow for geographical time zones that are ahead of or behind the host PC.
6. The Controller connected to a dial-up modem shall automatically buffer all normal transactions until its buffer reaches 80 percent of capacity. When the transaction buffer reaches 80 percent, the Controller shall automatically initiate a call to the Central Station and upload all transactions.
7. Alarms shall be reported immediately.
8. Dial-up modems shall be provided by manufacturer of the system. Modems used at the Controller shall be powered by the Controller. Power to the modem shall include battery backup if the Controller is so equipped.

I. Controller-to-Controller Communications:

1. Controller-to-Controller Communications: RS-485, 4-wire, point-to-point, regenerative (repeater) communications network methodology.
2. RS-485 communications signal shall be regenerated at each Controller.

J. Database Downloads:

1. All data transmissions from PCs to a Location, and between Controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
2. If a Controller is reset for any reason, it shall automatically request and receive a database download from the PC. The download shall restore data stored at the Controller to their normal working state and shall take place with no operator intervention.
3. Software shall provide for setting downloads via dial-up connection to once per 24-hour period, with time selected by the operator.
4. Software shall provide for setting delays of database downloads for dial-up connections. Delays change the download from immediately to a delay ranging from 1 to 999 minutes.

K. Operator Interface:

1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.

5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:
  - a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
  - b. Maps to provide real-time display animation and allow for control of points assigned to them.
  - c. System to allow inputs, outputs, and override groups to be placed on different maps.
  - d. Software to allow changing the order or priority in which maps will be displayed.
7. Override Groups Containing I/Os:
  - a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
  - b. Icon shall change automatically to show the live summary status of points in that group.
  - c. Override group icon shall provide a method to manually control or set to time zone points in the group.
  - d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.
8. Schedule Overrides of I/Os and Override Groups:
  - a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
  - b. Each schedule shall be composed of a minimum of two dates with separate times for each date.



- c. The first time and date shall be assigned the override state that the point shall advance to, when the time and date become current.
  - d. The second time and date shall be assigned the state that the point shall return to, when the time and date become current.
- 9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.
- L. Operator Access Control:
  - 1. Control operator access to system controls through [three] <Insert number> password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
  - 2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
  - 3. A minimum of [32] <Insert number> passwords shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
  - 4. The password shall not be displayed or printed.
  - 5. Each password shall be definable and assignable for the following:
    - a. Commands usable.
    - b. Access to system software.
    - c. Access to application software.
    - d. Individual zones that are to be accessed.
    - e. Access to database.
- M. Operator Commands:
  - 1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.

2. Command inputs shall be acknowledged and processing shall start in not less than [1] <Insert number> second(s).
3. Tasks that are executed by operator's commands shall include the following:
  - a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
  - b. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
  - c. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.
  - d. System Test: Allows the operator to initiate a system-wide operational test.
  - e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
  - f. Print reports.
  - g. Change Operator: Used for changing operators.
  - h. Security Lighting Controls: Allows the operator to remotely turn on/off security lights.
  - i. Display Graphics: Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
  - j. Run system tests.
  - k. Generate and format reports.
  - l. Request help with the system operation.
    - 1) Include in main menus.
    - 2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
    - 3) Provide navigation to specific topic from within the first help window.
    - 4) Help shall be accessible outside the applications program.
  - m. Entry-Control Commands:

- 1) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.
  - 2) Arm or disarm each monitored input up to four times a day through time-zone programming.
  - 3) Enable or disable readers or keypads up to twice a day through time-zone programming.
  - 4) Enable or disable cards or codes up to four times per day per entry point through access-level programming.
4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:
- a. Command entered is incorrect or incomplete.
  - b. Operator is restricted from using that command.
  - c. Command addresses a point that is disabled or out of service.
  - d. Command addresses a point that does not exist.
  - e. Command is outside the system's capacity.

N. Alarms:

1. System Setup:
  - a. Assign manual and automatic responses to incoming point status change or alarms.
  - b. Automatically respond to input with a link to other inputs, outputs, operator-response plans, unique sound with use of WAV files, and maps or images that graphically represent the point location.
  - c. 60-character message field for each alarm.
  - d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages.

Setup shall assign messages to [access point] [zone] [sensor]<other alarm originating device>.

- e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
  - f. Allow 25 secondary messages with a field of 4 lines of 60 characters each.
  - g. Store the most recent 1000 alarms for recall by the operator using the report generator.
2. Software Tamper:
- a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
  - b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond their authorization level.
  - c. Maintain a transcript file of the last 5000 commands entered at the each Central Station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
  - d. Allow only acknowledgment of software tamper alarms.
3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
5. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
6. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.

7. Alarm Automation Interface: High-level interface to Central Station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in same manner as burglar alarms, using an RS-232 ASCII interface.
8. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
9. Camera Control: Provides operator ability to select and control cameras from graphic maps.
- O. Alarm Monitoring: Monitor sensors, Controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
  1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
  2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
  3. Maps shall automatically display the alarm condition for each input assigned to that map, if that option is selected for that input location.
  4. Alarms initiate a status of "pending" and require the following two handling steps by operators:
    - a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
    - b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
  5. Each workstation shall display the total pending alarms and total unresolved alarms.
  6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.

7. Alarms shall transmit to Central Station in real time, except for allowing connection time for dial-up locations.
8. Alarms shall be displayed and managed from a minimum of four different windows.
  - a. Input Status Window: Overlay status icon with a large red blinking icon.  
Selecting the icon will acknowledge the alarm.
  - b. History Log Transaction Window: Display name, time, and date in red text.  
Selecting red text will acknowledge the alarm.
  - c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
  - d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
12. Identical alarms from same alarm point shall be acknowledged at same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
13. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and Controllers.
14. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

P. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.

1. Color Code:

- a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
- b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
- c. YELLOW: Advises operator that a zone is in access.
- d. GREEN: Indicates that a zone is secure and that power is on.

2. Graphics:

- a. Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from another drawing or graphics program.
- b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
- c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on graphic map.
- d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic map associated with inputs or outputs.
- e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
- f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
- g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

Q. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.

1. Test Report: The results of each test shall be stored for future display or printout.  
The report shall document the operational status of system components.
- R. Report Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest priority activity. Report generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.
  1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of period; and the default printer.
  2. Printing on Requests: An operator may request a printout of any report.
  3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm [(such as door alarm, intrusion alarm, tamper alarm, etc.)] <Insert alarm types>, the type of sensor, the location, the time, and the action taken.
  4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
  5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
  6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
  7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
  8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
  9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
  10. Who Is In (Muster) Report:



- a. Emergency Muster Report: One click operation on toolbar launches report.
  - b. Cardholder Report. Contain a count of persons that are "In" at a selected Location and a count with detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.
11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that they are available on-site at all times.
12. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events or alarms only.
13. History Reports: Custom reports that allows the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.
- a. Initially store history on the hard disk of the host PC.
  - b. Permit viewing of the history on workstations or print history to any system printer.
  - c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
  - d. Each report shall depict the date, time, event type, event description, device, or I/O name, cardholder group assignment, and cardholder name or code number.
  - e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
  - f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.
14. Reports shall have the following four options:
- a. View on screen.
  - b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to system.

- c. "Save to File" with full path statement.
  - d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.
- 15. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:
  - a. Active, inactive, or future activate or deactivate.
  - b. Code number, name, or imprinted card number.
  - c. Group, Location, access levels.
  - d. Start and stop code range.
  - e. Codes that have not been used since a selectable number of days.
  - f. In, out, or either status.
  - g. Codes with trace designation.
- 16. The reports of system database shall allow options so that every data field may be printed.
- 17. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.
- S. Anti-Passback:
  - 1. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.
  - 2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.
  - 3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.

4. Timed Anti-Passback: A Controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.
5. Provide four separate zones per Location that can operate without requiring interaction with the host PC (done at Controller). Each reader shall be assignable to one or all four anti-passback zones. In addition, each anti-passback reader can be further designated as "Hard," "Soft," or "Timed" in each of the four anti-passback zones. The four anti-passback zones shall operate independently.
6. The anti-passback schemes shall be definable for each individual door.
7. The Master Access Level shall override anti-passback.
8. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential holder population anti-passback status to a neutral status.

T. Visitor Assignment:

1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only access levels that have been designated as approved for visitors.
2. Provide an automated log of visitor name, time and doors accessed, and whom visitor contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. PACS shall be able to restrict the access levels that may be assigned to credentials that are issued to visitors.
5. Allow operator to recall visitors' credential holder file, once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

U. Time and Attendance:

1. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
  2. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length of the report.
  3. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.
    - a. Reports shall show in and out times for each day, total in time for each day, and a total in time for period specified by the user.
    - b. Allow the operator to view and print the reports, or save the report to a file.
    - c. Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.
- V. Training Software: Enables operators to practice system operation including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.
- W. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.
1. The enrollment station shall not have alarm response or acknowledgment functions.
  2. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
  3. The program shall provide means to disable the enrollment station when it is unattended to prevent unauthorized use.
  4. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity verification subsystems, this shall include biometric data. Allow

- entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
5. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
    - a. MASK: Determines a specific format that data must comply with.
    - b. REQUIRED: Operator is required to enter data into field before saving.
    - c. UNIQUE: Data entered must be unique.
    - d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
    - e. NAME ID: Data entered will be considered a unique ID for the cardholder.
  6. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
  7. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
  8. Batch card printing.
  9. Default card data can be programmed to speed data entry for sites where most card data are similar.
  10. Enhanced ACSII File Import Utility: Allows the importing of cardholder data and images.
  11. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.
  - X. System Redundancy & High Availability: The system shall provide multiple levels of communications redundancy and failover for all PACS hosted controllers, digital video recorders, and client workstations. The PACS shall be capable of automatically re-

routing communications to alternate computers across the system without operator intervention.

1. PACS system configuration with a single application/ database server shall provide at a minimum the following redundancy and failover capability:
  - a. The PACS shall provide communications redundancy and failover for network-attached devices. Each network attached device shall have one or more alternative communication sever(s) that can provide hosting in case of primary communications server failure.
  - b. In case of primary communications server failure, the system shall automatically re-route network-attached devices to their designated backup communications servers to allow continuous system operations without loss of alarm and event transaction processing during failover.
  - c. Network-attached devices which transition to backup communications servers, shall be able to be redirected back to their default primary servers, once the primary communications servers have been restored.
2. PACS system configuration with multiple regional application/ database servers shall provide at a minimum the following redundancy and failover capability:
  - a) The PACS shall support the same level of communications redundancy and failover for network-attached devices per regional application/database server, allowable to span across regional application/database servers in the event of a regional application/database server failure.
  - b) In case of a regional application/database server failure, client workstations shall be able to failover to their designated backup regional application/database server to allow continuous system operations.
  - c) In case of a regional application/database server failure, upon server restoration, the ISMS shall automatically update and synchronize the regional application/database server.

- d) Client workstations which transition to a backup regional application/database server, shall be able to be redirected back to their default regional application/database server, once the regional application/database server functions have been restored.

## **2.4 SURGE AND TAMPER PROTECTION**

- A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY
  - A. 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.
    - 1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
    - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
  - B. 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.

## **2.5 PACS SERVER HARDWARE**

- A. SMS Server Computer: Standard unmodified PC of modular design. The CPU word size shall be [64] <Insert number> bytes or larger; the CPU operating speed shall be at least [3.4] <Insert number> [GHz].
  - 1. Processor family: [Intel® Xeon® E5640 (4 core, 2.66 GHz, 12MB L3, 80W)] <Insert text>.
  - 2. Number of processors: 2

3. Memory: [12] <Insert number> GB RAM , expandable to a minimum of [192] <Insert number> GB without additional chassis or power supplies. Memory protection [Mirrored Memory, Online Spare, Advanced ECC, Memory Lock Step Mode] <Insert text>.
4. Input/Output: 2 expansions slots, Network Controller (2) 1GbE NC382i Multifunction 4 Ports.
5. Power Supply: Dual - minimum capacity of [460] <Insert number> W hot plug.
6. Real-Time Clock:
  - a. Accuracy: Plus or minus 1 minute per month.
  - b. Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; resettable by software.
  - c. Clock shall function for 1 year without power.
  - d. Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
7. Serial Ports: Provide two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
8. Parallel Port: An enhanced parallel port.
9. The server shall have a 1 GB NIC or greater network card, rated at 100/1000 MB/sec.
10. The server shall have dual [100] <Insert number> GB hard disk drives at [7200] ] <Insert number> RPM.
11. The server shall have a CD / DVD combo drive.
12. The server operating system shall be either:
  - a. Windows 2003 Server, 32 bit native mode, with Service Pack 2 or later with default services enabled.
  - b. Windows XP Professional Service Pack 2 or later and default services enabled.
  - c. Windows 2008.
13. The Web Server shall be [IIS 7.0] <Insert text> or better.
14. The Database shall be [SQL Server 2005 (Express, Standard, Data Center, or Enterprise)] <Insert text>.



15. Sound Card: For playback and recording of digital WAV sound files that are associated with audible warning and alarm functions.
16. Color Monitor: [17"] or larger SVGA (1024 x 768) monitor with true color support..  
The server shall have a dedicated 256 MB SVGA accelerated video card with at least 64 MB onboard RAM.
17. Keyboard: With a minimum of 64 characters, standard ASCII character set based on ANSI X3.154.
18. Mouse: Standard, compatible with the installed software.
19. Special function keyboard attachments or special function keys to facilitate data input of the following operator tasks:
  - a. Help.
  - b. Alarm Acknowledge.
  - c. Place Zone in Access.
  - d. Place Zone in Secure.
  - e. System Test.
  - f. Print Reports.
  - g. Change Operator.
  - h. <Insert operator tasks.>
20. CD-ROM Drive:
  - a. Nominal storage capacity of [650] <Insert number> MB.
  - b. Data Transfer Rate: [1.2] <Insert number> Mbps.
  - c. Average Access Time: [150] <Insert number> ms.
  - d. Cache Memory: [256] <Insert number> KB.
  - e. Data Throughput: [1] <Insert number> MB/second, minimum.
21. Dot Matrix Alarm Printer:
  - a. Connected to the Central Station.
  - b. Minimum of 96 characters, standard ASCII character set based on ANSI X3.154, and with graphics capability and programmable control of top-of-form.
  - c. Prints in both red and black without ribbon change.

- d. Adjustable sprockets for paper width up to 11 inches.
  - e. 80 columns per line, minimum speed of 200 characters per second.
  - f. Character Spacing: Selectable at 10, 12, or 17 characters per inch.
  - g. Paper: Sprocket-fed fan fold paper.
22. Report Printer:
- a. Connected to the Central Station and designated workstations.
  - b. Laser printer with minimum resolution of [1200] <Insert number> dpi.
  - c. RAM: [2] <Insert number> MB, minimum.
  - d. Printing Speed: Minimum [12] <Insert number> pages per minute.
  - e. Paper Handling: Automatic sheet feeder with [250] <Insert number>-sheet paper cassette and with automatic feed.
  - f. Interface: Bidirectional parallel and universal serial bus.
- B. Redundant Central Computer: One identical redundant central computer, connected in a hot standby, peer configuration. This computer shall automatically maintain its own copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.
- C. PACS controllers clustering shall support the following features:
- 1. Assignment of Master and alternate master controllers for cluster communication to the SMS server
  - 2. Primary and backup communication paths to the SMS server
  - 3. Encrypted communications
  - 4. Up to [16]<insert number> controllers per cluster
  - 5. Logical event linking between controllers in a cluster independent of SMS server communication
  - 6. Asynchronous communication via TCP/IP (Polled devices shall not be acceptable)
- D. UPS: Self-contained; complying with requirements in Division 26 Section "Static Uninterruptible Power Supply."

1. Size: Provide a minimum of [15] <Insert number> hours of operation of the central-station equipment, including 2 hours of alarm printer operation.
2. Batteries: Sealed, valve regulated, recombinant, lead calcium.
3. Accessories:
  - a. Transient voltage suppression.
  - b. Input-harmonics reduction.
  - c. Rectifier/charger.
  - d. Battery disconnect device.
  - e. Static bypass transfer switch.
  - f. Internal maintenance bypass/isolation switch.
  - g. External maintenance bypass/isolation switch.
  - h. Output isolation transformer.
  - i. Remote UPS monitoring.
  - j. Battery monitoring.
  - k. Remote battery monitoring.
  - l. <Insert accessories.>

## **2.6 STANDARD WORKSTATION HARDWARE**

- A. Workstation shall consist of a standard unmodified PC, with accessories and peripherals that configure the workstation for a specific duty.
- B. Workstation Computer: Standard unmodified PC of modular design. The CPU word size shall be [32] <Insert number> bytes or larger; the CPU operating speed shall be at least [66] <Insert number> [MHz] [GHz].
  1. Memory: [256] <Insert number> MB of usable installed memory, expandable to a minimum of [1024] <Insert number> MB without additional chassis or power supplies.
  2. Power Supply: Minimum capacity of [250] <Insert number> W.
  3. Real-Time Clock:
    - a. Accuracy: Plus or minus 1 minute per month.

- b. Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; resettable by software.
  - c. Provide automatic time correction once every [24 hours] <Insert number of hours or minutes> by synchronizing clock with the Central Station.
- 4. Serial Ports: Provide two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
- 5. Parallel Port: An enhanced parallel port.
- 6. LAN Adapter Card: [10/100] <Insert number> Mbps PCI bus, internal network interface card.
- 7. Sound Card: For playback and recording of digital WAV sound files that are associated with audible warning and alarm functions.
- 8. Color Monitor: Not less than [17 inches (430 mm)] <Insert inches (mm)>, with a minimum resolution of [1280 by 1024] <Insert numbers> pixels, noninterlaced, and a maximum dot pitch of [0.28] <Insert number> mm. The video card shall support at least [256] <Insert number> colors at a resolution of [1280 by 1024] <Insert numbers> at a minimum refresh rate of [70] <Insert number> Hz.
- 9. Keyboard: With a minimum of 64 characters, standard ASCII character set based on ANSI X3.154.
- 10. Mouse: Standard, compatible with the installed software.
- 11. Disk storage shall include the following, each with appropriate controller:
  - a. Minimum [10] <Insert number> GB hard disk, maximum average access time of [10] <Insert number> ms.
  - b. Floppy Disk Drive: High density, 3-1/2-inch (90-mm) size.
  - c. <Insert disk drives.>
- 12. CD-ROM Drive:
  - a. Nominal storage capacity of [650] <Insert number> MB.
  - b. Data Transfer Rate: [1.2] <Insert number> Mbps.
  - c. Average Access Time: [150] <Insert number> ms.
  - d. Cache Memory: [256] <Insert number> KB.

- e. Data Throughput: [1] <Insert number> MB/second, minimum.
- 13. Printer:
  - a. Connected to the Central Station and designated workstations.
  - b. Laser printer with minimum resolution of [600] <Insert number> dpi.
  - c. RAM: [2] <Insert number> MB, minimum.
  - d. Printing Speed: Minimum [12] <Insert number> pages per minute.
  - e. Paper Handling: Automatic sheet feeder with [250] <Insert number>-sheet paper cassette and with automatic feed.
- 14. Interface: Bidirectional parallel, and universal serial bus.
- 15. LAN Adapter Card: [10/100] <Insert number> Mbps internal network interface card.
- C. Redundant Workstation: One identical redundant workstation, connected in a hot standby, peer configuration. This workstation shall automatically maintain its own copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant workstation in near real time. If its associated workstation fails, redundant workstation shall assume control immediately and automatically.
- D. UPS: Self-contained, complying with requirements in Division 26 Section "Static Uninterruptible Power Supply."
  - 1. Size: Provide a minimum of [6] <Insert number> hours of operation of the central-station equipment, including 2 hours of alarm printer operation.
  - 2. Batteries: Sealed, valve regulated, recombinant, lead calcium.
  - 3. Accessories:
    - a. Transient voltage suppression.
    - b. Input-harmonics reduction.
    - c. Rectifier/charger.
    - d. Battery disconnect device.
    - e. Static bypass transfer switch.
    - f. Internal maintenance bypass/isolation switch.
    - g. External maintenance bypass/isolation switch.

- h. Output isolation transformer.
- i. Remote UPS monitoring.
- j. Battery monitoring.
- k. Remote battery monitoring.
- l. <Insert accessories.>

## **2.7 COMMUNICATIONS WORKSTATION**

- A. Standard workstation, modified as follows:
  - 1. <Insert number> additional RS-232-F serial ports. The CPU word size shall be [32] <Insert number> bytes or larger; the CPU operating speed shall be at least [66] <Insert number> MHz. Multiplexed serial ports shall be expandable with [8] <Insert number> character transmit and receive buffers for each port. Total buffer size shall be a minimum of [1] <Insert number> MB.
  - 2. Redundant workstation is [not] required.
  - 3. Printer is [not] required.

## **2.8 CONTROLLERS**

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the Central Station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this Article, manufacturers may use multipurpose Controllers.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
- D. Alarm Annunciation Controller:
  - 1. The Controller shall automatically restore communication within 10 seconds after an interruption with the field device network[ with dc line supervision on each of its alarm inputs].
    - a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.

- b. Alarm-Line Supervision:
  - 1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal[, and for conditions as described in UL 1076 for line security equipment] [by monitoring for abnormal open, grounded, or shorted conditions] using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of [5] [10] percent or more for longer than 500 ms.
  - 2) Transmit alarm-line-supervision alarm to the Central Station during the next interrogation cycle after the abnormal current condition.
- c. Outputs: Managed by Central Station software.
- 2. Auxiliary Equipment Power: A GFI service outlet inside the Controller enclosure.
- E. Entry-Control Controller:
  - 1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personal identity verification devices, door strikes, magnetic latches, gate and door operators, and exit push-buttons.
    - a. Operate as a stand-alone portal Controller using the downloaded database during periods of communication loss between the Controller and the field-device network.
    - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
      - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
      - 2) Privileges shall include, but not be limited to, time of day control, day of week control, group control, and visitor escort control.
    - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access

through a controlled portal by the presentation of credentials or other identifying information.

2. Inputs:
  - a. Data from entry-control devices; use this input to change modes between access and secure.
  - b. Database downloads and updates from the Central Station that include enrollment and privilege information.
3. Outputs:
  - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
  - b. Grant or deny entry by sending control signals to portal-control devices[ and mask intrusion alarm annunciation from sensors stimulated by authorized entries].
  - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the Central Station.
  - d. Door Prop Alarm: If a portal is held open for longer than [20 seconds] [time listed in a schedule], alarm sounds.
4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communications with Central Station, or when data transmission is degraded and generating continuous checksum errors, the Controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
  - a. Store up to [1000] <Insert number> transactions during periods of communication loss between the Controller and access-control devices for subsequent upload to the Central Station on restoration of communication.
6. Controller Power: NFPA 70, Class II power supply transformer, with 12- or 24-V ac secondary, backup battery and charger.



- a. Backup Battery: Premium, valve-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full 1-year warranty and a pro rata 19-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
- b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
- c. Backup Power Supply Capacity: [5] [90] minutes of battery supply. Submit battery and charger calculations.
- d. Power Monitoring: Provide manual dynamic battery load test, initiated and monitored at the control center; with automatic disconnection of the Controller when battery voltage drops below Controller limits. Report by using local Controller-mounted LEDs and by communicating status to Central Station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
  - 1) Trouble Alarm: Normal power off load assumed by battery.
  - 2) Trouble Alarm: Low battery.
  - 3) Alarm: Power off.

## **2.9 PIV MIDDLEWARE**

- A. PIV Middleware shall provide three-factor authentication, including biometric matching using a fingerprint capture device capable of single fingerprint capture. Unit shall enable digital certificates can to be verified by security personnel using the issuer's certificate authority, SCVP, OCSP responder/repeater, or the TSA hot list for TWIC cardholders. All cards shall be validated using FIPS-201 challenge-response protocol in order to identify forged or cloned cards. PIV Middleware solution shall validate all PIV, TWIC, NG CAC, and FRAC cards. TWIC card FASC-Ns shall also be verified against a live or cached TSA hot list.

B. PIV Middleware shall have ability to :

1. Verify cardholder identity and validates FIPS 201-compliant PIV-II, next-generation (NG) CAC, TWIC, or FRAC credentials in real-time
2. Perform three-factor authentication of cardholder using PIN, biometrics, and certificate (or serial numbers) detecting forged or cloned cards
3. Enroll FASC-N, photo, and pertinent cardholder information into PACS software
4. Automatically suspend a cardholder's badge if his or her PIV, TWIC, or CAC card certificate serial number is on the Certificate Revocation List (CRL)
5. Upload a cardholder transaction audit trail to central database or exports it to a .csv file for centralized transaction management
6. Be compatible with biometric mobile terminal for off-site verification and enrollment
7. Re-validate imported cardholder certificates on a periodic basis via the Internet
8. Operate with commercial, off-the-shelf (COTS) FIPS 201 PIV-II and ANSI INCITS 378-compliant fingerprint capture devices
9. Revalidate imported cardholder certificates at regular intervals, ensuring that the credentials used in PACS system are backed by a valid set of digital certificates. Digital certificates are verified against local OCSP repeater/validation authority using the issuer's validation authority, or Microsoft Crypto Application Programming Interface (API) on Windows XP SP3 or Vista.
10. Certificate Manager shall fully support SCVP and OCSP for fast, online validation.
11. Provide verification of TWIC credentials against a live TSA hot list.
12. Support uploading local transactions to a central database for consolidated activity reporting. This application shall support a variety of ODBC- or ADO-compliant databases, including Oracle, SQL Server 2005, Informix, DB2, and Firebird.
13. Provide user with ability to produce canned transaction log queries as well as creating queries directly from the SQL database.

C. PIV Middleware PC requirements:

1. PIV Middleware software shall operate on Intel-based PC with minimum 1.8 GHz CPU, 1 GB RAM, 40 GB hard disk, and Microsoft Windows XP SP2 with Microsoft .NET Framework 2.0
  2. Unit shall fingerprint capture devices and smart card reader.
- D. PIV Middleware shall be FIPS 201 approved product.

## **2.10 CARD READERS**

- A. Power: Card reader shall be powered from its associated Controller, including its standby power source.
- B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the Controller. Response time shall be [800]<insert number>ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
- C. Enclosure: Suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:
  1. Indoors, controlled environment.
  2. Indoors, uncontrolled environment.
  3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.
- D. Display: LED or other type of visual indicator display shall provide visual[ and audible] status indications and user prompts. Indicate power on/off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- E. Shall be utilized for controlling the locking hardware on a door and allows for reporting back to the main control panel with the time/date the door was accessed, the name of the person accessing the point of entry, and its location.
- F. Will be fully programmable and addressable, locally and remotely, and hardwired to the system.
- G. Shall be individually home run to the main panel.
- H. Shall be installed in a manner that they comply with:
  1. The Uniform Federal Accessibility Standards (UFAS)

2. The Americans with Disabilities Act (ADA)
3. The ADA Standards for Accessible Design
- I. Shall support a variety of card readers that must encompass a wide functional range.  
The PACS may combine any of the card readers described below for installations requiring multiple types of card reader capability (i.e., card only, card and/or PIN, card and/or biometrics, card and/or pin and/or biometrics, supervised inputs, etc.). These card readers shall be available in the approved technology to meet FIPS 201, and is ISO 14443 A or B, ISO/IEC 7816 compliant. The reader output can be Wiegand, RS-22, 485 or TCP/IP.
- J. Shall be housed in an aluminum bezel with a wide lead-in for easy card entry.
- K. Shall contain read head electronics, and a sender to encode digital door control signals.
- L. LED's shall be utilized to indicate card reader status and access status.
- M. Shall be able to support a user defined downloadable off-line mode of operation (e.g. locked, unlocked), which will go in effect during loss of communication with the main control panel.
- N. Shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two audible tones or beeps shall indicate access granted and three tones or beeps shall indicate access denied. All keypad buttons shall provide tactile audible feedback.
- O. Shall have a minimum of two programmable inputs and two programmable outputs.
- P. All card readers that utilize keypad controls along with a reader and shall meet the following specifications:
  1. Entry control keypads shall use a unique combination of alphanumeric and other symbols as an identifier. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII code ordinal sequence. Communications protocol shall be compatible with the local processor.
- Q. Shall include a Light Emitting Diode (LED) or other type of visual indicator display and provide visual or visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or

rejected. The design of the keypad display or keypad enclosure shall limit the maximum horizontal and vertical viewing angles of the keypad. The maximum horizontal viewing angle shall be plus and minus five (5) degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle shall be plus and minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

1. Shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.
2. Shall be powered from the source as designed and shall not dissipate more than 150 Watts.
3. Shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
4. Shall provide a means for users to indicate a duress situation by entering a special code.

R. PIV Contact Card Reader

1. Application Protocol Data Unit (APDU) Support: At a minimum, the contact interface shall support all card commands for contact based access specified in Section 7, Endpoint PIV Card Application Card Command Interface of SP 800-73-1, Interfaces for Personal Identity Verification.
2. Buffer Size: The reader must contain a buffer large enough to receive the maximum size frame permitted by International Organization for Standardization International Electrotechnical Commission (ISO/IEC) 7816-3:1997, Section 9.4.
3. Programming Voltage: PIV Readers shall not generate a Programming Voltage.
4. Support for Operating Class: PIV Readers shall support cards with Class A Vccs as defined in ISO/IEC 7816-3:1997 and ISO/IEC 7816-3:1997/Amd 1:2002.

5. Retrieval Time: Retrieval time<sup>1</sup> for 12.5 kilobytes (KB) of data through the contact interface of the reader shall not exceed 2.0 seconds.
  6. Transmission Protocol: The PIV Reader shall support both the character-based T=0 protocol and block-based T=1 protocol as defined in ISO/IEC 7816-3:1997.
  7. Support for PPS Procedure: The reader shall support Protocol and Parameters Selection (PPS) procedure by having the ability to read character TA1 of the Answer to Reset (ATR) sent by the card as defined in ISO/IEC 7816-3:1997.
- S. Contactless Smart Cards and Readers
1. Smart card readers shall read credential cards whose characteristics of size and technology meet those defined by ISO/IEC 7816, 14443, 15693.
  2. The readers shall have "flash" download capability to accommodate card format changes.
  3. The card reader shall have the capability of reading the card data and transmitting the data to the main monitoring panel.
  4. The card reader shall be contactless and meet or exceed the following technical characteristics:
    - a. Data Output Formats: FIPS 201 low outputs the FASC-N in an assortment of Wiegand bit formats from 40 – 200 bits. FIPS 201 medium outputs a combination FASC-N and HMAC in an assortment of Wiegand bit formats from 32 – 232 bits. All Wiegand formats or the upgradeability from Low to Medium Levels can be field configured with the use of a command card.
    - b. FIPS 201 readers shall be able to read, but not be limited to, DESfire and iCLASS cards.
    - c. Reader range shall comply with ISO standards 7816, 14443, and 15693, and also take into consideration conditions, are at a minimum 1" to 2" (2.5 – 5 cm).
    - d. APDU Support: At a minimum, the contactless interface shall support all card commands for contactless based access specified in Section 7, End-point PIV
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Card Application Card Command Interface of SP 800-73-1, Interfaces for Personal Identity Verification.

- e. Buffer Size: The reader shall contain a buffer large enough to receive the maximum size frame permitted by ISO/IEC 7816-3, Section 9.4.
- f. ISO 14443 Support: The PIV Reader shall support parts (1 through 4) of ISO/IEC 14443 as amended in the References of this publication.
- g. Type A and B Communication Signal Interfaces: The contactless interface of the reader shall support both the Type A and Type B communication signal interfaces as defined in ISO/IEC 14443-2:2001.
- h. Type A and B Initialization and Anti-Collision The contactless interface of the reader shall support both Type A and Type B initialization and anti-collision methods as defined in ISO/IEC 14443-3:2001.
- i. Type A and B Transmission Protocols: The contactless interface of the reader shall support both Type A and Type B transmission protocols as defined in ISO/IEC 14443-4:2001.
- j. Retrieval Time: Retrieval time for 4 KB of data through the contactless interface of the reader shall not exceed 2.0 seconds.
- k. Transmission Speeds: The contactless interface of the reader shall support bit rates of  $f_c/128$  (~106 kbits/s),  $f_c/64$  (~212 kbits/s), and configurable to allow activation/deactivation.
- l. Readability Range: The reader shall not be able to read PIV card more than 10cm(4inch) from the reader

## **2.11 BIOMETRIC IDENTITY VERIFICATION EQUIPMENT**

- A. Shall be FIPS 201 and NIST SP 800-76 compliant.
- B. Shall utilize hand/palm, fingerprint, retinal, facial image, or voice verification and could be utilized as secondary authentication in conjunction with card readers in high security area as defined by the VA. (Note: VA policy requires that the use of biometric measurements is limited to secondary authentication in high or medium security applications).

- C. Shall be programmable, addressable, and hardwired directly to the main control panel and individually home run to the main control panel.
- D. Shall be installed in a manner that they comply with:
  - 1. The Uniform Federal Accessibility Standards (UFAS)
  - 2. The Americans with Disabilities Act (ADA)
  - 3. The ADA Standards for Accessible Design
- E. Shall include a means to construct individual templates or profiles based upon measurements taken from the person to be enrolled. This template shall be stored as part of the System Reference Database Files. The stored template shall be used as a comparative base by the personnel identity verification equipment to generate appropriate signals to the associated local processors.
- F. Shall interface with PACS and SMS and provide the employee's name, contact information, and point of access.
- G. Shall allow for surface, flush, or pedestal mounting.
- H. Shall have communications protocol in place that shall allow for communications with the SMS.
- I. Shall determine when multiple attempts were made for verification, and shall automatically prompt the user for additional attempts up to a maximum of three tries. After a third failed attempt the unit shall generate an entry control alarm. This alarm will report to the SMS and the CCTV system. The camera viewpoint for where the alarm was generated shall automatically be called up onto a monitor and be recorded via the recording equipment. An alarm within the SMS shall also be generated recording, at a minimum, the date, time, and attempted point of entry.
- J. Hand/Palm Geometry Verification:
  - 1. Shall utilize unique human hand measurements to identify authorized, enrolled personnel.
  - 2. During the scan process the hand geometry device, which shall allow the user's hand to remain in full view during the scanning process, shall a three (3) dimensional measurement of the user's hand identifying its size and shape.



3. This scan process shall start automatically once the user's hand is positioned. The hand geometry device shall be able to use either left or right hands for enrollment and verification.
  4. Shall include an LED or other type of visual indicator display and provide visual or visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
  5. Shall only be updated at the unit itself and automatic updates via the SMS shall not be allowed.
  6. Any significant change to the user's hand, scars, loss of digit, or any other change that will alter the three dimension view of the hand shall require an update to the unit and SMS.
  7. Shall provide an enrollment, recognition, and code/credential verification mode. The enrollment mode shall create a hand template for new personnel and enter the template into the entry control database file created for that person. Template information shall be compatible with the system application software. The operating mode shall be selectable by the system manager/operator from the central processor. When operating in recognition mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches a hand geometry template stored in the database files. When operating in code/credential verification mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches the hand geometry template associated with the identification code entered into a keypad; or matches the hand geometry template associated with credential card data read by a card reader.
- K. Fingerprint Verification:
1. Shall use a unique human fingerprint pattern to identify authorized, enrolled personnel.

2. Shall allow the user's hand to remain in full view during the scanning process, shall incorporate positive measures to establish that the hand or fingers being scanned by the device belong to a living human being.
3. Shall provide an optical or other type of scan of the user's fingers. The fingerprint verification scanner shall automatically initiate the scan process provided the user's fingers are positioned.
4. LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
5. Any significant change to the user's finger such as scars, loss of digit, or any other change that will alter the finger print shall require an update to the unit and SMS.
6. Shall provide an adjustable acceptance tolerance or template match criteria under system manager/operator control.
7. Shall respond to passage requests by generating signals to the local processor. The verification time shall be 2.0 seconds or less from the moment the finger print analysis scanner initiates the scan process until the fingerprint analysis scanner generates a response signal.
8. Shall:
  - a. Provide an enrollment mode, recognition mode, and code/credential verification mode. The enrollment mode shall create a fingerprint template for new personnel and enter the template into the system database file created for that person.
  - b. Template information shall be compatible with the system application software.
  - c. The operating mode shall be selectable by the system manager/operator from the central station.
9. When operating in recognition mode, the fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt matches a fingerprint template stored in the database files.

10. When operating in code/credential verification mode, the fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt matches a fingerprint template associated with the identification code. When entered into a keypad or it matches the fingerprint template associated with credential, the card data will then be recognized by the card reader.
  11. Shall store template transactions involving fingerprint scans. The template match scores shall be stored in the matching personnel data file in a format compatible with the system application software, and shall be used for report generation.
  12. Shall be unit listed as FIPS 201 Approved product.
- L. Iris Verification:
1. Shall utilize unique patterns within the human eye to identify authorized, enrolled personnel.
  2. Shall use ambient light to capture an image of the iris of the person presenting themselves for identification. The resulting video image shall be compared against a stored template that was captured during the enrollment process.
  3. Shall utilize a threshold for identification. The efficiency and accuracy of the device shall not be adversely affected by enrollees who wear contact lenses or eye glasses.
  4. Shall provide a means for enrollees to align their eye for identification that does not require facial contact with the device.
  5. Initiation for the scan should be automatic, but push-button could be provided to initiate the scan process. The device shall include adjustments to accommodate differences in enrollee height and mounting height shall be UFAS compliant.
  6. The LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
  7. Verification time for the retinal verification unit shall be no greater than 1.5 seconds from the moment the action is initiated until a response signal has been generated.
  8. Shall provide an enrollment mode, recognition mode, and code/credential verification mode:

- a. The enrollment mode shall create an iris template for new personnel and enter the template into the system database file created for that person. Template information shall be compatible with the system application software.
  - b. When operating in recognition mode, the retinal verification unit shall allow passage when the retinal verification data from the verification attempt matches an iris template stored in the database files.
  - c. When operating in code/credential verification mode, the iris scanner shall allow passage when the retinal verification data from the verification attempt matches the retinal verification template. This will occur when the associated information matches the identification code entered into a keypad or matches the retinal verification template associated with the credential card data when recognized by a card reader.
9. Shall store template transactions involving retinal verifications. The template match scores shall be stored in the matching personnel data file in a file format compatible with the system application software, and shall be used for report generation.

M. Voice Verification:

1. Shall utilize unique patterns within the human speech pattern to identify authorized, enrolled personnel.
2. Shall digitize a profile of a person's speech to produce a stored model voice print, or template. Users shall record their full names utilizing their natural voice tendencies. This process shall be initiated by a push to talk button on the voice verification device.
3. Shall utilize a threshold for identification. The efficiency and accuracy of the device shall not be adversely affected by enrollees who have a speech impediment.
4. Shall provide a means for enrollees to align their voice for identification that does not require contact with the device.
5. The LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.

6. Verification time for the voice verification unit shall be no greater than 1.5 seconds from the moment the action is initiated until a response signal has been generated.
7. Shall provide an enrollment mode, recognition mode, and code/credential verification mode:
  - a. The enrollment mode shall create a voice template for new personnel and enter the template into the system database file created for that person. Template information shall be compatible with the system application software.
  - b. When operating in recognition mode, the voice verification unit shall allow passage when the voice verification data from the verification attempt matches a voice template stored in the database files.
  - c. When operating in code/credential verification mode, the voice verifier shall allow passage when the voice verification data from the verification attempt matches the voice verification template. This will occur when the associated information of the identification code entered into a keypad matches the voice verification template associated with a credential card data is recognized by a card reader.
8. Shall store template transactions involving voice verifications. The template match scores shall be stored in the matching personnel data file in a file format compatible with the system application software, MPEG or equivalent, and shall be used for report generation.

## **2.11 KEYPADS**

- A. Designed for use with unique combinations of alphanumeric and other symbols as an Identifier. Keys of keypads shall contain an integral alphanumeric/special symbol keyboard with symbols arranged in [ascending ASCII-code ordinal sequence] [random scrambled order]. Communications protocol shall be compatible with Controller.
  1. Keypad display or enclosure shall limit viewing angles of the keypad as follows:
    - a. Maximum Horizontal Viewing Angle: 5 degrees or less off in either direction of a vertical plane perpendicular to the plane of the face of the keypad display.

- b. Maximum Vertical Viewing Angle: 15 degrees or less off in either direction of a horizontal plane perpendicular to the plane of the face of the keypad display.
- 2. Duress Codes: Provide duress situation indication by entering a special code.

## **2.12 CREDENTIAL CARDS**

- A. Personal Identity Verification (PIV) credential cards shall comply to Federal Information Processing Standards Publication (FIPS) 201.
- B. Visual Card Topography shall be compliant with NIST 800-104.
- C. PIV logical credentials shall contain multiple data elements for the purpose of verifying the cardholder's identity at graduated assurance levels. These mandatory data elements shall collectively comprise the data model for PIV logical credentials, and include the following:
  - 1. CHUID
  - 2. PIN
  - 3. PIV authentication data (one asymmetric key pair and corresponding certificate)
  - 4. + Two biometric fingerprints.
- D. The credential card (PIV) shall be an ISO 14443 type smart card with contactless interface that operates at 13.56 MHZ.
- E. The credential card (PIV) shall be an ISO 7816 type smart card.

## **2.13 SYSTEM SENSORS AND RELATED EQUIPMENT**

- A. The PACS (Physical Access Control System) and related Equipment provided by the Contractor shall meet or exceed the following performer specifications:
- B. Request to Exit Detectors:
  - 1. Passive Infrared Request to Exit Motion Detector (REX PIR) (1) The Contractor shall provide a surface mounted motion detector to signal the physical access control system request to exit input. The motion detector shall be a passive infrared sensor designed for wall or ceiling mounting 2134 to 4572 mm (7 to 15 ft) height. The detector shall provide two (2) form "C" (SPDT) relays rated one (1) Amp. @ 30 VDC for DC resistive loads. The detectors relays shall be user adjustable with a latch time from 1-60 seconds. The detector shall also include a selectable relay reset mode to

follow the timer or absence of motion. The detection pattern shall be adjustable plus or minus fourteen ( $\pm 14$ ) degrees. The detector shall operate on 12 VDC with approximately 26 mA continuous current draw. The detector shall have an externally visible activation LED. The motion detector shall measure approximately 38 mm H x 158 mm W x 38 mm D (1.5 x 6.25 x 1.5 in). The detector shall be immune to radio frequency interference. The detector shall not activate or set-up on critical frequencies in the range 26 to 950 Megahertz using a 50 watt transmitter located 30.5 cm (1 ft) from the unit or attached wiring. The detector shall be available on gray or black enclosures. The color of the housing shall be coordinated with the surrounding surface.

C. Guard tour stations:

1. The guard tour station shall be single gang brushed steel plate flush mounted in a single gang box. The switch shall be a normally open momentary keyed switch.

D. Delayed Egress (DE)

1. General:

- a. The delay egress locking hardware shall provide a method to secure emergency exits and provide an approved delayed emergency exit method. The package shall be Underwriters Laboratories listed as a delay egress-locking device. The delay egress device shall be available to support configurations with both rated and non-rated fire doors. The delay egress device shall comply with Life Safety Codes (NFPA-101, BOCA) as it applies to special locking arrangements for delay egress locks. Unless specifically identified as a non-fire rated opening, all doors shall be equipped with fire rated door hardware. The Contractor shall be responsible for providing all equipment and installation to provide a fully functioning system. Need to amend to use crashbars type mechanical release switches.

2. The delay-locking device shall include all of the following features:

- a. Delay Egress Mode

- 1) The delayed egress device shall be a SDC 101V Series Exit Check with wall mounted control module. Upon activation of an approved panic bar the delay locking device shall begin a delay sequence of 30 seconds; a flush mounted wall LED panel adjacent to the door will indicate initiation of the countdown time. During the 30 second delay period, a local sounding device shall annunciate a tone activation of the delay cycle and verbal exit instructions. At the end of the delay cycle the locking device shall unlock and allow free egress. The reset of the local sounding device shall be user definable and include options to select either local sound until silenced by reset or local sounder silenced upon opening of the door. Unless otherwise indicated the local delay sounder shall be silenced upon opening of the door. The SDC's device trigger output shall be connected to the SMS DGP alarm panel for pre-activation warning. The contractor shall specify the bond sensor option when ordering the delayed egress hardware; this output shall be wired to the SMS DGP to activate an alarm if the door does not lock. Use of reset panel not top mounted device.
  - 2) Delayed egress doors will have bond sensors.
  - 3) Delayed egress activation shall also trigger CCTV call –up.
- b. Fire Alarm Mode
- 1) Upon activation of the facility's fire evacuation and water flow alarm signal the delay locking devices shall immediately unlock and provide free egress. The Contractor shall provide any required fire alarm relays or interface devices.
- c. Reset Mode
- 1) The delay egress device shall be manually reset by the Delayed Egress controller located at the door via key switch.
  - 2) The delay egress device shall automatically reset upon fire alarm system reset.
  - 3) The delayed egress shall be resettable through the SMS.



- d. The Contractor shall provide a Master Open Switch for all the facility's delayed egress hardware, with protective cover and permanent labeling in the Unit Control Room. The switch shall be wired into the fire alarm system to activate the evacuation alarms. When the switch is pressed all delayed egress or evacuation doors shall unlock and generate an alarm at the security console monitor showing and recording time and date of when the switch was pressed. The contractor is responsible for coordinating the wiring and connection with the fire alarm contactor. The Master Open Switch shall be linked to the fire alarm panel for the release of doors locks.
- e. Each individual delayed egress door shall have the ability to unlock through a manual action on the SMS.
- f. Unless otherwise indicated the Contractor shall provide all of the above reset methods for each door. All signs will meet the latest ADA requirements.
- g. Signs
  - 1) The delay egress package shall be provided with a warning sign complying with local code requirements. The warning sign shall be attached to the interior side of the controlled door. The sign shall be located on the interior side of the door above and within 304 mm (12 in) of the panic bar. The sign shall read:  
EMERGENCY EXIT.  
PUSH UNTIL  
ALARM SOUNDS  
DOOR CAN BE OPENED,  
IN 30 SECONDS.
  - 2) Signs shall be coordinated and comply with the building's existing sign specifications. Signs shall include grade 2 Braille.
  - 3) Signs shall meet the current ADA requirements.
  - 4) In instances of code and specification conflicts, the life safety code requirement shall prevail.

5) The Division 10 Contractor shall provide samples for approval with their submittal package.

3. Physical Access Control Interface

- a. The delay egress device shall be capable of interface with card access control systems.
- b. The system shall include a bypass feature that is activated via a dry contact relay output from the physical access control system. This bypass shall allow authorized personnel to pass through the controlled portal without creating an alarm condition or activating the delay egress cycle. The bypass shall include internal electronic shunts or door switches to prevent activation (re-arming) until the door returns to the closed position. An unused access event shall not cause a false alarm and shall automatically rearm the delay egress lock upon expiration of the programmed shunt time. The delay egress physical access control interface shall support extended periods of automated and/or manual lock and unlock cycles.

E. Crash Bar:

1. Emergency Exit with Alarm (Panic):

- a. Entry control portals shall include panic bar emergency exit hardware as designed.
- b. Panic bar emergency exit hardware shall provide an alarm shunt signal to the PACS and SMS.
- c. The panic bar shall include a conspicuous warning sign with one (1) inch (2.5 cm) high, red lettering notifying personnel that an alarm will be annunciated if the panic bar is operated.
- d. Operation of the panic bar hardware shall generate an intrusion alarm that reports to both the SMS and Intrusion Detection System. The use of a micro switch installed within the panic bar shall be utilized for this.
- e. The panic bar shall utilize a fully mechanical connection only and shall not depend upon electric power for operation.

- f. The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key by-pass. Refer to Section 2.2.1.9 for key-bypass specifications.
  - g. Normal Exit:
    - 1) Entry control portals shall include panic bar non-emergency exit hardware as designed.
    - 2) Panic bar non-emergency exit hardware shall be monitored by and report to the SMS.
    - 3) Operation of the panic bar hardware shall not generate a locally audible or an intrusion alarm within the IDS.
    - 4) When exiting, the panic bar shall depend upon a mechanical connection only. The exterior, non-secure side of the door shall be provided with an electrified thumb latch or lever to provide access after the credential I.D. authentication by the SMS.
    - 5) The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key by-pass. Refer to Section 2.2.1.9 for key-bypass specifications. The strikes/bolts shall include a micro switch to indicate to the system when the bolt is not engaged or the strike mechanism is unlocked. The signal switches shall report a forced entry to the system in the event the door is left open or accessed without the identification credentials.
- F. Key Bypass:
- 1. Shall be utilized for all doors that have a mortise or rim mounted door hardware.
  - 2. Each door shall be individually keyed with one master key per secured area.
  - 3. Cylinders shall be six (6)-pin and made of brass or equivalent. Keys for the cylinders shall be constructed of solid material and produced and cut by the same distributor. Keys shall not be purchased, cut, and supplied by multiple dealers.
  - 4. All keys shall have a serial number cut into the key. No two serial numbers shall be the same.

5. All keys and cylinders shall be stored in a secure area that is monitored by the Intrusion Detection System.

G. Automatic Door Opener and Closer:

1. Shall be low energy operators.
2. Door closing force shall be adjustable to ensure adequate closing control.
3. Shall have an adjustable back-check feature to cushion the door opening speed if opened violently.
4. Motor assist shall be adjustable from 0 to 30 seconds in five (5) second increments. Motor assist shall restart the time cycle with each new activation of the initiating device.
5. Unit shall have a three-position selector mode switch that shall permit unit to be switched "ON" to monitor for function activation, switched to "H/O" for indefinite hold open function or switched to "OFF," which shall deactivate all control functions but will allow standard door operation by means of the internal mechanical closer.
6. Door control shall be adjustable to provide compliance with the requirements of the Americans with Disabilities Act (ADA) and ANSI standards A117.1.
7. All automatic door openers and closers shall:
  - a. Meet UL standards.
  - b. Be fire rated.
  - c. Have push and go function to activate power operator or power assist function.
  - d. Have push button controls for setting door close and door open positions.
  - e. Have open obstruction detection and close obstruction detection built into the unit.
  - f. Have door closer assembly with adjustable spring size, back-check valve, sweep valve, latch valve, speed control valve and pressure adjustment valve to control door closing.
  - g. Have motor start-up delay, vestibule interface delay; electric lock delay and door hold open delay up to 30 seconds. All operators shall close door under full spring power when power is removed.

- h. Are to be hard wired with power input of 120 VAC, 60Hz and connected to a dedicated circuit breaker located on a power panel reserved for security equipment.
- H. Door Status Indicators:
  - 1. Shall monitor and report door status to the SMS.
  - 2. Door Position Sensor:
    - a. Shall provide an open or closed indication for all doors operated on the PACS and report directly to the SMS.
    - b. Shall also provide alarm input to the Intrusion Detection System for all doors operated by the PACS and all other doors that require monitoring by the intrusion detection system.
    - c. Switches for doors operated by the PACS shall be double pole double throw (DPDT). One side of the switch shall monitor door position and the other side if the switch shall report to the intrusion detection system. For doors with electromagnetic locks a magnetic bonding sensor (MBS) can be used in place of one side of a DPDT switch, in turn allowing for the use of a single pole double throw (SPDT) switch in it place of a DPDT switch.
    - d. Switches for doors not operated by the PACS shall be SPDT and report directly to the IDS.
    - e. Shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).

## **2.14 PUSH BUTTON SWITCHES**

- A. Push-Button Switches: Momentary-contact back-lighted push buttons, with stainless-steel switch enclosures.
  - 1. Electrical Ratings:
    - a. Minimum continuous current rating of [10] <Insert number> A at 120 V ac or [5] <Insert number> A at 240-V ac.
    - b. Contacts that will make 720 VA at [60] <Insert number> A and that will break at 720 VA at [10] <Insert number> A.

2. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
3. Enclosures shall additionally be suitable for installation in the following locations:
  - a. Indoors, controlled environment.
  - b. Indoors, uncontrolled environment.
  - c. Outdoors.
4. Power: Push-button switches shall be powered from their associated Controller, using dc control.

## **2.15 PORTAL CONTROL DEVICES**

- A. Shall be used to assist the PACS.
- B. Such devices shall:
  1. Provide a means of monitoring the doors status.
  2. Allow for exiting a space via either a push button, request to exit, or panic/crash bar.
  3. Provide a means of override to the PACS via a keypad or key bypass.
  4. Assist door operations utilizing automatic openers and closures.
  5. Provide a secondary means of access to a space via a keypad.
- C. Shall be connected to and monitored by the main PACS panel.
- D. Shall be installed in a manner that they comply with:
  1. The Uniform Federal Accessibility Standards (UFAS)
  2. The Americans with Disabilities Act (ADA)
  3. The ADA Standards for Accessible Design
- E. Shall provide a secondary means of physical access control within a secure area.
- F. Push-Button Switches:
  1. Shall be momentary contact, back lighted push buttons, and stainless steel switch enclosures for each push button as shown. Buttons are to be utilized for secondary means of releasing a locking mechanism.
    - a. In an area where a push button is being utilized for remote access of the locking device then no more than two (2) buttons shall operate one door from within one secure space. Buttons will not be wired in series with one other.

- b. In an area where locally stationed guards control entry to multiple secure points via remote switches. An interface board shall be designed and constructed for only the amount of buttons it shall house. These buttons shall be flush mounted and clearly labeled for ease of use. All buttons shall be connected to the PACS and SMS system for monitoring purposes.
  - c. Shall have double-break silver contacts that will make 720 VA at 60 amperes and break 720 VA at 10 amperes.
- G. Entry Control Devices:
- 1. Shall be hardwired to the PACS main control panel and operated by either a card reader or a biometric device via a relay on the main control panel.
  - 2. Shall be fail-safe in the event of power failure to the PACS system.
  - 3. Shall operate at 24 VCD, with the exception of turnstiles and be powered by a separate power supply dedicated to the door control system. Each power supply shall be rated to operate a minimum of two doors simultaneously without error to the system or overload the power supply unit.
  - 4. Shall have a diode or metal-oxide varistor (MOV) to protect the controller and power supply from reverse current surges or back-check.
  - 5. Electric Strikes/Bolts: Shall be:
    - a. Made of heavy-duty construction and tamper resistant design.
    - b. Tested to over one million cycles.
    - c. Rated for a minimum of 1000 lbs. holding strength.
    - d. Utilize an actuating solenoid for the strike/bolt. The solenoid shall move from fully open to fully closed position and back in not more than 500 milliseconds and be rated for continuous duty.
    - e. Utilize a signal switch that will indicate to the system if the strike/bolt is not engaged or is unlocked when it should be secured.
    - f. Flush mounted within the door frame.
  - 6. Electric Mortise Locks: Shall be installed within the door and an electric transfer hinge shall be utilized to allow the wires to be transferred from the door frame to

the lock. If utilized with a double door then the lock shall be installed inside the active leaf. Electric Mortise Locks shall:

- a. These locks shall be provided and installed by the Division 8 "DOOR HARDWARE" Contractor.
  - b. Have integrated Request to Exit switch for new doors receiving physical access control devices.
  - b. Provide integration of the Electric Mortise Locks with the PACS for:
    - 1) Lock Power
    - 2) Request to Exit switch.
7. Electromagnetic Locks:
- a. These locks shall be without mechanical linkage utilizing no moving parts, and securing the door to its frame solely on electromagnetic force.
  - b. Shall be comprised of two pieces, the mag-lock and the door plate. The electromagnetic locks shall be surface mounted to the door frame and the door plate shall be surface mounted to the door.
  - c. Ensure a diode is installed in line with the DC voltage supplying power to the unit in order to prevent back-check on the system when the electromagnetic lock is powered.
  - d. Shall utilize a magnetic bonding sensor (MBS) to monitor the door status and report that status to the SMS.
  - e. Electromagnetic locks shall meet the following minimum technical characteristics:

Operating Voltage		24 VDC
Current Draw		.5A
Holding Force	Swing Doors	675 kg (1500 lbs)
	Sliding Doors	225 kg (500 lbs)

8. Turnstiles:



- a. Shall operate at 110 VAC, 60 Hz or 220 VAC, 50 Hz supplied from a dedicated circuit breaker on a security power panel. This device does not require a back-up power source.
  - b. Shall be utilized as a means of monitoring and controlling access in a lobby.
  - c. Shall meet the following minimum requirements:
    - 1) Be UFAS compliant.
    - 2) Provide either an audible or visual confirmation that access has been granted to a cleared individual.
    - 3) Provide an audible alarm in the event a non-cleared individual is attempting to gain access.
    - 4) Interface with the SMS and utilize a card reader for accessing and exiting a facility, and provide a recorded event of personnel accessing these points.
    - 5) Have a built-in step-down transformer to provide power to a card reader unit.
    - 6) Have built-in signal wiring chassis to allow for plug and play capabilities with the PACS.
    - 7) Have the ability to detect tailgating within one quarter on an inch to prevent unauthorized access to a facility.
9. Vehicle Gate Operator: Interface electrical operation of gate with controls of this Section. Vehicle gate operators shall be connected, monitored, and controlled, by the security access Controllers. Vehicle gate and accessories are specified in Division 32 Section "Chain Link Fences and Gates."

## **2.16 SECONDARY ALARM ANNUNCIATOR**

- A. Secondary Alarm Annunciation Site: A workstation with limited I/O capacity, consisting of a secondary alarm annunciation workstation [to allow the operator to duplicate functions of the main operator interface, and to show system status changes] [to display alarms or system status changes only].

## 2.17 INTERFACES

### A. CCTV System Interface

1. An RS232 [Ethernet] interface associated driver, and controller shall be provided for connection of the SMS Central Computer to the CCTV Alarm interface and switcher. The interface shall provide alarm data to the CCTV Alarm interface for automatic camera call-up. If required the Security Contractor shall be responsible for programming the command strings into the SMS Server.

### B. Intercom System Interface

1. The CCTV call-up from intercom stations shall be through the intercom unit via RS232 [Ethernet] communications interface to the SMS system, then through the matrix switcher.
  - a. Application Software
    - 1) Provides the interface between the Alarm Annunciation System and Operator; all sensors, local processors and data links, drive displays, report alarms, and report generation.
    - 2) Software is categorized as System Software and Application Software. System Software must consist of software to support set-up, operation, hard drive back-ups and maintenance processor. Application Software must consist of software to provide the completion of Physical Access Control System.

### C. Power Supplies:

1. Shall be UL rated and able to adequately power (enter number) entry control devices on a continuous base without failure.
2. Shall meet the following minimum technical characteristics:

INPUT POWER	110 VAC 60 HZ (enter amperage)A
OUTPUT VOLTAGE	12 VDC Nominal (13.8 VDC) 24 VDC Nominal (27.6 VDC)

	Filtered and Regulated
BATTERY	Dependant on Output Voltage shall provide up to <__> Ah
OUTPUT CURRENT	[10] amp max. [@ 13.8] VDC [5] amp max. [@ 27.6] VDC
PRIMARY FUSE SIZE	6.3 amp (non-removable)
BATTERY FUSE SIZE	12 amp, 3AG
CHARGING CIRCUIT	Built-in standard

## 2.18 FLOOR SELECT ELEVATOR CONTROL

- A. Elevator access control shall be integral to security access.
1. System shall be capable of providing full elevator security and control through dedicated Controllers without relying on the control-station host PC for elevator control decisions.
  2. Access-control system shall enable and disable car calls on each floor and floor select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.
  3. System setup shall, through programming, automatically secure and unsecure each floor select button of a car individually by time and day. Each floor select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.
  4. When a floor select button is secure, it shall require the passenger to use his/her access code and have access to that floor before the floor select button will operate. The passenger's credential shall determine which car call and floor select buttons are to be enabled, restricting access to floors unless authorized by system's access code database. Floor select button shall be enabled only in the car where the credential holder is the passenger.

- B. PACS shall record which call button is pressed, along with credential and time information.
  - 1. System Controller shall record elevator access data.
  - 2. The Controller shall reset all additional call buttons that may have been enabled by the user's credential.
  - 3. The floor select elevator control shall allow for manual override either individually by floor or by cab as a group from a workstation PC.

## **2.19 AFTER-HOURS HVAC CONTROL**

- A. After-Hours HVAC Control: Provide for any credential read to activate or control individual HVAC zones based on access level. This control module shall control and record the after-hours use of the heating and cooling system in zones or tenant space.
  - 1. This control shall give the administrator the ability to determine how much extra energy consumption each tenant is responsible for. This information can be used in billing tenants for the extra after-hour usage.
  - 2. At the specified time every day, the HVAC shall automatically go into its after-hours mode. It shall then revert into its normal business hours mode by a tenant using an access code or card at a designated keypad or reader.
  - 3. Once enabled, the tenant's HVAC zone shall be under thermostat control for a preset amount of time. When the preset amount of time elapses, the HVAC for that zone shall revert back to after-hours mode unless a tenant uses his/her code or card again. This shall continue until the unit automatically returns to its normal business hours operation.
- B. Control module activates the HVAC system after a valid access by any of three methods; however, the HVAC control shall always allow for manual override from the PC.
  - 1. By time expiration after access of an adjustable period from 1 second to 546 minutes (9.1 hours).
  - 2. By use of the card or code again at the same or different reader or keypad.
  - 3. By system returning to its normal business hours operation.

- C. After-hours HVAC control shall operate with all other features running simultaneously and use the central-station PC that controls access for the building but shall not rely on the host PC for any HVAC control decisions.

## **2.20 REAL TIME GUARD TOUR**

- A. Guard tour module shall provide the ability to plan, track, and route tours. Module shall input an alarm during tour if guard fails to make a station. Tours can be programmed for sequential or random tour-station order.
  - 1. Guard tour setup shall define specific routes or tours for the guard to take, with time restrictions in which to reach every predefined tour station.
  - 2. Guard tour activity shall be automatically logged to the central-station PC's hard drive.
  - 3. If the guard is early or late to a tour station, a unique alarm per station shall appear at the Central Station to indicate the time and station.
  - 4. Guard tour setup shall allow the tours to be executed sequentially or in a random order with an overall time limit set for the entire tour instead of individual times for each tour station.
  - 5. Setup shall allow recording of predefined responses that will display for the operator at the control station should a "Failed to Check-in" alarm occur.
- B. A tour station is a physical location a guard shall reach and perform an action indicating that the guard has arrived. This action, performed at the tour station, shall be 1 of 13 different events with any combination of station types within the same tour. A tour station shall be one of the following event types:
  - 1. Access Granted.
  - 2. Access Denied Code.
  - 3. Access Denied Card plus PIN.
  - 4. Access Denied Time Zone.
  - 5. Access Denied Level.
  - 6. Access Denied Facility.
  - 7. Access Denied Code Timer.

8. Access Denied Anti-Passback.
  9. Access Granted Passback Violation.
  10. Alarm.
  11. Restored.
  12. Input Normal.
  13. Input Abnormal.
- C. Guard tour and other system features shall operate simultaneously with no interference.
- D. Guard Tour Module Capacity: 999 possible guard tour definitions with each tour having up to 99 tour stations. System shall allow all 999 tours to be running at same time.

## **2.21 VIDEO AND CAMERA CONTROL**

- A. Control station or designated workstation displays live video from a CCTV source.
1. Control Buttons: On the display window, with separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan, and a minimum of two custom command auxiliary controls.
  2. Provide at least seven icons to represent different types of cameras, with ability to import custom icons. Provide option for display of icons on graphic maps to represent their physical location.
  3. Provide the alarm-handling window with a command button that will display the camera associated with the alarm point.
- B. Display mouse-selectable icons representing each camera source, to select source to be displayed. For CCTV sources that are connected to a video switcher, control station shall automatically send control commands through a COM port to display the requested camera when the camera icon is selected.
- C. Allow cameras with preset positioning to be defined by displaying a different icon for each of the presets. Provide control with Next and Previous buttons to allow operator to cycle quickly through the preset positions.

## 2.22 WIRES AND CABLES

- A. Refer to section 280513 "CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY".
- A. Comply with Division 28 Section "CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY."
- B. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  - 1. NFPA 70, Type CM.
  - 2. Flame Resistance: UL 1581 Vertical Tray.
- C. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  - 1. NFPA 70, Type CMP.
  - 2. Flame Resistance: NFPA 262 Flame Test.
- D. RS-485 communications require 2 twisted pairs, with a distance limitation of 4000 feet (1220 m).
- E. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
- F. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.
  - 1. NFPA 70, Type CMP.
  - 2. Flame Resistance: NFPA 262 Flame Test.
- G. Multiconductor, Readers and Wiegand Keypads Cables: No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC

insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CMG.
2. Flame Resistance: UL 1581 Vertical Tray.
3. For TIA/EIA-RS-232 applications.

- H. Paired Readers and Wiegand Keypads Cables: Paired, 3 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CM.
2. Flame Resistance: UL 1581 Vertical Tray.

- I. Paired Readers and Wiegand Keypads Cable: Paired, 3 pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.

1. NFPA 70, Type CM.
2. Flame Resistance: UL 1581 Vertical Tray.

- J. Plenum-Type, Paired, Readers and Wiegand Keypads Cable: Paired, 3 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum foil-polypropylene tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.

1. NFPA 70, Type CMP.
2. Flame Resistance: NFPA 262 Flame Test.

- K. Plenum-Type, Multiconductor, Readers and Keypads Cable: 6 conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.

1. NFPA 70, Type CMP.



2. Flame Resistance: NFPA 262 Flame Test.
- L. Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
  1. NFPA 70, Type CMG.
  2. Flame Resistance: UL 1581 Vertical Tray.
- M. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
  1. NFPA 70, Type CMP.
  2. Flame Resistance: NFPA 262 Flame Test.
- N. Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
  1. NFPA 70, Type CMG.
  2. Flame Resistance: UL 1581 Vertical Tray.
- O. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
  1. NFPA 70, Type CMP.
  2. Flame Resistance: NFPA 262 Flame Test.
- P. Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum foil-polyester tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
  1. NFPA 70, Type CMR.
  2. Flame Resistance: UL 1666 Riser Flame Test.
- Q. Plenum-Type, Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum foil-polyester tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.
  1. NFPA 70, Type CMP.

2. Flame Resistance: NFPA 262 Flame Test.
- R. Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
1. NFPA 70, Type CMG.
- S. Plenum-Type, Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
1. NFPA 70, Type CMP.
  2. Flame Resistance: NFPA 262 Flame Test.
- T. Elevator Travel Cable: Steel center core, with shielded, twisted pairs, No. 20 AWG conductor size.
1. Steel Center Core Support: Preformed, flexible, low-torsion, zinc-coated, steel wire rope; insulated with 60 deg C flame-resistant PVC and covered with a nylon or cotton braid.
  2. Shielded Pairs: Insulated copper conductors; color-coded, insulated with 60 deg C flame-resistant PVC; each pair shielded with bare copper braid for 85 percent coverage.
  3. Jute Filler: Electrical grade, dry.
  4. Binder: Helically wound synthetic fiber.
  5. Braid: Rayon or cotton braid applied with 95 percent coverage.
  6. Jacket: 60 deg C PVC specifically compounded for flexibility and abrasion resistance. UL VW-1 and CSA FT1 flame rated.
- U. LAN (Ethernet) Cabling: Comply with Division 28 Section "Conductors and Cables for Electronic Safety and Security."

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. The Contractor shall install all system components and appurtenances in accordance with the manufacturers' instructions, ANSI C2, and shall furnish all necessary

interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.

- B. Consult the manufacturers' installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

### **3.2 CURRENT SITE CONDITIONS**

- A. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions which will affect performance of the system to the Owner in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Owner.

### **3.3 EXAMINATION**

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.4 PREPARATION**

- A. Comply with recommendations in SIA CP-01.

- B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."
- C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
  - 1. Record setup data for control station and workstations.
  - 2. For each Location, record setup of Controller features and access requirements.
  - 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
  - 4. Set up groups, linking, and list inputs and outputs for each Controller.
  - 5. Assign action message names and compose messages.
  - 6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
  - 7. Prepare and install alarm graphic maps.
  - 8. Develop user-defined fields.
  - 9. Develop screen layout formats.
  - 10. Propose setups for guard tours and key control.
  - 11. Discuss badge layout options; design badges.
  - 12. Complete system diagnostics and operation verification.
  - 13. Prepare a specific plan for system testing, startup, and demonstration.
  - 14. Develop acceptance test concept and, on approval, develop specifics of the test.
  - 15. Develop cable and asset management system details; input data from construction documents. Include system schematics and Technical Drawings.
- D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

### **3.5 CABLING**

- A. Comply with NECA 1, "Good Workmanship in Electrical Contracting."

- B. Install cables and wiring according to requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5E rating of components and that ensure Category 5E performance of completed and linked signal paths, end to end.
- F. Install cables without damaging conductors, shield, or jacket.
- G. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- H. Install end-of-line resistors at the field device location and not at the Controller or panel location.

### **3.6 CABLE APPLICATION**

- A. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. RS-232 Cabling: Install at a maximum distance of 50 feet (15 m).
- D. RS-485 Cabling: Install at a maximum distance of 4000 feet (1220 m).
- E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
  2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet (75 m), and install No. 20 AWG wire if maximum distance is 500 feet (150 m).
  3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
  4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed [250 feet (75 m)] [500 feet (150 m)] <Insert distance>.
- G. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of [25 feet (8 m)] <Insert distance>.

### **3.7 GROUNDING**

- A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Signal Ground:
  1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
  2. Bus: Mount on wall of main equipment room with standoff insulators.
  3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### **3.8 INSTALLATION**

- A. System installation shall be in accordance with UL 294, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.
- B. Components shall be configured with appropriate “service points” to pinpoint system trouble in less than 30 minutes.
- C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a operable system.
- D. The PACS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a network.
- E. For integration purposes, the PACS shall be integrated where appropriate with the following associated security subsystems:
  - 1. CCTV:
    - a. Provide 24 hour coverage of all entry points to the perimeter and agency buildings. As well as all emergency exits utilizing a fixed color camera.
    - b. Be able to monitor, control and record cameras on a 24 hours basis.
    - c. Be programmed automatically call up a camera when an access point is but into an alarm state.
    - d. For additional PACS system requirements as they relate to the CCTV, refer to Section 28 23 00, VIDEO SURVEILLANCE.
  - 2. IDS:
    - a. Be able monitor door control sensors.
    - b. Be able to monitor and control the IDS on a 24 hours basis.
    - c. Be programmed to go into an alarm state when an IDS device is put into an alarm state, and notify the operator via an audible alarm.

- d. For additional PACS system requirements as they relate to the IDS, refer to Section 28 16 11, INTRUSION DETECTION SYSTEM.
- 3. Security Access Detection:
  - a. Be able to monitor all objects that have been screened with an x-ray machine and be able to monitor all data acquired by the bomb detection unit.
  - b. For additional PACS system requirements as they relate to the Security Access Detection, refer to Section 28 13 53, SECURITY ACCESS DETECTION.
- 4. EPPS:
  - a. Be programmed to go into an alarm state when an emergency call box or duress alarm/panic device is activated, and notify the Physical Access Control System and Database Management of an alarm event.
  - b. For additional PACS requirements as they relate to the EPPS, refer to Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM.
- F. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.
- G. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.
- H. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system. The Contractor shall not take any corrective action without written permission from the Government.
- I. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.
- J. Existing Equipment:



1. The Contractor shall connect to and utilize existing door equipment, control signal transmission lines, and devices as outlined in the design package. Door equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.
  2. The Contractor shall perform a field survey, including testing and inspection of all existing door equipment and signal lines intended to be incorporated into the PACS, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
  3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
  4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or improper installation of equipment.
  5. The Contracting Officer shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.
- K. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to

exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.

- L. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

M. Control Panels:

1. Connect power and signal lines to the controller.
2. Program the panel as outlined by the design and per the manufacturer's programming guidelines.

N. SMS:

1. Coordinate with the VA agency's IT personnel to place the computer on the local LAN or Intranet and provide the security system protection levels required to insure only authorized VA personnel have access to the system.
2. Program and set-up the SMS to ensure it is in fully operation.

O. Card Readers:

1. Connect all signal inputs and outputs as shown and specified.
2. Terminate input signals as required.
3. Program and address the reader as per the design package.
4. Readers shall be surface or flushed mounted and all appropriate hardware shall be provided to ensure the unit is installed in an enclosed conduit system.

P. Biometrics:

1. Connect all signal input and output cables along with all power cables.
2. Program and ensure the device is in operating order.

Q. Portal Control Devices:

1. Install all signal input and output cables as well as all power cables.

2. Devices shall be surface or flush mounted as per the design package.
  3. Program all devices and ensure they are working.
- R. Door Status Indicators:
1. Install all signal input and output cables as well as all power cables.
  2. RTE's shall be surface mounted and angled in a manner that they cannot be compromised from the non-secure side of a windowed door, or allow for easy release of the locking device from a distance no greater than 6 feet from the base of the door.
  3. Door position sensors shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).
- S. Entry Control Devices:
1. Install all signal input and power cables.
  2. Strikes and bolts shall be mounted within the door frame.
  3. Mortise locks shall be mounted within the door and an electric transfer hinge shall be utilized to transfer the wire from within the door frame to the mortise lock inside the door.
  4. Electromagnetic locks shall be installed with the mag-lock mounted to the door frame and the metal plate mounted to the door.
- T. System Start-Up:
1. The Contractor shall not apply power to the PACS until the following items have been completed:
    - a. PACS equipment items and have been set up in accordance with manufacturer's instructions.
    - b. A visual inspection of the PACS has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
    - c. System wiring has been tested and verified as correctly connected as indicated.
    - d. All system grounding and transient protection systems have been verified as installed and connected as indicated.

- e. Power supplies to be connected to the PACS have been verified as the correct voltage, phasing, and frequency as indicated.
- 2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.
- 3. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.
- U. Supplemental Contractor Quality Control:
  - 1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed PACS; and are approved by the Contracting Officer.
  - 2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
  - 3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
  - 4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

### **3.9 SYSTEM SOFTWARE**

- A. Install, configure, and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner.

### **3.10 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect[, test, and adjust] field-assembled components and equipment installation, including connections[, and to assist in field testing]. Report results in writing.
- B. Testing Agency: [Owner will engage] [Engage] a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:

- C. Perform the following field tests and inspections and prepare test reports:
1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
  2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
  3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

### **3.11 PROTECTION**

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured, with an activated burglar alarm and access-control system reporting to a Central Station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

### **3.12 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.13 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.
- C. Develop separate training modules for the following:
  - 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  - 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  - 3. Security personnel.
  - 4. Hardware maintenance personnel.
  - 5. Corporate management.
- D. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

**SECTION 28 23 00**  
**VIDEO SURVEILLANCE**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. Provide and install a complete 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.
- B. This Section includes video surveillance system consisting of cameras, data transmission wiring, and a control station with its associated equipment.
- C. Video surveillance system Video assessment & surveillance system shall be integrated with monitoring and control system specified in Division 28 Section PHYSICAL ACCESS CONTROL that specifies systems integration.

**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 10 14 00 - SIGNAGE. Requirements for labeling and signs.
- F. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.
- G. Section 26 05 21 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- H. Section 26 05 41 - UNDERGROUND ELECTRICAL CONSTRUCTION. Requirements for underground installation of wiring.
- I. Section 26 56 00 - EXTERIOR LIGHTING. Requirements for perimeter lighting.
- J. 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.
- K. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for conductors and cables.

- L. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY.  
Requirements for grounding of equipment.
- M. Section 28 05 28.33 - CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for infrastructure.
- N. Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY.  
Requirements for commissioning, systems readiness checklists, and training.
- O. Section 28 13 00 - PHYSICAL ACCESS CONTROL SYSTEM. Requirements for physical access control system integration.

### **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 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 COTR 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 Commission (FCC):

- (47 CFR 15) Part 15      Limitations on the Use of Wireless Equipment/Systems
- E. National Electrical Contractors Association (NECA):  
303-2005 .....Installing Closed Circuit Television (CCTV) Systems
- F. National Fire Protection Association (NFPA):  
70-08 .....Article 780-National Electrical Code
- G. Federal Information Processing Standard (FIPS):  
140-2-02 .....Security Requirements for Cryptographic Modules
- H. Underwriters Laboratories, Inc. (UL):  
983-06 .....Standard for Surveillance Camera Units  
3044-01 .....Standard for Surveillance Closed Circuit Television  
Equipment

## **1.7 COORDINATION**

- A. Coordinate arrangement, mounting, and support of video surveillance equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  3. To allow right of way for piping and conduit installed at required slope.
  4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for video surveillance items that are behind finished surfaces or otherwise concealed.

## **1.8 WARRANTY OF CONSTRUCTION**

- A. Warrant 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. Pan/Tilt/Zoom (P/T/Z) cameras shall be color and are to be utilized to complement the fixed cameras.

3. Shall be powered by either 12 volts direct current (VDC) or 24 volts alternate current (VAC). Power supplies shall be Class 2 and UL compliant and have a back-up power source to ensure cameras are still operational in the event of loss of primary power to the VASS System..
4. 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.
5. Shall be rated for continuous operation under the environmental conditions listed in Part 1, Project Conditions.
6. Will be home run to a monitoring and recording device via a controlling device such as a matrix switcher or network server and monitored on a 24 hour basis at a designated Security Management System location.
7. 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.
8. 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.
9. Shall be programmed to digitally flip from color to black and white at dusk and vice versa at low light conditions.
10. Will be fitted with AI/DC lenses to ensure the image quality under different light conditions.
11. P/T/Z cameras shall be utilized in a manner that they complement fixed cameras and shall not be used as a primary means of monitoring activity.
12. Dummy or fake cameras will not be utilized at any time.
13. Appropriate signage shall be designed, provided, and posted that notifies people that an area is under camera surveillance.



14. Camera shall be Axis Network Camera #P3715-PLVE with accessories as required, or approved equal. Where camera cannot cover the degree of coverage, a second camera shall be provided to cover the full area of coverage.

## **2.3 DIGITAL BASED VIDEO MANAGEMENT SYSTEM**

### **A. Key Features**

1. Open Platform: Open API/SDK, supports seamless integration with third party applications.
2. Multi-server and multi-site video surveillance solution: Unlimited recording of video from IP cameras, IP video encoders and selected DVRs with analog cameras.
3. Optimized Recording Storage Management: Unique data storage and archiving solution that combines superior performance and scalability and cost efficient long-term video storage
4. Wide IP camera and device support: Supports connection of more than 839 IP cameras, IP video encoders and selected DVR models from over 79 different vendors through dedicated device integration
5. ONVIF™ and PSIA compliant: Supports ONVIF™ and PSIA compliant cameras and devices
6. Wide compression technology support: Supports the news compression methods; MPEG4 ASP, MxPEG and H.264, besides MJPEG and MPEG4
7. System configuration wizards: Guides the user through the process of adding cameras, configuring video and recording, adjustment of motion detection and user configuration
8. Sequence Explorer: Displaying sequences and time intervals in thumbnail pre-views, the Sequence Explorer gives unparalleled visual overview of recorded video combined with smooth navigation
9. Overlay buttons: Intuitive control of cameras, camera-integrated devices and other integrated systems- directly from the camera view

10. Independent Playback: Instant and independent playback function allows you to independently playback recorded video for one or more cameras, while in live viewing or playback mode
11. Built-in Video Motion Detection: Independent of camera model and supporting up to 64 cameras simultaneously per server
12. Multiple language support: Let operators use the system in their native language with support for 20 different languages
13. Multi-channel, two-way audio: Communicate with people at gates/entrances or broadcast messages to many people at once with multichannel, two-way audio
14. Fast evidence export: Quickly deliver authentic evidence to public authorities by exporting video to various formats, including video from multiple cameras with viewer, logs, and user notes included

B. Administration Features

1. Single Management Application: A new Management Application provides a consolidated single point management access to Recording Servers.
2. System configuration wizards: Guides the user through the process of adding cameras, configuring video and recording, adjustment of motion detection and user configuration.
3. Automated device discovery: Enables fast discovery of camera devices using methods such as Universal Plug And Play, Broadcast and IP Range scanning.
4. Smart bulk configuration option: Change settings across multiple devices simultaneously and in a very few clicks.
5. Adaptable application behavior: Guides novice users, while expert users can optimize the application for efficient use.
6. Export/import of system and user configuration data: System backup for reliable system operation and fast system recovery. System cloning for efficient rollout of multiple systems with the same, or similar, configuration.
7. Import of off-line configuration data: Enabling off-line editing of configuration data, including camera and device definitions.

8. Automatic system restore points: A 'Restore Point' is created each time a configuration change is confirmed.
9. Enables easy rollback to previously defined system configuration points and enables cancelation of undesired configuration changes and restoration of earlier valid configurations.

C. Integration Options

1. Open Software Development Kit (SDK) makes it possible to video enable your business processes, through seamless integration of third party applications, such as video analytics, access systems, etc.
2. Compatible with Central for alarm overviews and operational status in larger video surveillance installations.
3. Integrate with physical access control systems, alarms, gates, building management systems, etc. using hardware I/O, internal events and TCP/IP events
4. Create, import and use HTML pages for navigation between views or to trigger a Smart Wall preset
5. Develop third party plug-ins for the Smart Client to expand with new functionality

D. Server Modules

1. Recording Server
  - a. Simultaneous digital multi-channel video and audio recording and live viewing (relaying).
  - b. Two-way audio enables integrated control of microphones and speakers connected to IP devices.
  - c. Bandwidth optimized multi-streaming by splitting a single camera video stream to differentiated streams for live view and recording, where each can be optimized independently with respect to frame rate and resolution.
  - d. Connectivity to cameras, video encoders and selected DVRs supports MJPEG, MPEG4, MPEG4 ASP\*, H.264\* and MxPEG.
  - e. Auto-detect camera models during setup.
2. Flexible multi-site, multi-server license structure charged per camera.

3. Unlimited number of installed cameras; simultaneous recording and live view of up to 64 cameras per server.
4. Recording technology: secure high speed database holding JPEG images or MPEG4 and MxPEG streams including audio.
5. Recording speed: 30+ frames per second per camera, limited only by hardware.
6. Recording quality depends entirely on camera and video encoder capabilities: no software limitation.
7. Start cameras on live view requests from clients.
8. Unlimited recording capacity with multiple archives possible per day.
9. Hourly to daily database archiving with optional automatic move to network drive saves storage capacity on the local server – with images still available transparently for playback
10. Built-in, real-time, camera independent motion detection (VMD); fully adjustable sensitivity, zone exclusions, recording activation with frame rate speed up, and alert activation through email or SMS.
11. Start recording on event.
12. Client initiated start of recording based on pre-defined recording time and access privileges.
13. Pan Tilt Zoom (PTZ) preset positions, up to 50 per camera.
14. Absolute\* and relative PTZ positioning.
15. PTZ go-to preset position on events.
16. Combine PTZ patrolling and go-to positions on events.
17. Set multiple patrolling schedules per camera per day: i.e. different for day/night/weekend.
18. PTZ scanning on supported devices: viewing or recording while moving slowly between PTZ positions.
19. VMD-sensitive PTZ patrolling among selected presets allows sending of Wipe and Wash commands to supported PTZ models.

20. On pre-defined events Matrix remote commands are automatically sent to display live video remotely on computers running the Matrix Monitor or the Smart
21. Client with Matrix Plug-in.
  - a. Flexible notification (sound, e-mail and SMS) and camera patrolling scheduling, triggered by time or event.
- E. Recording Server Manager
  1. Local console management of the Recording Server accessible from the notification area.
  2. Start and stop Recording Server service.
  3. Access to Recording Server configuration settings.
  4. Access to Recording Server help system.
  5. View system status and log information.
- F. Image Server
  1. Remote access for Smart and Remote Clients.
  2. Built-in web server for download and launch of clients and plug-ins.
  3. Set up one Master and multiple Slave Servers.
  4. Authenticate access based on Microsoft Active Directory user account, or user name and password.
  5. Authorize access privileges per Microsoft Active Directory user account/group, user profile or grant full access.
  6. User profiles control access to: Live view, PTZ, PTZ presets, Output control, Events, Listen to microphone, Talk to speaker, Manual recording; Playback, AVI export, JPG export, DB export, Sequences, Smart Search and audio. As well as Set up views, Edit private views and Edit shared public views.
  7. Audit logs of exported evidence by user and file.
  8. Audit logs of client user activity by time, locations and cameras.
- G. Recording Viewer
  1. Playback recorded video and audio locally on the
- H. Recording Server.

1. View up to 16 cameras time-synched during playback.
2. Scrollable activity timeline with magnifying feature.
3. Instant search on recordings based on date/time and activity/alarm (Video Motion Detection).
4. 'Smart Search' for highlighted image zones and objects.
5. Evidence can be generated as a printed report, a JPEG image, an AVI film or in the native database format.
6. Export audio recordings in WAV or AVI format.
7. Export video digitally zoomed to view area of interest only and to minimize export footprint size.
8. Export 'Evidence CD' containing native database and Recording Viewer for instant, easy viewing by authorities.
9. Encryption & password protection option for exported recordings and files.
10. Ability to add comments to exported evidence, also encrypted.
11. Option to send email.
12. De-interlacing of video from analog cameras.
13. IPIX technology for PTZ in 360° recorded images.
- I. PDA Server
  1. Remote access for PDA Client.
  2. Handle login and session requests between PDA clients and Image Server.
  3. Resize video surveillance images to fit the screen layout of PDA Client.
- J. Smart Client Module
  1. Smart Client includes all the features of Remote Client plus more:
  2. Installed per default on Recording Server for local viewing and playback of video and audio.
  3. Start recording on cameras for a pre-defined time (default 5 minutes). Subject to privileges set by administrator.
  4. • Independent Playback capability allows for instant playback of recorded video for one or more cameras, while in live and playback mode

5. Live view digital zoom allows zoomed-out recordings while the operator digitally can zoom in to see details.
6. 'Update On Motion Only' optimizes CPU usage by letting motion detection control whether the image should be decoded and displayed or not. The visual effect is a still image in the view until motion is detected.
7. Shared and private camera views offer 1x1 up to 10x10 layouts in addition to asymmetric views.
8. Views optimized for both 4:3 and 16:9 screen ratios.
9. Multiple computer monitor support with a main window and any number of either windowed or full screen views.
10. Hotspot function for working in details with a camera selected from a view containing multiple cameras.
11. Carousel function allows a specified view to rotate between pre-defined cameras with individual timing and order with multiple appearances. Carousel function can be controlled allowing the operator to pause carousel function and to switch to previous or next camera.
12. Overlay buttons provides intuitive control of cameras, camera-integrated devices and other integrated systems- directly from the camera view
13. Matrix function to view live video from multiple cameras through the Image Server in any view layout with customizable rotation path, remotely controlled by Smart
14. Clients or Recording Servers sending Matrix remote commands
15. Send Matrix remote commands to display live video remotely on computers running the Matrix Monitor or the Smart Client with Matrix Plug-in.
16. Cameras' built-in audio sources available in live and in playback.
17. Separate pop-up window displaying sequences and time intervals in thumbnail pre-views, the Sequence Explorer gives unparalleled visual overview of recorded video combined with smooth navigation
18. Presents recorded sequences for individual cameras, or all cameras in a view
19. Seamlessly available in both Live and Playback modes

20. Smooth navigation with sliding preview and “drag-andthrow” function for video thumbnails
21. Instant playback of video sequences
22. Application Options allows users to adapt the layout and personalize the application to their particular preferences

K. Remote Client

1. View live video or playback recordings for 1-16 cameras simultaneously; from the same or different servers.
2. Advanced video navigation including fast/slow playback, jump to date/time, single step and video motion search.
3. Individual views can be user-defined in various layouts: view or playback camera images from multiple servers simultaneously in the same view.
4. Shared views can be managed centrally via the server with admin/user rights and user groups.
5. Import static or active HTML maps for fast navigation to cameras and good premise overviews.
6. Control output port relay operation, for example control of gates.
7. Quick overview of sequences with detected motion and preview window.
8. Quick overview of events/alerts.
9. Control PTZ cameras remotely, also using preset positions.
10. Remote PTZ Point-and-Click control
11. Remote PTZ zoom to a marked rectangle.
12. Take manual control over a PTZ camera that runs a patrolling scheme; after a timeout with no activity the camera reverts to its scheduled patrolling.
13. IPIX 1x2 or 2x2 ‘Quad View’ for viewing all 360° at once.
14. Optional video compression in streaming from server to client gives better use of bandwidth.
15. Create AVI files or save JPEG images.
16. Print incident reports with free-text user comments.



17. System logon using user name and password.
18. System logon using Microsoft Active Directory user accounts.

L. PDA Client

1. View live or playback video from a single server or from multiple servers in half-screen or full-screen formats.
2. In live view you can control Pan/Tilt/Zoom cameras manually or use preset positions, and control the cameras' output relays to trigger external actions like opening doors or gates, turning on lights, etc.
3. To find recordings, you can jump to specific time/date or to next detected motion, or use motion detection sequence overviews.
4. When viewing recordings, you can playback at variable speed or single step image by image.
5. The PDA client shall connect to the VMS server using any IP connection; typically wireless LAN, GPRS, etc.
6. Video compression from the server to PDA optimizes bandwidth usage.
7. System logon using user name and password.

M. Matrix Monitor

1. Virtual Matrix showing live video directly from up to 4 cameras at a time triggered remotely by Matrix remote commands.
2. Camera view shifts by FIFO (first-in-first-out)
3. Multiple events can control a single Matrix monitor and single events can control multiple monitors.

N. Minimum System Requirements VMS Server

1. HW Platform:
  - a. Minimum 2.4 GHz CPU and 1 GB RAM (2.4 GHz dual core processor and 2 GB RAM or more recommended).
  - b. Minimum 1 GB disk space available, excluding space needed for recordings.
2. OS:

- a. Microsoft® Windows® XP Professional (32 bit or 64 bit\*), Windows Server 2003 (32 bit or 64 bit\*), Windows Server 2008 R1/R2 (32 bit or 64 bit\*), Windows Vista™ Business (32 bit or 64 bit\*), Windows Vista Enterprise (32 bit or 64 bit\*), Windows Vista Ultimate (32 bit or 64 bit\*), Windows 7 Professional (32 bit or 64 bit\*), Windows 7 Enterprise (32 bit or 64 bit\*) and Windows 7 Ultimate (32 bit or 64 bit\*).
  3. Software:
    - a. Microsoft .NET 3.5 Framework SP1, or newer.
    - b. DirectX 9.0 or newer required to run Playback Viewer application.
- O. Minimum System Requirements PDA Server
1. HW Platform:
    - a. Minimum 2.4 GHz CPU and 1 GB RAM (2.4 GHz dual core processor and 2 GB RAM or more recommended).
    - b. Minimum 1 GB disk space available.
  2. OS:
    - a. Microsoft Windows XP Professional (32 bit or 64 bit\*), Windows Server 2003 (32 bit or 64 bit\*).
  3. Software:
    - a. Microsoft .NET 2.0 (not compatible with newer versions). Internet Information Server (IIS) 5.1.
- P. Minimum System Requirements VMS Client
1. HW Platform:
    - a. Minimum 2.4 GHz CPU, 1 GB RAM (more powerful CPU and higher RAM recommended for Smart Clients running high number of cameras and multiple views and displays).
  2. Graphics Card:

- a. AGP or PCI-Express, minimum 1024 x 768 (1280 x 1024 recommended), 16 bit colors.
- 3. OS:
  - a. Microsoft Windows XP Professional (32 bit or 64 bit\*), Windows Server 2003 (32 bit or 64 bit\*), Windows Server 2008 R1/R2 (32 bit or 64 bit\*), Windows Vista Business (32 bit or 64 bit\*), Windows Vista Enterprise (32 bit or 64 bit\*), Windows Vista Ultimate (32 bit or 64 bit\*), Windows 7 Professional (32 bit or 64 bit\*), Windows 7 Enterprise (32 bit or 64 bit\*) and Windows 7 Ultimate (32 bit or 64 bit\*).
- 4. Software:
  - a. DirectX 9.0 or newer required to run Playback Viewer application.
  - b. Microsoft .NET 3.5 Framework SP1, or newer.
- Q. Minimum System Requirements VMS Remote Client
  - 1. HW Platform:
    - a. Minimum 2.4 GHz CPU, RAM 1 GB (2 GB or higher recommended on Microsoft Windows Vista).
  - 2. OS:
    - a. Microsoft Windows XP Professional (32 bit or 64 bit\*), Windows Server 2003 (32 bit or 64 bit\*), Windows Server 2008 R1/R2 (32 bit or 64 bit\*), Windows Vista Business (32 bit or 64 bit\*), Windows Vista Enterprise (32 bit or 64 bit\*) and Windows Vista Ultimate (32 bit or 64 bit\*), Windows 7 Professional (32 bit or 64 bit\*), Windows 7 Enterprise (32 bit or 64 bit\*) and Windows 7 Ultimate (32 bit or 64 bit\*).
  - 3. Software:
    - a. DirectX 9.0 or newer required to run Playback Viewer Application Microsoft Internet Explorer 6.0, or newer, 32 bit version required
- R. Licensing Structure
  - 1. Base Server License

- a. An VMS Base Server license is mandatory for installing the product.
- 2. The Base Server license contains:
  - a. Unlimited numbers of Recording Server licenses
  - b. Unlimited numbers of Smart Clients, Remote Clients, PDA Clients and Matrix Monitor licenses
- 3. Camera License
  - a. To connect to a camera, a Device License per camera channel is required
  - b. In total, for all copies of the product installed under a given Base Server license, the product may only be used with as many cameras as you have purchased camera licenses for • Video encoders and DVRs with multiple analog cameras require a license per channel to operate
  - c. Camera Licenses can be purchased in any numbers. To extend the installation with additional Camera Licenses, the Base Server License number (SLC) is required when ordering.
- 4. Client License:
  - a. All client modules are not licensed and can be installed and used on any number of computers.
- S. IP NETWORK DECODER
  - 1. The unit shall be used for video monitoring and surveillance over IP networks. Network decoder shall decode MPEG-4 digital video to analog video.
  - 2. The decoder shall use MPEG-4 compression for efficient distribution of images over a network.
  - 3. The decoder shall be available as a standalone unit that can be horizontally or vertically mounted.
  - 4. The decoder shall include, but not be limited to the following:
    - a. The decoder shall use “hybrid” technology in providing both analog and network connections with the purpose of allowing users to integrate existing equipment and digital IP products.
      - 1) The decoder shall provide one composite video input and output connection.

- 2) The decoder shall provide one Ethernet connection.
- b. The decoder shall have the following digital resolution:
  - 1) D1: 720x576 (NTSC); 720x480 (PAL)
  - 2) CIF: 352 x 288 (NTSC); 352 x 240 (PAL)
  - 3) QCIF: 160 x 144 (NTSC); 160 x 112 (PAL)
- c. The decoder shall have a digital frame rate of up to 30 frames per second (NTSC) at 720x480 resolution or 25 fps (PAL) at 720x586 resolution.
- d. The decoder shall use the following protocols:
  - 1) TCP/IP
  - 2) UDP/IP
  - 3) DHCP
  - 4) Multicast
  - 5) Data Throttle
  - 6) Heart beat
- e. The decoder shall have the following connectors:
  - 1) Power connector: 3-pin male – for connecting the external power supply
  - 2) I/O connector: 16-pin male – for connecting alarm, audio, RS-232, RS-485 input and output
  - 3) Video I/O connector: SVHS style – for input and output connection of two composite monitors
  - 4) Ethernet port: RJ-45 – for connecting to a network
- f. The decoder shall have the following indicators:
  - 1) Power LED
  - 2) Link – indicates activity on the Ethernet port
  - 3) Tx activity
  - 4) Rx activity
5. The decoder shall have the following additional specifications:
  - a. Video
    - 1) Video signal output: 1 V p-p into 75 ohms

- 2) Input termination: 75 ohm
- 3) Video compression standard: MPEG-4
- 4) Audio compression standard: MPEG-1 Layer 2
- b. Audio
  - 1) Audio input: 315 mV, 40 kOhms, unbalanced
  - 2) Audio output: 315 mV, 600 ohms, unbalanced
- c. Electrical
  - 1) External power supply: 100 to 240 VAC
  - 2) Output voltage: 13.5 V, 1.33 A
  - 3) Power consumption: 0.5 W maximum

## 2.4 VIDEO DISPLAY EQUIPMENT

### A. Video Display Equipment

- 1. Will consist of color monitors and shall be EIA 375A compliant.
- 2. Shall be able to display analog, digital, and other images in either NTSC or MPEG format associated with the operation of the Security Management System (SMS).
- 3. Shall:
  - a. Have front panel controls that provide for power on/off, horizontal and vertical hold, brightness, and contrast.
  - b. Accept multiple inputs, either directly or indirectly.
  - c. Have the capabilities to observe and program the VASS System.
  - d. Be installed in a manner that they cannot be witnessed by the general public.

### B. Color Video Monitors Technical Characteristics:

Sync Format	PAL/NTSC
Display Tube	90° deflection angle
Horizontal Resolution	250 TVL minimum, 300 TVL typical
Video Input	1.0 Vp-p, 75 Ohm
Front Panel Controls	Volume, Contrast, Brightness, Color
Connectors	BNC

- C. Liquid Crystal Display (LCD) Flat Panel Display Monitor
- D. The 17-inch color LCD monitor shall have a flat screen and 17-inch diagonal viewing area and consists of an LCD panel, bezel, and stand.
- E. The monitor shall meet or exceed the following specifications:
  - 1. The monitor shall incorporate a 17.1-inch active matrix TFT LCD panel.
    - a. The pixel pitch of the monitor's LCD panel shall be 0.264 mm horizontal and 0.264 mm vertical.
    - b. The monitor shall have a maximum resolution of 500television lines.
    - c. The contrast ratio shall be 500:1.
    - d. The typical brightness shall be 250 cd/m<sup>2</sup>
    - e. The monitor shall display at least 16.7 million colors.
    - f. The light source for the LCD panel shall have a lifetime of 50,000 hours.
    - g. The scan frequency horizontal shall be 30 K to 80 KHz and the scan frequency vertical shall be 56 to 75 Hz.
    - h. The viewing angle for the monitor shall be 170 degrees horizontal and 170 degrees vertical.
  - 2. The monitor shall have automatic NTSC or PAL recognition.
  - 3. The monitor shall have a picture-in-picture function.
  - 4. The monitor shall use the following signal connectors:
    - a. Video 1.0 V peak-to-peak at 75 ohms
    - b. BNC in/out
    - c. Y/C (S-video) in/out
    - d. Audio in/out
    - e. VGA 15-pin D-Sub
  - 5. The monitor shall have twoaudio speaker(s).
    - a. The speaker shall be 0.5 W minimum.
  - 6. The monitor shall have the following front control panel buttons:

- a. Power on/off
  - b. LED indicator
  - c. Mode
  - d. Increase (volume)
  - e. Decrease (volume)
  - f. Up (contrast adjustment)
  - g. Down (brightness adjustment)
  - h. Menu
  - i. Auto
7. The monitor shall have the following options for adjustment in an onscreen display menu:
- a. Color
  - b. Tint
    - 1) NTSC mode only
      - a) Brightness
      - b) Contrast
      - c) Sharpness
      - d) Volume
      - e) Language
      - f) Scan
      - g) Color Temp
      - h) H-Position
      - i) Recall
- F. The electrical specifications for the monitor shall be as follows:
- 1. Input voltage shall be 12 VDC/3 A.
  - 2. Power consumption shall be 50 W maximum.
- G. The environmental specifications for the monitor shall be as follows:
- 1. Operating temperature shall be 32 to 104 degrees Fahrenheit or 0 to 40 degrees Celsius.



2. Operating humidity shall be 10 to 85 percent.
- H. The physical specifications for the monitor shall be as follows:
  - I. The monitor shall conform to these compliance standards:
    1. FCC
    2. CE (EMC/LVD)3. UL

## **2.5 CONTROLLING EQUIPMENT**

- A. Shall be utilized to call up, operate, and program all cameras associated VASS System components.
- B. Will have the ability to operate the cameras locally and remotely. A matrix switcher or a network server shall be utilized as the VASS System controller.
- C. The controller shall be able to fit into a standard 47.5 cm (19 inch) equipment rack.
- D. Control and programming keyboards shall be provided with its own type of switcher. All keyboards shall:
  1. Be located at each monitoring station.
  2. Be addressable for programming purposes.
  3. Provide interface between the operator and the VASS System.
  4. Provide full control and programming of the switcher.
  5. Have the minimum following controls:
    - a. programming
    - b. switching
    - c. lens function
    - d. P/T/Z
    - e. environmental housing
    - f. annotation

## **2.6 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 a 1/3-inch image sensor 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.
3. The camera shall optimize each pixel independently.
4. The camera shall have onscreen display menus for programming of the camera's settings.
5. 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.
- H. 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 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	3-6mm
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 mounting adapters as required for installation:
  - a. Surface mount adapter
  - b. Wall mount adapter
  - c. Flush mount adapter
12. Video camera shall be Axis Network Camera #P3715-PLVE with accessories as required, or approved equal. Where camera cannot cover the degree of coverage, a second camera shall be provided to cover the full area of coverage.

## 2.8 POWER SUPPLIES

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

## 2.10 NETWORK SERVER

- A. Allow for the transmission of live video, data, and audio over either an existing Ethernet network or a dedicated security system network, requiring an IP address or Internet Explorer 5.5 or higher, or shall work as an analog-to-Ethernet “bridge” controlling matrices, multiplexers, and pan/tilt/zoom cameras. The network shall operate in a box-to-box configuration allowing for encoded video to be decoded and displayed on an analog monitor.
- B. If a VASS System network is going to be utilized as the primary means of monitoring, operating, and recording cameras then the following equipment shall be required as part of the system:
  - 1. System Server
  - 2. Computer Workstation
  - 3. Recording Device

4. Encoder/Decoder
  5. Monitor
  6. Hub/Switch
  7. Router
  8. Encryptor
- C. Shall provide overall control, programming, monitoring, and recording of all cameras and associated devices within the VASS System.
- D. All equipment on the network shall be IP addressable.
- E. The VASS System network shall meet or exceed the following design and performance specifications:
1. Two MPEG-4 video streams for a total of 40 images per second will be provided.
  2. PC Software that manages the installation and maintenance of all hardware transmitters and receivers on the network shall be provided.
  3. Video Source that supports any NTSC video source to the computer network shall be addressed.
  4. Receivers that could be used to display the video on a standard analog NTSC or PAL monitor will be addressed.
- F. The system shall support the following network protocols:
1. Internet connections: RTP, Real Time Control Protocol (RTCP), UDP, IP, TCP, ICMP, HTTP, Simple Network Management Protocol (SNMP), IGMP, DHCP, and ARP.
  2. Video Display: MPEG-4, M-JPEG in server push mode only.
  3. Have the ability to adjust bandwidth, image quality and image rate.
  4. Support image sizes of either 704 x 576 pixels or 352 x 288 pixels.
  5. Have an audio coding format of G.711 or G.728.
  6. Provide a video frame rate of at least 30 images per second.
  7. Support LAN Interface Ethernet 10/100BaseT and be auto sensing.
  8. Have a LAN Data Rate of 9.6 Kbps to 5.0 Mbps.
  9. Utilize data interface RS-232/RS-422/RS-485.

- G. All connections within the system shall be via CAT-5 cable and RJ-45 jacks. If analog equipment is used as part of the system, then either an encoder or a decoder will be utilized to convert the analog signal to a digital one.
- H. The VASS network system shall conform to all VA agency wide security standards for administrator and operator use.
- I. Server Technical Characteristics:

Hardware	Personal Computer
CPU	Pentium IV, 3.0 GHz or better
Hard Disk Interface	IDE or better
RAM	256 MB
OS	Windows XP Home/XP Professional
Graphic Card	NVIDIA GeForce 6600      NVIDIA Quadro FX 1400      ATI RADEON X600/X800 or better
Ethernet Card	100 Mb
Software	DirectX 9.0c
Free Memory	120 MB

- J. Network Switch Technical Characteristics

Protocol and standard	IEEE802.3 IEEE802.3u IEEE802.3ab
Ports	24 10/100/1000M auto-negotiation RJ-45 ports with auto MDI/MDI-X
Network media	Cat 5 UTP for 1,000Mbps   Cat 3 UTP for 10Mbps
Transmission method	store-and-forward
LED	indicator power, act/link, speed

- K. Router Technical Characteristics

Network Standards	IEEE 802.3, 802.3u      10Base-T Ethernet (WAN)      100Base-T Ethernet (LAN)      IEEE 802.3x Flow Control      IEEE802.1p Priority Queue      ANS/IEEE 802.3 NWay auto- negotiation
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Protocol	CSMA/CD, TCP, IP, UDP, PPPoE, AND DHCP (client and server)
VPN Supported	PPTP, IPSec pass-through
Management	Browser
Ports	4 x 10/100Base-T Auto sensing RJ45 ports, and an auto uplink RJ45port(s) 1 x 10Base-T RJ45 port, WAN
LEDs	Power, WAN Activity, LAN Link (10/100), LAN Activity

L. Encryptor Technical Characteristics:

Cryptography	Standard - Triple DES 168-bit (ANSI 9.52) Rijndael - AES (128, 192, 256)
Performance	Throughput (end-to-end) @ 100 Mbps line speed: >188 Mbps full duplex (large frames) >200 kfps full duplex (small frames) Latency (end-to-end) @ 100 Mbps
Key Management	Automatic KEK/DEK Exchange Using Signed Diffie-Hellman Unit Authentication Using X.509 Certificates
Physical Interfaces	10BaseT or 10/100BaseT Ethernet (Host and Network Ports) 10BaseT Ethernet Management Port Back and Front-Panel Serial Control Port
Device Management	THALES Element Manager, Front Panel Viewer, and Certificate Manager 10Base T (RJ-45) or 9-pin Serial Control Port SNMP Network Monitoring
Security Features	Tamper Proof Cryptographic Envelope Tamper Evident Chassis Hardware Random Number Generator
Management	Channel Encrypted Using Same Algorithm as Data Traffic
Security Certifications	FIPS 140-2 Level 3 CAPS Baseline and Enhanced Grades Common Criteria EAL4 and EAL5 (under evaluation)
Regulatory	EN60950, FCC, UL, CE, EN 50082-1, and EN

	55022
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## 2.11 RECORDING DEVICES

- A. All cameras on the VASS System shall be recorded in real time using a Digital Video Recorder (DVR), Network Video Recorder (NVR), or attached storage. The type of recording device utilized should be determined by the size and type of VASS System designed and installed, and to what extent the system is to be utilized.
- B. All recording devices shall be 47.5 cm (19 inch) rack-mountable.
- C. All DVR's and NVR's that are viewable over an Intranet or Internet will be routed through an encryptor.
- D. Encryptors shall:
  - 1. Comply with FIPS PUB 140-2.
  - 2. Support TCP/IP.
  - 3. Directly interfaces to low-cost commercial routers.
  - 4. Provide packet-based crypto synchronization.
  - 5. Encrypt source and destination IP addresses.
  - 6. Support web browser based management requiring no additional software.
  - 7. Have a high data sustained throughput — 1.544 Mbps (T1) full duplex data rate.
  - 8. Provide for both bridging and routing network architecture support.
  - 9. Support Electronic Key Management System (EKMS) compatible.
  - 10. Have remote management ability.
  - 11. Automatically reconfigure when secure network or wide area network changes.
- E. Digital Video Recorder (DVR)
  - 1. Shall record video to a hard drive-based digital storage medium in either NTSC or MPEG format.
  - 2. Shall meet the following minimum requirements:
    - a. Record at minimum rate of 30 images per second (IPS).
    - b. Have a minimum of eight (8) to 16 looping inputs.
    - c. Have a minimum of eight (8) to 16 alarm inputs and two (2) relay outputs.



- d. Shall provide instantaneous playback of all recorded images.
  - e. Be IP addressable, if part of a VASS network.
  - f. Have built-in digital motion detection with masking and sensitivity adjustments.
  - g. Provide easy playback and forward/reverse search capabilities.
  - h. Complete audit trail database, with minimum of a six-month history that tracks all events related to the alarm; specifically who, what, where and when.
  - i. DVR management capability providing automatic video routing to a back-up spare recorder in case of failure.
  - j. Accessible locally and remotely via the Internet, Intranet, or a personal digital assistant (PDA).
  - k. Records all alarm events in real time, ensuring 60 seconds before and after the event are included in the recording.
  - l. Utilize RS-232 or fiber optic connections for integration with the SMS computer station via a remote port on a network hub.
  - m. Allow for independently adjustable frame rate settings.
  - n. Be compatible with the matrix switcher utilized to operate the cameras. The DVR could be utilized as a matrix switcher only if it meets all of the requirements listed in the matrix switcher section.
3. Technical Characteristics:

Compression	MPEG-4
Internal Storage Capacities.	[160] GB, [320] GB, [500] GB, [1] TB, and 2 TB. Available USB hard drive up to 250 GB. Optional internal DVD available
Digital Recording	Up to 8 video and 4 audio channels.
Full real-time video recording	Up to 400 IPS@352 x 288: PAL Up to 200 IPS@352 x 288: PAL
Multiple simultaneous functions	Live viewing, Recording, playback, network transmission, back-up
Search functions	Date/time search, event search, bookmark search, smart (pixel) Search

PTZ Control	Third party PTZ control
User ID security	3 levels
Connectivity to external devices:	<p>Eight [8] or sixteen [16] video input and looping output channels.</p> <p>VGA and dual monitor BNC outputs.</p> <p>Four [4] or eight [8] audio inputs and one [1] audio output.</p> <p>Ethernet 10/100BaseT network connection.</p> <p>Eight [8] to sixteen [16] alarm inputs and four [4] or eight [8] relay outputs.</p> <p>Biphase connection to control Bosch PTZ cameras.</p> <p>Third party PTZ control via RS-422/RS-485 connection.</p> <p>Front and back USB connectors to connect to a PC mouse, or archive video to a USB memory stick or similar device.</p>
PC requirements	<p>Windows 2000 or above; DirectX 8.1 or above.</p> <p>Intel Pentium III or above, AMD Athlon with 800 MHz or faster CPU.</p> <p>512 MB or more RAM.</p> <p>50 MB hard drive.</p> <p>AGP VGA with 64 MB video RAM or above.</p> <p>10/100-BaseT network interface.</p>
Electrical	<p>Power Input: 100 to 240 VAC; 50/60 Hz</p> <p>Power consumption: [120W]</p> <p>Max. [1.2] A</p>
Video	<p>Video standard: PAL or NTSC selectable.</p> <p>Resolution: 704 x 576 PAL, 704 x 480 NTSC</p> <p>Compression: MPEG-4</p> <p>Inputs: 8 or 16 composite video 0.5-2 Vpp, 75 Ohm automatic termination.</p> <p>Outputs 8 or 16 composite video 1 Vpp, 75 Ohm.</p>
Audio	<p>Inputs: 4 or 8 line in, 30 kOhm</p> <p>Output: 1 line, 100 kOhm</p>

Monitors	VGA: analog RGB 800x600 MON A: CVBS 1 Vpp@0.1 V, 75 Ohm, BNC Monitor A multi-screen (VGA or CVBS) MON B: CVBS 1 Vpp@0.1 V, 75 Ohm, BNC Monitor B spot/alarm
Frame Rate and Resolution	[16]-channels PAL: Up to 400 IPS@352x288, up to 200 IPS@704x288, up to 100 IPS@704x576.
Alarm inputs	[8] [16] configurable NO/NC, max. input 5 VDC.
Alarm outputs	[4] or [8] relay outputs, configurable NO/NC, max. rated 1A, 125 VAC.
Connections	Ethernet: RJ45 modular jack 8 pins shielded, 10/100 Base-T. Biphase: Screw terminal connector (5 outputs). Maximum 5 controllable cameras per Biphase output. PTZ control interfaces: RS485/RS422. Serial interface: RS232 output signal, DB9 male connector Keyboard: RJ11 modular jack 6 pins
Network:	Transmission speed: up to 120 IPS@352x240 Bandwidth control: Automatic Remote users: Maximum 5 simultaneous connected Control Center users.

Processor	Intel Pentium III 750 MHz
Memory	256 MB RAM
Operating System	Windows 98, NT, ME, 2000, and XP
Video Card	4 MB of RAM capable of 24-bit true color display
Free Hard Disk Space	160 MB for software installation
Network Card	10Base-T network for LAN operation
Archiving	80 GB, 160 GB, 320 GB and 640 GB Hard Drive; CD-RW
Video Input	1.0 Vpp (signal 714mV, sync 286mV) 75 ohms

	(BNC unbalanced)
Video Output Level	1.0 Vpp +/-10%,75 ohms(BNC unbalanced)
Impedance	75 ohms/Hi- impedance x 16 switchable
Network Interface	Ethernet (RJ-45, 10/100M)
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/P/T/Z control
Recording Rate	30 ips for 720 x 240 (NTSC)
Password Protection	Menu Setup, Remote Access
Recording Capacity	160 (1 or 2 fixed HDD) 1 CD-RW
Power Interrupt	Auto recovered to recording mode

F. Network Video Recorder (NVR)

1. Shall record video to a hard drive-based digital storage medium in MPEG, MPEG4 or H.264 format.
2. Shall meet the following minimum requirements:
  - a. Record at minimum rate of 30 IPS.
  - b. Have a minimum of eight (8) to 16 looping inputs.
  - c. Have a minimum of eight (8) to 16 alarm inputs and two (2) relay outputs.
  - d. Shall provide instantaneous playback of all recorded images.
  - e. Be IP addressable, if part of a VASS network.
  - f. Have built-in digital motion detection with masking and sensitivity adjustments.
  - g. Easy playback and forward/reverse search capabilities.
  - h. Complete audit trail database, with minimum of a six-month history that tracks all events related to the alarm; specifically who, what, where and when.
  - i. NVR management capability providing automatic video routing to a back-up spare recorder in case of failure.
  - j. Accessible locally and remotely via the internet, intranet, or a personal digital assistant (PDA).
  - k. Records all alarm events in real time, ensuring 60 seconds before and after the event are included in the recording.

- l. Utilize RS-232 or fiber optic connections for integration with the SMS computer station via a remote port on a network hub.
  - m. Allow for independently adjustable frame rate settings.
  - n. Be compatible with the matrix switcher utilized to operate the cameras.
3. Technical Characteristics:

Hardware/CPU	Pentium III Xeon or IV, 1.8 GHz
HDD Interface	IDE or better; optional: SCSI II, SCSI Ultra, or Fiber Channel
RAM	1024 MB
Operating System	Windows 2000/XP Professional/Server 2003 Standard
Graphic	Card VGA
Ethernet Card	100/1000 MB
Memory	20 MB
Software Setup	Centralized setup from each authorized PC; access via integrated web server
Storage Media	All storage media possible (e.g., HD, RAID), depending on operating system
Storage Mode	Linear mode, ring mode (capacity-based)
Recording Configuration	Camera name assignment, bandwidth limit, frame rate, video quality
Recording Content	Video and/or audio data
Search Parameters	Time, date, event
Playback	Playback via any IP network (LAN/WAN) simultaneous recording, playback, and backup
Network Interface	Ethernet (RJ-45, 10/100M)
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/P/T/Z control
Recording Rate	30 ips for 720 x 240 (NTSC)
Password Protection	Menu Setup, Remote Access
Recording Capacity	160 (1 or 2 fixed HDD) 1 CD-RW
Power Interrupt	Auto recovered to recording mode

## 2.12 WIRES AND CABLES

- A. Shall meet or exceed the manufactures recommendation for power and signal.
- B. Will be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, 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 than 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.
- J. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within 1 m. (3 ft.) of

the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:

1. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 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. Coaxial Cables
1. All video signal cables for the VASS System, with exception to the PoE cameras, shall be a coaxial cable and have a characteristic impedance of 75 ohms plus or minus 3 ohms.
  2. For runs up to 750 feet use of an RG-59/U is required. The RG-59/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 23 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
  3. For runs between 750 feet and 1250 feet, RG-6/U is required. RG-6/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 18 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
  4. For runs of 1250 to 2750 feet, RG-11/U is required. RG-11/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 14 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
  5. All runs greater than 2750 feet will be substituted with a fiber optic cable. If using fiber optics as a signal carrier then the following equipment will be utilized:
    - a. Multimode fiber optic cable a minimum size of 62 microns

- b. Video transmitter, installed at the camera that utilizes 12 VDC or 24 VAC for power.
  - c. Video receiver, installed at the switcher.
6. RG-59/U Technical Characteristics

AWG	22
Stranding	7x29
Conductor Diameter	.031 in.
Conductor Material	BCC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.145 in.
Outer Shield Type	Braid/Braid
Outer Jacket Material	PVC
Overall Nominal Diameter	.242 in.
UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.094 $\mu$ H/ft
Nom. Capacitance	Conductor to Shield 17.0 pF/ft
Nom. Velocity of Propagation	80 %
Nom. Delay	1.3 ns/ft
Nom. Conductor DC Resistance @ 20°C	12.2 Ohms/1000 ft
Nom. Outer Shield DC Resistance @ 20°C	2.4 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

7. RG-6/U Technical Characteristics:

AWG	18
Stranding	7x27



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

8. RG-11/U Technical Characteristics:

AWG	15
Stranding	19x27
Conductor Diameter	.064 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.312 in.
Inner Shield Type	Braid
Inner Shield Material	BC - Bare Copper
Inner Shield %Coverage	95 %
Inner Jacket Material	PE – Polyethylene
Inner Jacket Diameter	.391 in.

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

9. Signal Cables:

- a. Signal wiring for PoE cameras depends on the distance the camera is being installed from either a hub or the server.
- b. If the camera is up to 300 ft from a hub or the server, then use a shielded UTP category 5 (CAT-V) cable 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-5 Technical Characteristics:

Number of Pairs	4
Total Number of Conductors	8

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

10. Fiber Optic Cables Technical Characteristics:

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

Numerical Aperture	.275
Maximum Gigabit Ethernet	300 meters
Maximum Gigabit Ethernet	550 meters

#### 11. Power Cables

- a. Will be sized accordingly and shall comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket. Low voltage cables will be a minimum of 18 AWG, stranded and non-conductive polyvinylchloride (PVC) jacket.
- b. Will be utilized for all components of the 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 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 integration purposes, the VASS System shall be integrated where appropriate with the following associated security subsystems:
1. PACS:
    - a. Provide 24 hour coverage of all entry points to the perimeter and agency buildings, as well as all emergency exits utilizing a fixed color camera.
    - b. Record cameras on a 24 hours basis.

- c. Be programmed go into an alarm state when an emergency exit is opened, and notify the Physical Access Control System and Database Management of an alarm event.
- 2. IDS:
  - a. Provide a recorded alarm event via a color camera that is connected to the IDS system by either direct hardwire or a security system computer network.
  - b. Record cameras on a 24 hours basis.
  - c. Be programmed to go into an alarm state when an IDS device is put into an alarm state, and notify the PACS.
  - d. For additional VASS System requirements as they relate to the IDS, refer to Section 28 16 00 "INTRUSION DETECTION".
- 3. Security Access Detection:
  - a. Provide full coverage of all vehicle and lobby entrance screening areas utilizing a fixed color camera.
  - b. Record cameras on a 24 hours basis.
  - c. The VASS System should have facial recognition software to assist in identifying individuals for current and future purposes.
- 4. EPPS:
  - a. Provide a recorded alarm event via a color camera that is connected to the EPPS system by either direct hardwire or a security system computer network.
  - b. Record cameras on a 24 hours basis.
  - c. Be programmed to go into an alarm state when an emergency call box or duress alarm/panic device is activated, and notify the Physical Access Control System and Database Management of an alarm event.
- F. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.
- G. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.

- H. A complete VASS System shall be comprised of, but not limited to, the following components:
1. Cameras
  2. Lenses
  3. Video Display Equipment
  4. Camera Housings and Mounts
  5. Controlling Equipment
  6. Recording Devices
  7. Wiring and Cables
- I. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.
- J. Existing Equipment
1. The Contractor shall connect to and utilize existing 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.
- K. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.
- L. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.
- M. 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.

N. 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.

O. Monitors:

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

P. Switcher:

1. Install the switcher as shown in the design and construction documents, and according to the OEM.
2. Connect all subassemblies as specified by the manufacturer and as shown.
3. Connect video signal inputs and outputs as shown and specified; terminate video inputs as required.
4. Connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown.
5. Connect the switcher CPU and switcher subassemblies to AC power.

6. Load all software as specified and required for an operational VASS System configured for the site and building requirements, including data bases, operational parameters, and system, command, and application programs.
7. Provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test.
8. Program the video annotation for each camera.

Q. Video Encoder/Decoder

1. Install the Video Encoder/Decoder per design and construction documents, and as specified by the OEM.
2. Connect analog camera inputs to video encoder.
3. Connect network camera to video decoder.
4. Connect video encoder to VASS network.
5. Connect video decoder to video matrix, DVR, monitor etc.
6. Connect unit to AC power (UPS).
7. Configure the video encoder/decoder per manufacturer's recommendation and project requirements.

R. Video Server:

1. Install the video server per design and construction documents, and as specified by the OEM.
2. Connect video server to AC power (UPS).
3. Connect to VASS network.
4. Install operating system and Video Management Software.
5. Provide Video Management Software programming per VA guidance and the requirements provided by the Owner. Programming shall include:
  - a. Camera names
  - b. Screen views
  - c. Camera recording schedules (continuous and event) driven recording. Events include alarms from other systems (sensors), manual input, and video motion detection.

- d. Video detection zones for each camera requiring video motion detection
- e. Alarm interface
- f. Alarm outputs
- g. GUI maps, views, icons and actions
- h. PTZ controls (presets, time schedules for privacy zones etc.)
- i. Reports

S. Video Workstation:

1. Install the video workstation per design and construction documents, and as specified by the OEM.
2. Connect video workstation to AC power (UPS).
3. Connect to VASS network.
4. Install operating system and application software.
5. Provide application software programming per VA guidance and the requirements provided by the Owner. Programming shall include:
  - a. Screen views
  - b. Graphical User Interface (GUI) maps, views, icons and actions
  - c. Alarm outputs
  - d. Reports

T. Network Switch:

1. Install the network switch per design and construction documents, and as specified by the OEM.
2. Connect network switch to AC power (UPS).
3. Connect network cameras to network switch.
4. Configure the network switch per manufacturer's recommendation and project requirements.

U. Network Recording Equipment

1. Install the NVR or video storage unit as shown in the design and construction documents, and as specified by the OEM.
2. Connect recording device to AC power (UPS).

3. Connect recording device to network switch as shown and specified.
4. Configure network connections
5. Provide recording unit programming per VA guidance and the requirements provided by the Owner. Programming shall include:
  - a. Camera names
  - b. Screen views
  - c. Camera recording schedules (continuous and event) driven recording. Events include alarms from other systems (sensors), manual input, and video motion detection.
  - d. Video detection zones for each camera requiring video motion detection
  - e. Alarm interface
  - f. Alarm outputs
  - g. GUI maps, views, icons and actions
  - h. PTZ controls (presets, time schedules for privacy zones etc.)
  - i. Reports

V. Video Recording Equipment:

1. Install the video recording equipment as shown in the design and construction documents, and as specified by the OEM.
2. Connect video signal inputs and outputs as shown and specified.
3. Connect alarm signal inputs and outputs as shown and specified.
4. Connect video recording equipment to AC power.
5. Program the video recording equipment;
  - a. Recording schedules
  - b. Camera caption

W. Video Signal Equipment:

1. Install the video signal equipment as shown in the design and construction documents, and as specified by the OEM.
2. Connect video or signal inputs and outputs as shown and specified.
3. Terminate video inputs as required.

4. Connect alarm signal inputs and outputs as required.
5. Connect control signal inputs and outputs as required
6. Connect electrically powered equipment to AC power.

X. 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 Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.
- C. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

### **3.4 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL**

- A. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed 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**

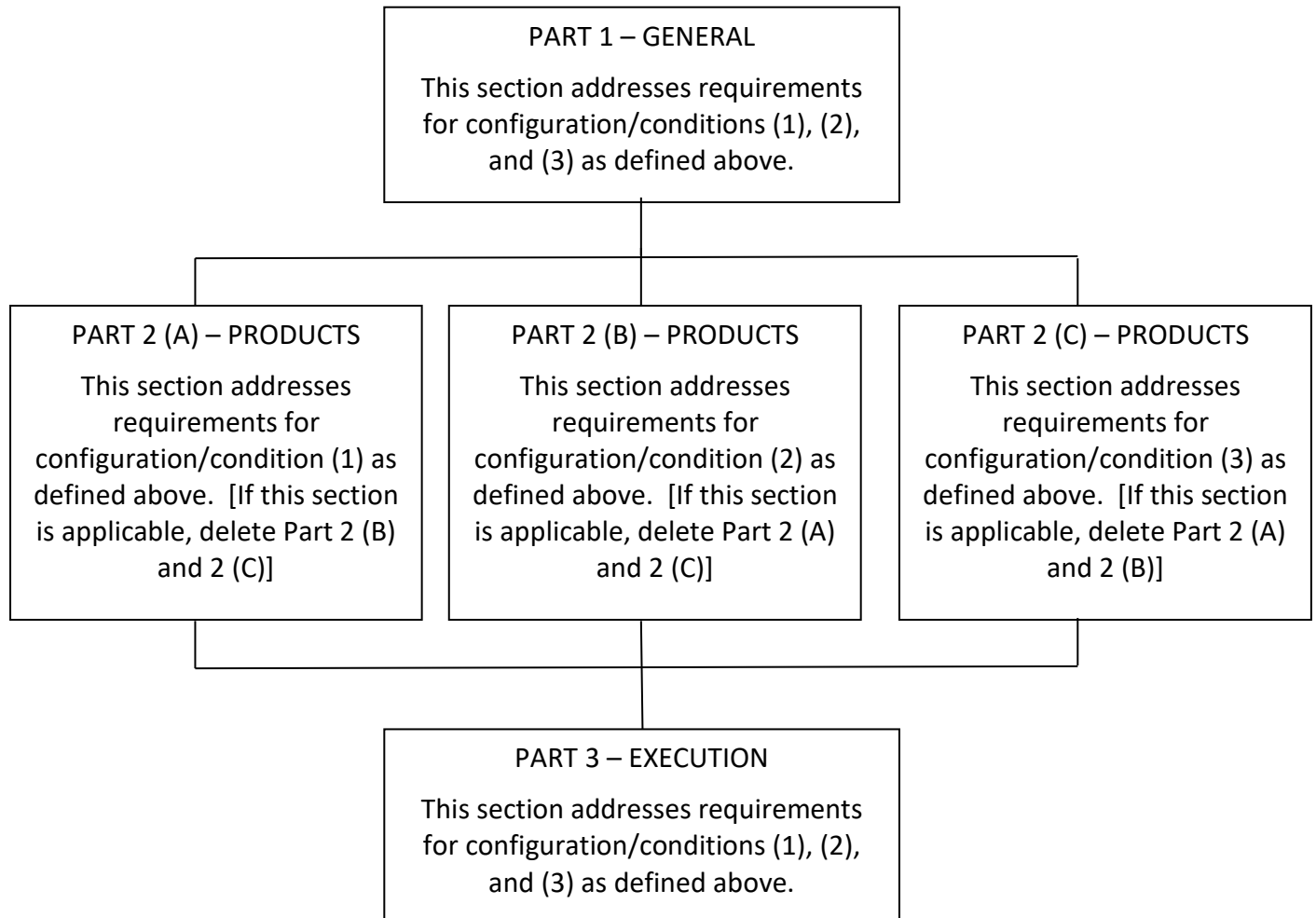
- A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, “GENERAL REQUIREMENTS”.

- B. Provide services of manufacturer's technical representative for [four] <insert hours> 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 28 31 00**  
**FIRE DETECTION AND ALARM**



## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. This section of the specifications includes the furnishing, installation, and connection of the fire alarm equipment to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control units, fire safety control devices, annunciators, power supplies, and wiring as shown on the drawings and specified. The fire alarm system shall not be combined with other systems such as building automation, energy management, security, etc.
- B. Fire alarm systems shall comply with requirements of the most recent VA FIRE PROTECTION DESIGN MANUAL and NFPA 72 unless variations to NFPA 72 are specifically identified within these contract documents by the following notation: "variation". The design, system layout, document submittal preparation, and supervision of installation and testing shall be provided by a technician that is certified NICET level III or a registered fire protection engineer. The NICET certified technician shall be on site for the supervision and testing of the system. Factory engineers from the equipment manufacturer, thoroughly familiar and knowledgeable with all equipment utilized, shall provide additional technical support at the site as required by the Resident Engineer COTR or his authorized representative. Installers shall have a minimum of 2 years experience installing fire alarm systems.
- C. Fire alarm signals:
  - 1. Building(s) identify which buildings shall have a general evacuation fire alarm signal in accordance with ASA S3.41 to notify all occupants in the respective building to evacuate.
- D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the main fire alarm system

control unit located in the security office telephone operator's office boiler plant fire department .

- E. The main fire alarm control unit shall automatically transmit alarm signals to a listed central station using a digital alarm communicator transmitter in accordance with NFPA 72.

## 1.2 SCOPE

- A. A fully addressable fire alarm system shall be designed and installed in accordance with the specifications and drawings. Device location and wiring runs shown on the drawings are for reference only unless specifically dimensioned. Actual locations shall be in accordance with NFPA 72 and this specification.
- B. Basic Performance:
1. Alarm and trouble signals from each building fire alarm control panel shall be digitally encoded by UL listed electronic devices onto a multiplexed communication system.
  2. Response time between alarm initiation (contact closure) and recording at the main fire alarm control unit (appearance on alphanumeric read out) shall not exceed 5 seconds.
  - 3.
  4. Initiating device circuits (IDC) wiring shall be Class B in accordance with NFPA 72.
  5. Signaling line circuits (SLC) wiring shall be Class B in accordance with NFPA 72. Individual signaling line circuits shall be limited to covering 22,500 square feet (2,090 square meters) of floor space.
  6. Notification appliance circuits (NAC) wiring shall be Class B in accordance with NFPA 72.
  7. Wiring installed in metal raceway within buildings that are protected throughout by sprinklers shall be considered to meet the requirements for Pathway Survivability

Level 2 in accordance with NFPA 72(2010) as a 2-hour performance alternative that has been approved by the authority having jurisdiction and shall be permitted for voice communication systems in VA facilities.

**C. THE BOISE VAMC HAS A FULL-SERVICE MAINTENANCE CONTRACT FOR MAINTENANCE AND TESTING OF THE FIRE ALARM SYSTEM. IN ACCORDANCE WITH THIS CONTRACT THE FIRE ALARM MAINTENANCE CONTRACTOR (FIRE SENTRY SYSTEMS, PH: 208.887.4774) MUST CERTIFY ALL PROGRAMMING DONE TO THE FIRE ALARM SYSTEM. UNDER THIS CONTRACT, THE CONSTRUCTION CONTRACTOR MUST EITHER HIRE THE CURRENT FIRE ALARM MAINTENANCE CONTRACTOR TO PERFORM ALL FIRE ALARM PROGRAMMING WORK OR IF THE PROGRAMMING IS COMPLETED BY ANOTHER FIRE ALARM CONTRACTOR, THE CONSTRUCTION CONTRACTOR MUST HIRE THE CURRENT FIRE ALARM MAINTENANCE CONTRACTOR TO FULLY INSPECT, TEST, AND CERTIFY THE PROGRAMMING WORK DONE BY ANOTHER CONTRACTOR.****1.3 RELATED WORK**

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

Requirements for procedures for submittals.

B. Section 07 84 00 - FIRESTOPPING. Requirements for fire proofing wall penetrations.

C. Section 08 71 00 - DOOR HARDWARE. For combination Closer-Holders.

D. Section 21 13 13 - WET-PIPE SPRINKLER SYSTEMS. Requirements for sprinkler systems.

E. 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.

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

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

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

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

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

- K. Section 28 13 00, PHYSICAL ACCESS CONTROL SYSTEMS (PACS). Requirements for integration with physical access control system.

#### **1.4 SUBMITTALS**

- A. General: Submit 5 copies in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Drawings:
1. Prepare drawings using AutoCAD Release 14 software and include all contractors information. Layering shall be by VA criteria as provided by the Contracting Officer's Technical Representative (COTR). Bid drawing files on AutoCAD will be provided to the Contractor at the pre-construction meeting. The contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by VA.
  2. Floor plans: Provide locations of all devices (with device number at each addressable device corresponding to control unit programming), appliances, panels, equipment, junction/terminal cabinets/boxes, risers, electrical power connections, individual circuits and raceway routing, system zoning; number, size, and type of raceways and conductors in each raceway; conduit fill calculations with cross section area percent fill for each type and size of conductor and raceway. Only those devices connected and incorporated into the final system shall be on these floor plans. Do not show any removed devices on the floor plans. Show all interfaces for all fire safety functions.
  3. Riser diagrams: Provide, for the entire system, the number, size and type of riser raceways and conductors in each riser raceway and number of each type device per floor and zone. Show door holder interface, elevator control interface, HVAC shutdown interface, fire extinguishing system interface, and all other fire safety interfaces. Show wiring Schedules on the riser diagram for all circuits. Provide diagrams both on a per building and campus wide basis.
  4. Detailed wiring diagrams: Provide for control panels, modules, power supplies, electrical power connections, auxiliary relays and annunciators showing termination

identifications, size and type conductors, circuit boards, LED lamps, indicators, adjustable controls, switches, ribbon connectors, wiring harnesses, terminal strips and connectors, spare zones/circuits. Diagrams shall be drawn to a scale sufficient to show spatial relationships between components, enclosures and equipment configuration.

5. Two weeks prior to final inspection, the Contractor shall deliver to the COTR 3 sets of as-built drawings and one set of the as-built drawing computer files (using AutoCAD 2007 or later) . As-built drawings (floor plans) shall show all new and/or existing conduit used for the fire alarm system.

C. Manuals:

1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets for all items used in the system, power requirements, device wiring diagrams, dimensions, and information for ordering replacement parts.
  - a. Wiring diagrams shall have their terminals identified to facilitate installation, operation, expansion and maintenance.
  - b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
  - c. Include complete listing of all software used and installation and operation instructions including the input/output matrix chart.
  - d. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate, inspect, test and maintain the equipment and system. Provide all manufacturer's installation limitations including but not limited to circuit length limitations.
  - e. Complete listing of all digitized voice messages.
  - f. Provide standby battery calculations under normal operating and alarm modes. Battery calculations shall include the magnets for holding the doors open for one minute.

- g. Include information indicating who will provide emergency service and perform post contract maintenance.
  - h. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
  - i. A computerized preventive maintenance schedule for all equipment. The schedule shall be provided on disk in a computer format acceptable to the VAMC and shall describe the protocol for preventive maintenance of all equipment. The schedule shall include the required times for systematic examination, adjustment and cleaning of all equipment. A print out of the schedule shall also be provided in the manual. Provide the disk in a pocket within the manual.
  - j. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
  - k. A print out for all devices proposed on each signaling line circuit with spare capacity indicated.
2. Two weeks prior to final inspection, deliver 4 copies of the final updated maintenance and operating manual to the COTR.
- a. The manual shall be updated to include any information necessitated by the maintenance and operating manual approval.
  - b. Complete "As installed" wiring and schematic diagrams shall be included that shows all items of equipment and their interconnecting wiring. Show all final terminal identifications.
  - c. Complete listing of all programming information, including all control events per device including an updated input/output matrix.
  - d. Certificate of Installation as required by NFPA 72 for each building. The certificate shall identify any variations from the National Fire Alarm Code.
  - e. Certificate from equipment manufacturer assuring compliance with all manufacturers installation requirements and satisfactory system operation.
- D. Certifications:

1. Together with the shop drawing submittal, submit the technician's NICET level III fire alarm certification as well as certification from the control unit manufacturer that the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include in the certification the names and addresses of the proposed supervisor of installation and the proposed performer of contract maintenance. Also include the name and title of the manufacturer's representative who makes the certification.
2. Together with the shop drawing submittal, submit a certification from either the control unit manufacturer or the manufacturer of each component (e.g., smoke detector) that the components being furnished are compatible with the control unit.
3. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer that the wiring and connection diagrams meet this specification, UL and NFPA 72 requirements.

#### **1.5 WARRANTY**

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by the basic designation only and the latest editions of these publications shall be applicable.
- B. National Fire Protection Association (NFPA):
  - NFPA 13 .....Standard for the Installation of Sprinkler Systems, 2019 edition
  - NFPA 14 ..... Standard for the Installation of Standpipes and Hose Systems, 2019 edition
  - NFPA 20 ..... Standard for the Installation of Stationary Pumps for Fire Protection, 2019 edition



- NFPA 70.....National Electrical Code (NEC), 2020 edition
- NFPA 72.....National Fire Alarm Code, 2019 edition
- NFPA 90A .....Standard for the Installation of Air Conditioning and  
Ventilating Systems, 2021 edition
- NFPA 101.....Life Safety Code, 2021 edition
- C. Underwriters Laboratories, Inc. (UL): Fire Protection Equipment Directory
- D. Factory Mutual Research Corp (FM): Approval Guide, 2007-2011
- E. American National Standards Institute (ANSI):
  - S3.41.....Audible Emergency Evacuation Signal, 1990 edition,  
reaffirmed 2008
- F. International Code Council, International Building Code (IBC), 2009 edition

## **PART 2 A- PRODUCTS**

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

- A. All equipment and components shall be new and the manufacturer's current model. All equipment shall be tested and listed by Underwriters Laboratories, Inc. or Factory Mutual Research Corporation for use as part of a fire alarm system. The authorized representative of the manufacturer of the major equipment shall certify that the installation complies with all manufacturers' requirements and that satisfactory total system operation has been achieved.

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

- A. Conduit shall be in accordance with Section 28 05 28.33 CONDUIT AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY and as follows:
  - 1. All new conduits shall be installed in accordance with NFPA 70.
  - 2. Conduit fill shall not exceed 40 percent of interior cross sectional area.
  - 3. All new conduits shall be 3/4 inch (19 mm) minimum.
- B. Wire:
  - 1. Wiring shall be in accordance with NEC article 760, Section 28 05 13, CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY, and as recommended by the manufacturer of the fire alarm system. All wires shall be color coded. Number and

- size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and 14 AWG for notification device circuits.
2. Addressable circuits and wiring used for the multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer in writing.
  3. Any fire alarm system wiring that extends outside of a building shall have additional power surge protection to protect equipment from physical damage and false signals due to lightning, voltage and current induced transients. Protection devices shall be shown on the submittal drawings and shall be UL listed or in accordance with written manufacturer's requirements.
  4. All wire or cable used in underground conduits including those in concrete shall be listed for wet locations.
- C. Terminal Boxes, Junction Boxes, and Cabinets:
1. Shall be galvanized steel in accordance with UL requirements.
  2. All boxes shall be sized and installed in accordance with NFPA 70.
  3. covers shall be repainted red in accordance with Section 09 91 00, PAINTING and shall be identified with white markings as "FA" for junction boxes and as "FIRE ALARM SYSTEM" for cabinets and terminal boxes. Lettering shall be a minimum of 3/4 inch (19 mm) high.
  4. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
  5. Terminal boxes and cabinets shall have identified pressure type terminal strips and shall be located at the base of each riser. Terminal strips shall be labeled as specified or as approved by the COTR.

## **2.3 FIRE ALARM CONTROL UNIT**

### **A. General:**

1. Each building building expansion shall be provided with a fire alarm control unit and shall operate as a supervised zoned fire alarm system.
2. Each power source shall be supervised from the other source for loss of power.
3. All circuits shall be monitored for integrity.
4. Visually and audibly annunciate any trouble condition including, but not limited to main power failure, grounds and system wiring derangement.
5. Transmit digital alarm information to the main fire alarm control unit.

### **B. Enclosure:**

1. The control unit shall be housed in a cabinet suitable for both recessed and surface mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. Cabinet shall contain all necessary relays, terminals, lamps, and legend plates to provide control for the system.

### **C. Operator terminal at main control unit:**

1. Operator terminal shall consist of the central processing unit, display screen, keyboard and printer.
2. Display screen shall have a minimum 15-inch (380 mm) diagonal non-glare screen capable of displaying 24 lines of 80 characters each.
3. Keyboard shall consist of 60 alpha numeric and 12 user/functional control keys.
4. Printer shall be the automatic type, printing the date, time and location for all alarm, supervisory, and trouble conditions.

### **D. Power Supply:**

1. The control unit shall derive its normal power from a 120 volt, 60 Hz dedicated supply connected to the emergency power system. Standby power shall be provided by a 24 volt DC battery as hereinafter specified. The normal power shall be transformed, rectified, coordinated, and interfaced with the standby battery and charger.

2. The door holder power shall be arranged so that momentary or sustained loss of main operating power shall not cause the release of any door.
  3. Power supply for smoke detectors shall be taken from the fire alarm control unit.
  4. Provide protectors to protect the fire alarm equipment from damage due to lightning or voltage and current transients.
  5. Provide new separate and direct ground lines to the outside to protect the equipment from unwanted grounds.
- E. Circuit Supervision: Each alarm initiating device circuit, signaling line circuit, and notification appliance circuit, shall be supervised against the occurrence of a break or ground fault condition in the field wiring. These conditions shall cause a trouble signal to sound in the control unit until manually silenced by an off switch.
- F. Supervisory Devices: All sprinkler system valves, standpipe control valves, post indicator valves (PIV), and main gate valves shall be supervised for off-normal position. Closing a valve shall sound a supervisory signal at the control unit until silenced by an off switch. The specific location of all closed valves shall be identified at the control unit. Valve operation shall not cause an alarm signal. Low air pressure switches and duct detectors shall be monitored as supervisory signals. The power supply to the elevator shunt trip breaker shall be monitored by the fire alarm system as a supervisory signal.
- G. Trouble signals:
1. Arrange the trouble signals for automatic reset (non-latching).
  2. System trouble switch off and on lamps shall be visible through the control unit door.
- H. Function Switches: Provide the following switches in addition to any other switches required for the system:
1. Remote Alarm Transmission By-pass Switch: Shall prevent transmission of all signals to the main fire alarm control unit when in the "off" position. A system trouble signal shall be energized when switch is in the off position.

2. Alarm Off Switch: Shall disconnect power to alarm notification circuits on the local building alarm system. A system trouble signal shall be activated when switch is in the off position.
  3. Trouble Silence Switch: Shall silence the trouble signal whenever the trouble silence switch is operated. This switch shall not reset the trouble signal.
  4. Reset Switch: Shall reset the system after an alarm, provided the initiating device has been reset. The system shall lock in alarm until reset.
  5. Lamp Test Switch: A test switch or other approved convenient means shall be provided to test the indicator lamps.
  6. Drill Switch: Shall activate all notification devices without tripping the remote alarm transmitter. This switch is required only for general evacuation systems specified herein.
  7. Door Holder By-Pass Switch: Shall prevent doors from releasing during fire alarm tests. A system trouble alarm shall be energized when switch is in the abnormal position.
  8. Elevator recall By-Pass Switch: Shall prevent the elevators from recalling upon operation of any of the devices installed to perform that function. A system trouble alarm shall be energized when the switch is in the abnormal position.
  9. HVAC/Smoke Damper By-Pass: Provide a means to disable HVAC fans from shutting down and/or smoke dampers from closing upon operation of an initiating device designed to interconnect with these devices.
- I. Remote Transmissions:
1. Provide capability and equipment for transmission of alarm, supervisory and trouble signals to the main fire alarm control unit.
  2. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.
- J. Remote Control Capability: Each building fire alarm control unit shall be installed and programmed so that each must be reset locally after an alarm, before the main fire

alarm control unit can be reset. After the local building fire alarm control unit has been reset, then the all system acknowledge, reset, silence or disabling functions can be operated by the main fire alarm control unit

- K. System Expansion: Design the control units and enclosures so that the system can be expanded in the future (to include the addition of 20 percent more alarm initiating, alarm notification and door holder circuits) without disruption or replacement of the existing control unit and secondary power supply.

## **2.4 STANDBY POWER SUPPLY**

A. Batteries:

1. Battery shall be of the sealed, maintenance free type, 24-volt nominal.
2. Battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus 5 minutes of alarm to an end voltage of 1.14 volts per cell, upon a normal AC power failure.
3. Battery racks shall be steel with an alkali-resistant finish. Batteries shall be secured in seismic areas 2B, 3, or 4 as defined by the Uniform Building Code.

B. Battery Charger:

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120-volt, 60 hertz emergency power source.
2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
3. Shall have protection to prevent discharge through the charger.
4. Shall have protection for overloads and short circuits on both AC and DC sides.
5. A trouble condition shall actuate the fire alarm trouble signal.
6. Charger shall have automatic AC line voltage regulation, automatic current-limiting features, and adjustable voltage controls.

## **2.5 ANNUNCIATION**

A. Annunciator, Alphanumeric Type (System):

1. Shall be a supervised, LCD display containing a minimum of 2 lines of 40 characters for alarm annunciation in clear English text.
2. Message shall identify building number, floor, zone, etc on the first line and device description and status (pull station, smoke detector, waterflow alarm or trouble condition) on the second line.
3. The initial alarm received shall be indicated as such.
4. A selector switch shall be provided for viewing subsequent alarm messages.
5. The display shall be UL listed for fire alarm application.
6. Annunciators shall display information for all buildings connected to the system. Local building annunciators, for general evacuation system buildings, shall be permitted when shown on the drawings and approved by the COTR.

## **2.6 ALARM NOTIFICATION APPLIANCES**

### **A. Bells:**

1. Shall be electric, single-stroke or vibrating, heavy-duty, under-dome, solenoid type.
2. Unless otherwise shown on the drawings, shall be 6 inches (150 mm) diameter and have a minimum nominal rating of 80 dBA at 10 feet (3,000 mm).
3. Mount on removable adapter plates on outlet boxes.
4. Bells located outdoors shall be weatherproof type with metal housing and protective grille.
5. Each bell circuit shall have a minimum of 20 percent spare capacity.

### **B. Speakers:**

1. Shall operate on either 25 VRMS or 70.7 VRMS with field selectable output taps from 0.5 to 2.0W and originally installed at the 1/2 watt tap. Speakers shall provide a minimum sound output of 80 dBA at 10 feet (3,000 mm) with the 1/2 watt tap.
2. Frequency response shall be a minimum of 400 HZ to 4,000 HZ.
3. Four inches (100 mm) or 8 inches (200 mm) cone type speakers ceiling mounted with white colored baffles in areas with suspended ceilings and wall mounted in areas without ceilings.

C. Strobes:

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

D. Fire Alarm Horns:

1. Shall be electric, utilizing solid state electronic technology operating on a nominal 24 VDC.
2. Shall be a minimum nominal rating of 80 dBA at 10 feet (3,000 mm).
3. Mount on removable adapter plates on conduit boxes.
4. Horns located outdoors shall be of weatherproof type with metal housing and protective grille.
5. Each horn circuit shall have a minimum of 20 percent spare capacity.

## **2.7 ALARM INITIATING DEVICES**

A. Manual Fire Alarm Stations:

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



5. Unless otherwise specified, all exposed parts shall be red in color and have a smooth, hard, durable finish.
6. Stations identified as key operated only shall have a single standardized lock and key separate from the control equipment.

B. Smoke Detectors:

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

C. Heat Detectors:

1. Heat detectors shall be of the addressable restorable rate compensated fixed-temperature spot type.
2. Detectors shall have a minimum smooth ceiling rating of 2,500 square feet (230 square meters).

3. Ordinary temperature (135 degrees F (57 degrees C)) heat detectors shall be utilized in elevator shafts and elevator mechanical rooms. Intermediate temperature rated (200 degrees F (93 degrees C)) heat detectors shall be utilized in all other areas.
4. Provide a remote indicator lamp, key test station and identification nameplate (e.g. "Heat Detector - Elevator P-\_\_\_\_\_ ) for each elevator group. Locate key test station in plain view on elevator machine room wall.

D. Water Flow and Pressure Switches:

1. Wet pipe water flow switches and dry pipe alarm pressure switches for sprinkler systems shall be connected to the fire alarm system by way of an address reporting interface device.
2. All new water flow switches shall be of a single manufacturer and series and non-accumulative retard type. See Section 21 12 00, FIRE-SUPPRESSION STANDPIPES and Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS for new switches added. Connect all switches shown on the approved shop drawings.
3. All new switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Timing shall be recorded and documented during testing.

E. Extinguishing System Connections:

1. Kitchen Range Hood and Duct Suppression Systems:
  - a. Each suppression system shall be equipped with a micro-switch connected to the building fire alarm control unit. Discharge of a suppression system shall automatically send a alarm signal to the building fire detection and alarm system for annunciation.
  - b. Operation of this suppression system shall also automatically shut off all sources of fuel and heat to all equipment requiring protection under the same hood.
2. Each gaseous suppression system shall be monitored for system alarm and system trouble conditions via addressable interface devices.

## 2.8 SUPERVISORY DEVICES

A. Duct Smoke Detectors:

1. Duct smoke detectors shall be provided and connected by way of an address reporting interface device. Detectors shall be provided with an approved duct housing mounted exterior to the duct, and shall have perforated sampling tubes extending across the full width of the duct (wall to wall). Detector placement shall be such that there is uniform airflow in the cross section of the duct.
2. Interlocking with fans shall be provided in accordance with NFPA 90A and as specified hereinafter under Part 3.2, "TYPICAL OPERATION".
3. Provide remote indicator lamps, key test stations and identification nameplates (e.g. "DUCT SMOKE DETECTOR AHU-X") for all duct detectors. Locate key test stations in plain view on walls or ceilings so that they can be observed and operated from a normal standing position.

B. Sprinkler and Standpipe System Supervisory Switches:

1. Each sprinkler system water supply control valve, riser valve or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valve shall be equipped with a supervisory switch.
3. Valve supervisory switches shall be connected to the fire alarm system by way of address reporting interface device. See Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS for new switches to be added. Connect tamper switches for all control valves shown on the approved shop drawings.
4. The mechanism shall be contained in a weatherproof die-cast aluminum housing that shall provide a 3/4 inch (19 mm) tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The entire installed assembly shall be tamper-proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting.

6. Where dry-pipe sprinkler systems are installed, high and low air pressure switches shall be provided and monitored by way of an address reporting interface devices.
7. Fire supervisory signals required by NFPA 20 and monitored by the pump controller shall be provided and monitored by way of address reporting interface devices for the fire pump located indicate location.

## **2.09 ADDRESS REPORTING INTERFACE DEVICE**

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

## **2.10 SMOKE BARRIER DOOR CONTROL**

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

### **2.11 UTILITY LOCKS AND KEYS:**

- A. All key operated test switches, control units, annunciator panels and lockable cabinets shall be provided with a single standardized utility lock and key.
- B. Key-operated manual fire alarm stations shall have a single standardized lock and key separate from the control equipment.
- C. All keys shall be delivered to the COTR.

### **2.13 INSTRUCTION CHART:**

Provide typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame with a backplate. Install the frame in a conspicuous location observable from each control unit where operations are performed. The card shall show those steps to be taken by an operator when a signal is received under all conditions, normal, alarm, supervisory, and trouble. Provide an additional copy with the binder for the input output matrix for the sequence of operation. The instructions shall be approved by the COTR before being posted.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION:**

- A. Installation shall be in accordance with NFPA 70, 72, 90A, and 101 as shown on the drawings, and as recommended by the major equipment manufacturer. Fire alarm wiring shall be installed in conduit. All conduit and wire shall be installed in accordance with, Section 28 05 13 CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY, Section 28 05 26 GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY, Section 28 05 28.33 CONDUIT AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY, and all penetrations of smoke and fire barriers shall be protected as required by Section 07 84 00, FIRESTOPPING.
- B. All conduits, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas.
- C. All new and reused exposed conduits shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas.

SPEC WRITER NOTE: Delete sections 3.1.D and 3.1.E  
if project is for new construction.

- D. All existing accessible fire alarm conduit not reused shall be removed.
- E. Existing devices that are reused shall be properly mounted and installed. Where devices are installed on existing shallow backboxes, extension rings of the same material, color and texture of the new fire alarm devices shall be used. Mounting surfaces shall be cut and patched in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Restoration, and be re-painted in accordance with Section 09 91 00, PAINTING as necessary to match existing.
- F. All fire detection and alarm system devices, control units and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Exact locations are to be approved by the COTR.
- G. Speakers shall be ceiling mounted and fully recessed in areas with suspended ceilings. Speakers shall be wall mounted and recessed in finished areas without suspended ceilings. Speakers may be surface mounted in unfinished areas.
- H. Strobes shall be flush wall mounted with the bottom of the unit located 80 inches (2,000 mm) above the floor or 6 inches (150 mm) below ceiling, whichever is lower. Locate and mount to maintain a minimum 36 inches (900 mm) clearance from side obstructions.
- I. Manual pull stations shall be installed not less than 42 inches (1,050 mm) or more than 48 inches (1,200 mm) from finished floor to bottom of device and within 60 inches (1,500 mm) of a stairway or an exit door.
- J. Where possible, locate water flow and pressure switches a minimum of 12 inches (300 mm) from a fitting that changes the direction of the flow and a minimum of 36 inches (900 mm) from a valve.
- K. Mount valve tamper switches so as not to interfere with the normal operation of the valve and adjust to operate within 2 revolutions toward the closed position of the valve control, or when the stem has moved no more than 1/5 of the distance from its normal position.

- L. Connect flow and tamper switches installed under Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS.
- M. Connect combination closer-holders installed under Section 08 71 00, DOOR HARDWARE.

### 3.2 TYPICAL OPERATION

- A. Activation of any manual pull station, water flow or pressure switch, heat detector, kitchen hood suppression system, gaseous suppression system, or smoke detector shall cause the following operations to occur:
  - 1. Operate the emergency voice communication system in Buildings indicate buildings . For sprinkler protected buildings, flash strobes continuously only in the zone of alarm. For buildings without sprinkler protection throughout, flash strobes continuously only on the floor of alarm.
  - 2. Continuously sound a temporal pattern general alarm and flash all strobes in the building in alarm until reset at the local fire alarm control unit in Buildings indicate buildings .
  - 3. Release only the magnetic door holders in the smoke zone on the floor from which alarm was initiated after the alert signal.
  - 4. Transmit a separate alarm signal, via the main fire alarm control unit to the fire department.
  - 5. Unlock the electrically locked exit doors within the zone of alarm.
- B. Smoke detectors in the remaining elevator lobbies, elevator machine room, or top of hoistway shall, in addition to the above functions, return all elevators in the bank to the primary floor.
- C. Operation of a smoke detector at a corridor door used for automatic closing shall also release only the magnetic door holders on that floor in that smoke zone . Operation of a smoke detector at a shutter used for automatic closing shall also release only the shutters on that floor in that smoke zone .

- D. Operation of duct smoke detectors shall cause a system supervisory condition and shut down the ventilation system and close the associated smoke dampers as appropriate.
- E. Operation of any sprinkler or standpipe system valve supervisory switch, high/low air pressure switch, or fire pump alarm switch shall cause a system supervisory condition.
- F. Alarm verification shall not be used for smoke detectors installed for the purpose of early warning.
- G. Fire Alarm System Input/Output Matrix

FIRE ALARM SYSTEM INPUT/OUTPUT MATRIX		OUTPUT										
		1. Sound general building alarm for Other and High Rise (non-Health Care). See VAFPD Section 7.2.1.	2. Notify necessary staff for response for Health Care, Ambulatory Health Care, and High Rise buildings only (alarm signal may be different on different floors).	3. Notify Fire Department.	4. Initiate supervisory signal to a 24-hour manned point for immediate response.	5. Close associated smoke barrier doors on the floor.	6. Close dampers on fan proximate detector.	7. Shutdown air handler served by the detector.	8. Recall elevator.	9. Initiate the elevator shutdown and disconnect elevator power.	10. Open locked egress doors on floor of fire origin.	11. Disconnect fuel source from cooking equipment.
INPUT DEVICE	Duct Smoke Detector				X		X	X				
	Area Smoke Detector	X	X	X							X	
	Door Release Smoke Detector											
	Elevator Smoke Detector											
	Manual Pull Station	X	X	X							X	
	Elevator Machine Room Heat Detector											
	Generator Room Heat Detector											
	Sprinkler Waterflow / Pressure Switch	X	X	X							X	
	Water Control Valve Tamper				X							
	Fire Pump (Any Alarm Condition Required by NFPA 20)											
	High/Low Pressure Dry-Pipe Sprinkler System											
	Kitchen Hood Suppression System											
	Gas Extinguishing Systems											
	Dry-Pipe Valve Room Temperature Alarm											
	Dedicated Fire Water Storage Tank Low Level											
	Dedicated Fire Water Storage Tank Low Temperature											

### 3.3 TESTS

- A. Provide the service of a NICET level III, competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the COTR.
- B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the COTR. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm systems



meets all contract requirements. After the system has passed the initial test and been approved by the COTR, the contractor may request a final inspection.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
3. Run water through all flow switches. Check time delay on water flow switches. Submit a report listing all water flow switch operations and their retard time in seconds.
4. Open each alarm initiating and notification circuit to see if trouble signal actuates.
5. Ground each alarm initiation and notification circuit and verify response of trouble signals.

### **3.4 FINAL INSPECTION AND ACCEPTANCE**

- A. Prior to final acceptance a minimum 30 day "burn-in" period shall be provided. The purpose shall be to allow equipment to stabilize and potential installation and software problems and equipment malfunctions to be identified and corrected. During this diagnostic period, all system operations and malfunctions shall be recorded. Final acceptance will be made upon successful completion of the "burn-in" period and where the last 14 days is without a system or equipment malfunction.
- B. At the final inspection a factory trained representative of the manufacturer of the major equipment shall repeat the tests in Article 3.3 TESTS and those required by NFPA 72. In addition the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of a VA representative.

### **3.5 INSTRUCTION**

- A. The manufacturer's authorized representative shall provide instruction and training to the VA as follows:
  1. Six 1-hour sessions to engineering staff, security police and central attendant personnel for simple operation of the system. Two sessions at the start of

- installation, 2 sessions at the completion of installation and 2 sessions 3 months after the completion of installation.
2. Four 2-hour sessions to engineering staff for detailed operation of the system. Two sessions at the completion of installation and 2 sessions 3 months after the completion of installation.
  3. Three 8-hour sessions to electrical technicians for maintaining, programming, modifying, and repairing the system at the completion of installation and one 8-hour refresher session 3 months after the completion of installation.
- B. The Contractor and/or the Systems Manufacturer's representative shall provide a typewritten "Sequence of Operation" including a trouble shooting guide of the entire system for submittal to the VA. The sequence of operation will be shown for each input in the system in a matrix format and provided in a loose leaf binder. When reading the sequence of operation, the reader will be able to quickly and easily determine what output will occur upon activation of any input in the system. The INPUT/OUTPUT matrix format shall be as shown in Appendix A to NFPA 72.
- C. Furnish the services of a competent instructor for instructing personnel in the programming requirements necessary for system expansion. Such programming shall include addition or deletion of devices, zones, indicating circuits and printer/display text.

#### **PART 4 - SCHEDULES**

##### **4.1 DIGITIZED VOICE MESSAGES:**

- A. Digitized voice messages shall be provided for each smoke zone of Buildings indicate buildings . The messages shall be arranged with a 3 second alert tone, a "Code Red" "Nurse Blaze" "Doctor Firestone" message and a description of the fire alarm area (building number, floor, level and smoke zone). A sample of such a message is as follows:
- Alert Tone
- Code Red
- Building One, Second Floor, East Wing

Code Red

Building One, Second Floor, East Wing

Code Red

Building One, Second Floor, East Wing

**4.2 LOCATION OF VOICE MESSAGES:**

Upon receipt of an alarm signal from the building fire alarm system, the voice communication system shall automatically transmit a 3 second tone alert and a pre-recorded fire alarm message throughout the floor in alarm, the floor above and the floor below the building .

**- - END - -**

**SECTION 31 20 00  
EARTHWORK**

**PART 1- GENERAL**

**1.1 DESCRIPTION OF WORK:**

- A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork including, but not limited to, the following:
1. Site preparation.
  2. Excavation.
  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 Resident Engineer's approval.

- B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.
- C. Trench Earthwork: Trench work required for utility lines.
- D. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.
- E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D6938.
- F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term "fill" means fill or backfill as appropriate.
- G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
- H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the Resident Engineer. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
- I. Authorized additional excavation: Removal of additional material authorized by the Resident Engineer based on the determination by the Government's soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
- K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

- M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- N. Bedding course: Layer placed over the excavated sub-grade in a trench before laying pipe. Bedding course shall extend up to the springline of the pipe.
- O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.
- P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.
- R. Contaminated soils: Soil that contains contaminants as defined and determined by the Resident Engineer 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: 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. Classified Excavation: Removal and disposal of all material not defined as Rock.
- C. 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 m<sup>3</sup> (1 cubic yard) for open excavation, or 0.57 m<sup>3</sup> (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 pits, 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.

#### **1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION:**

- A. Measurement: Cross section and measure uncovered and separated materials, and compute quantities by Registered Professional Land Surveyor or Registered Civil



Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. Do not measure quantities beyond the following limits:

1. 600 mm (24 inches) from outside face of concrete work for which forms are required, except for footings.
  2. 300 mm (12 inches) from outside of perimeter of formed footings.
  3. 150 mm (6 inches) below bottom of pipe and not more than pipe diameter plus 600 mm (24 inches) in width for pipe trenches.
  4. From outside dimensions of concrete work for which no forms are required (trenches, conduits, and similar items not requiring forms).
- B. Payment: No separate payment shall be made for rock excavation quantities shown. Contract price and time will be adjusted for overruns or underruns in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
- C. Payment for Differing Site Conditions: When rock excavation, as classified, is encountered, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

**1.7 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 Resident Engineer:

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<sup>3</sup> (600 kN m/m<sup>3</sup>))
- 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<sup>3</sup> (2700 kN m/m<sup>3</sup>))
- D2167-08.....Standard Test Method for Density and Unit Weight of Soil  
in Place by the Rubber Balloon Method
- D2487-11.....Standard Classification of Soils for Engineering Purposes  
(Unified Soil Classification System)
- D2940-09.....Standard Specifications for Graded Aggregate Material for  
Bases or Subbases for Highways or Airports
- D6938-10.....Standard Test Method for In-Place Density and Water  
Content of Soil and Soil-Aggregate by Nuclear Methods  
(Shallow Depth
- D. Society of Automotive Engineers (SAE):
- J732-07 .....Specification Definitions - Loaders

J1179-08.....Hydraulic Excavator and Backhoe Digging Forces

## **PART 2- PRODUCTS**

### **2.1 MATERIALS:**

- A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
- B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups; free of rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a minimum dry density of 1760 kg/m<sup>3</sup> (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.
- C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75-μm (No. 200) sieve, per ASTM D2940;.
- D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75-μm (No. 200) sieve.
- E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.
- F. Granular Fill:
  - 1. Under concrete slab, - granular fill shall consist of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Fine aggregate grading shall conform to ASTM C 33 with a maximum of 3 percent by weight passing ASTM D 1140, (No. 200) sieve, or (1-1/2 inches) and no

- more than 2 percent by weight passing the (No. 4) size sieve or coarse aggregate Size 57, 67, or 77.
2. Bedding for sanitary and storm sewer pipe, crushed stone or gravel graded from 13 mm (1/2 inch) to 4.75 mm (No 4), per ASTM D2940.
- G. Requirements for Offsite Soils: Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCLP test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA SW-846.3-3a Method 5030/8020. TCLP shall be performed in accordance with EPA SW-846.3-3a Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site.
- H. Buried Warning and Identification Tape: 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

- I. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.076 mm (0.003 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise, and 8.6 MPa (1250 psi) crosswise, with a maximum 350 percent elongation.
- J. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.102 mm (0.004 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise and 8.6 MPa (1250 psi) crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 0.9 m (3 feet) deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.
- K. Detection Wire For Non-Metallic Piping: Detection wire shall be Insulated single strand, solid copper with a minimum of 12 AWG.

### **PART 3- EXECUTION**

#### **3.1 SITE PREPARATION:**

- A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from Medical Center.
- B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.
- C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by Resident Engineer. Remove materials from Medical Center. 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 Resident Engineer. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m<sup>3</sup> (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 elevations indicated on plans, except spot elevations, are approximate from a site survey that measured spot elevations and subsequently

- generated existing contours and spot elevations. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Contractor is responsible to notify Resident Engineer of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify Resident Engineer 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, Sheet piling and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the Resident Engineer, 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 Sheet piling 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 sheet piling 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 sheet piling 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 Resident Engineer.



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 Resident Engineer, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by Resident Engineer.
  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 Resident Engineer 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 Resident Engineer 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 Resident Engineer. Approval by the Resident Engineer 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 (5feet) 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 Resident Engineer.

D. 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 using a heavy rubber-tired, fully loaded, tandem axle dump truck or equivalent. When proof rolling, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Notify the Resident Engineer a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the

presence of the Resident Engineer. Verification of subgrade competence shall be done by the Geotechnical Engineer at the time construction is required. Rutting or pumping of material shall be undercut as directed by the Resident Engineer.

Maintain subgrade until succeeding operation has been accomplished.

E. Building Earthwork:

1. Excavation shall be accomplished as required by drawings and specifications.
2. Excavate foundation excavations to solid undisturbed subgrade.
3. Remove loose or soft materials to a solid bottom.
4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
5. Do not tamp earth for backfilling in footing bottoms, except as specified.
6. Slope grades to direct water away from excavations and to prevent ponding.
7. Capillary water barrier (granular fill) under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.
8. Ensure that footing subgrades have been inspected and approved by the Resident Engineer prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Resident Engineer. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

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 Resident Engineer.
- 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 as follows:
  - 1) Class I: Angular, 6 to 40 mm (0.25 to 1.5 inches), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

- 2) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.
  - 3) Clean, coarse-grained sand classified as Type III Bedding in accordance with Section 305 – Pipe Bedding of the ISPWC 2017 Edition.
  - 4) Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as Type I Bedding in accordance with Section 305 - Pipe Bedding, of the ISPWC 2017 Edition.
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.
  - c. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
  - d. Use granular fill for bedding where rock or rocky materials are excavated.

- e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade
- f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.
- g. Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:
  - 1) Class I: Angular, 6 to 40 mm (0.25 to 1.5 inches), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.
  - 2) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry.

Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

- 3) Clean, coarse-grained sand classified as Type III Bedding in accordance with Section 305 – Pipe Bedding of the ISPWC 2017 Edition.
- 4) Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as Type I Bedding in accordance with Section 305 - Pipe Bedding , of the ISPWC 2017 Edition.

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 Resident Engineer as unsuitable, and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the contractor shall obtain samples of the material, under the direction of the Resident Engineer, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. When unsuitable material is encountered and removed, 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 (1/2 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 Resident Engineer.
- 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, sheepfoot 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 Resident Engineer. 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 95 percent maximum dry density as determined by ASTM D1557.
- b. Curbs, curbs and gutters 95 percent maximum dry density as determined by ASTM D1557.
- 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 95 percent.
- d. Landscaped areas, top 400 mm (16 inches), 85 percent.
- e. Landscaped areas, below 400 mm (16 inches) of finished grade, 90 percent.

2. Natural Ground (Cut or Existing)

- a. Under building slabs, steps and paved areas, top 150 mm (6 inches), 95 percent maximum dry density as determined by ASTM D1557.
- b. Curbs, curbs and gutters, top 150 mm (6 inches), 95 percent maximum dry density as determined by ASTM D1557.
- c. Under sidewalks, top 150 mm (6 inches), 95 percent maximum dry density as determined by ASTM D1557.

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 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 Resident Engineer 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 Resident Engineer 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 Resident Engineer 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:**

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.

----- 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, gutters, and combination curbs and gutters
  - 3. Pedestrian Pavement: Walks, .
  - 4. Vehicular Pavement: driveways, parking lots.
  - 5. .

**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.
- 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.
  - 2. Colored Concrete Panel: As specified in Section 09 06 00, SCHEDULE FOR FINISHES, with mix data.

- E. Test reports: Certify products comply with specifications.
  - 1. Concrete materials.
  - 2. Select subbase materials.
  - 3. Field test reports.
- F. Certificates: Certify products comply with specifications.
  - 1. Expansion joint filler.
  - 2. Reinforcement.
  - 3. Curing materials.
  - 4. Concrete protective coating.
- G. Qualifications: Substantiate qualifications comply with specifications.
  - 1. Installer with project experience list .
  - 2. Land surveyor.
- H. Concrete mix design.
- I. Select subbase job-mix design.
- J. Proposed hot and cold weather concreting methods.
- K. Land surveyor's construction staking notes, before placing concrete.
  - 1. Identify discrepancies between field conditions and Drawings.

## **1.6 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 80, Grade 100 or Grade 120.
3. Silica Fume: ASTM C1240.
- C. Coarse Aggregate: ASTM C33/C33M; per ISPWC Section 703, 2.1E
- D. Fine Aggregate: ASTM C33/C33M per ISPWC Section 703, 2.1D.
- 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, 60 ksi, yield grade; deformed billet.
- I. Welded Wire Fabric: AASHTO M 55; in flat sheets or coiled rolls; unfinished. Smooth Dowel bars. .
- J. Expansion Joint Filler: ASTM D1751.
- K. Sheet Materials for Curing Concrete: ASTM C171.
- L. Color Pigment: ASTM C979/C979M, colored and white powder pigments.

## **2.2 SELECT SUBBASE**

- A. Refer to the Geotechnical Report provided by Atlas Materials Testing & Inspection dated November 11, 2020 for full subbase requirements.
- B. Granular structural fill materials shall be per ISPWC Section 801, Table 1.
- C. 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.

## 2.5 CONCRETE MIXES

- A. Design concrete mixes according to ASTM C94/C94M, Option C.
- B. Concrete Type: Non-air-entrained. See Table I.

TABLE I - CONCRETE TYPES					
Concrete Type	Minimum 28 Day Compressive Strength f'c MPa (psi)	Non-Air-Entrained		Air-Entrained	
		Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio	Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio
A	35 (5000)1,3	375 (630)	0.45	385 (650)	0.40
B	30 (4000)1,3	325 (550)	0.55	340 (570)	0.50
C	25 (3000)1,3	280 (470)	0.65	290 (490)	0.55
D	25 (3000)1,2	300 (500)	*	310 (520)	*
Footnotes:					
1. If trial mixes are used, achieve compressive strength 8.3 MPa (1,200 psi) in excess of f'c. For concrete strengths greater than 35 MPa (5,000 psi), achieve compressive strength 9.7 MPa (1,400 psi) in excess of f'c.					

2. For Concrete Exposed to High Sulfate Content Soils: Maximum water cement ratio is 0.44.
3. Laboratory Determined according to ACI 211.1 for normal weight concrete.

C. Maximum Slump: ASTM C143/C143M. See Table II.

TABLE II - MAXIMUM SLUMP	
APPLICATION	MAXIMUM SLUMP
Curb & Gutter	75 mm (3 inches)
Pedestrian Pavement	75 mm (3 inches)
Vehicular Pavement	50 mm (2 inches) Machine Finished
	100 mm (4 inches) Hand Finished
Equipment Pad	75 to 100 mm (3 to 4 inches)

## 2.6 ACCESSORIES

- A. Equipment and Tools: Obtain 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 construction joints between slabs of vehicular pavement as shown on approved submittal Drawings.
- B. Place transverse construction joints of type shown, where indicated, and whenever concrete placement is suspended for more than 30 minutes.
- C. Provide butt-type joint with dowels in curb and gutter at planned joint locations.

- D. Provide keyed joints with tie bars when joint occurs in middle third of planned curb and gutter joint interval.

### **3.7 CONTRACTION JOINTS**

- A. Tool or cut joints to width, depth, and radius edge shown on drawings using grooving tool, jointer, or saw.
- B. Construct joints in curbs and gutters by inserting 3 mm (1/8 inch) steel plates conforming to curb and gutter cross sections.
  - 1. Keep plates in place until concrete can hold its shape.
- C. Finish joint edges with edging tool.
- D. Score pedestrian pavement with grooving tool or jointer.

### **3.8 EXPANSION JOINTS**

- A. 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**

- A. Place concrete in one layer conforming to cross section shown on Drawings after consolidating and finishing.
- B. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.
- C. Strike concrete surface to proper section ready for consolidation.
- D. Consolidate concrete by tamping and spading or with approved mechanical finishing equipment.
- E. Finish concrete surface with wood or metal float.
- F. Construct concrete pads and pavements with sufficient slope to drain, preventing standing water.

### **3.11 PLACING CONCRETE FOR VEHICULAR PAVEMENT**

- A. Deposit concrete as close as possible to its final position.
- B. Place concrete continuously between construction joints without cold joints.
- C. Strike and consolidate concrete with finishing machine, vibrating screed, or by hand-finishing.
- D. Finish concrete surface to elevation and crown shown on drawings.
- E. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.
- F. Obtain Contracting Officer's Representative's approval before placing adjacent lanes.

- G. Curb-Forming Machines: Curb-forming machines for constructing integral curbs curbs and gutter will be approved based on trial use on the project. When equipment produces unsatisfactory results, discontinue use of the equipment at any time during construction and accomplish work by hand method construction. Remove unsatisfactory work and reconstruct full length between regularly scheduled joints. Dispose of removed portions off the project site.

### **3.12 FORM REMOVAL**

- A. Keep forms in place minimum 12 hours after concrete placement. Remove forms without damaging concrete.
- B. Do not use bars or heavy tools against concrete to remove forms. Repair damage concrete found after form removal.

### **3.13 CONCRETE FINISHING - GENERAL**

- A. Follow operation sequence below, unless otherwise indicated on Drawings:
1. Consolidating, floating, striking, troweling, texturing, and joint edging.
- B. Use edging tool with 6 mm (1/4 inch) radius, unless otherwise shown on Drawings.
- C. Keep finishing equipment and tools clean and suitable for use.
- D. Step Treads, Risers and Sidewalls: Finish as specified for pedestrian pavement, except as follows:
1. Remove riser forms sequentially, starting with top riser.
  2. Rub riser face with wood or concrete rubbing block and water. Remove blemishes, form marks, and tool marks. Use outside edger to round nosing; use inside edger to finish bottom of riser.
  3. Apply uniform brush finish to treads, risers, and sidewalk.
    - a. Apply stiff brush finish to treads to provide slip resistant surface complying with ANSI B101.3.
  4. Step Tolerance:
    - a. Variation from Indicated Plane: Maximum 5 mm in 3000 mm (3/16 inch in 10 feet).



### **3.14 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.

### **3.15 CONCRETE FINISHING - CURBS AND GUTTERS**

- A. Round edges of gutter and top of curb with edging tool.
- B. Gutter and Curb Top:
  - 1. Float surfaces and finish with smooth wood or metal float until true to grade and section and uniform color.
  - 2. Finish surfaces, while still plastic, longitudinally with bristle brush.
- C. Curb Face:
  - 1. Remove curb form and immediately rub curb face with wood or concrete rubbing block removing blemishes, form marks, and tool marks and providing uniform color.
  - 2. Brush curb face, while still plastic, matching gutter and curb top.
- D. Curb and Gutter Tolerances:
  - 1. Variation from Indicated Plane and Grade:
    - a. Gutter: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).

- b. Curb Top and Face: Maximum 6 mm in 3000 mm (1/4 inch in 10 feet).
- E. Replace curbs and gutters within joint boundary when curbs and gutters exceed specified tolerances.
- F. Correct depressions causing standing water.

### **3.16 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.

--- E N D ---

**SECTION 32 12 16  
ASPHALT PAVING**

**PART 1- GENERAL**

**1.1 DESCRIPTION**

This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

**1.2 RELATED WORK**

- A. Laboratory and field testing requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Paragraph 3.3 and Section 31 20 00, EARTH MOVING.
- C. Pavement Markings: Section 32 17 23, PAVEMENT MARKINGS.

**1.3 INSPECTION OF PLANT AND EQUIPMENT**

The Resident Engineer shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

**1.4 ALIGNMENT AND GRADE CONTROL**

The Contractor's Registered Professional Land Surveyor shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the Drawings.

**1.5 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. Data and Test Reports:

1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other tests required by State Highway Department.
  2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by State Highway Department.
  3. Job-mix formula.
- C. Certifications:
1. Asphalt prime and tack coat material certificate of conformance to State Highway Department requirements.
  2. Asphalt cement certificate of conformance to State Highway Department requirements.
  3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the State Highway Specification.
- D. One copy of State Highway Department Specifications.
- E. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

## **PART 2- PRODUCTS**

### **2.1 GENERAL**

- A. Aggregate base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State Highway Material Specifications, including amendments, addenda and errata. Where the term "Engineer" or "Commission" is referenced in the State Highway Specifications, it shall mean the VA Resident Engineer or VA Contracting Officer.

### **2.2 AGGREGATES**

- A. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.
- B. Subbase aggregate (where required) maximum size: 38mm(1-1/2").
- C. Base aggregate maximum size:
1. Base course over 152mm(6") thick: 38mm(1-1/2");
  2. Other base courses: 19mm(3/4").

- E. Aggregates for asphaltic concrete paving: Provide a mixture of sand, mineral aggregate, and liquid asphalt mixed in such proportions that the percentage by weight will be within:

<u>Sieve Sizes</u>	<u>Percentage Passing</u>
19mm(3/4")	100
9.5mm(3/8")	67 to 85
6.4mm(1/4")	50 to 65
2.4mm(No. 8 mesh)	37 to 50
600µm(No. 30 mesh)	15 to 25
75µm(No. 200 mesh)	3 to 8

plus 50/60 penetration liquid asphalt at 5 percent to 6-1/2 percent of the combined dry aggregates.

### **2.3 ASPHALTS**

- A. Asphalt mix design shall meet the requirements of ISPWC, Section 810 Class III plan mix.
- B. Comply with provisions of Asphalt Institute Specification SS2:
1. Asphalt cement: Penetration grade 50/60
  2. Prime coat: Cut-back type, grade MC-250
  3. Tack coat: Uniformly emulsified, grade SS-1H

### **2.4 SEALER**

- A. Provide a sealer consisting of suitable fibrated chemical type asphalt base binders and fillers having a container consistency suitable for troweling after thorough stirring, and containing no clay or other deleterious substance.
- B. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

## **PART 3- EXECUTION**

### **3.1 GENERAL**

The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the State Highway Specifications for the type of material specified.

### **3.2 MIXING ASPHALTIC CONCRETE MATERIALS**

- A. Provide hot plant-mixed asphaltic concrete paving materials.
  - 1. Temperature leaving the plant: 143 degrees C(290 degrees F) minimum, 160 degrees C(320 degrees F) maximum.
  - 2. Temperature at time of placing: 138 degrees C(280 degrees F) minimum.

### **3.3 SUBGRADE**

- A. Shape to line and grade and compact with self-propelled rollers.
- B. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.
- C. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.
- D. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.
- E. Proof-roll the subgrade with maximum 45 tonne (50 ton) gross weight dump truck as directed by VA Resident Engineer or VA Contracting Officer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

### **3.4 BASE COURSES**

- A. Subbase (when required)
  - 1. Spread and compact to the thickness shown on the drawings.
  - 2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
  - 3. After completion of the subbase rolling there shall be no hauling over the subbase other than the delivery of material for the top course.



B. Base

1. Spread and compact to the thickness shown on the drawings.
2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.

C. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0mm (0.0") to plus 12.7mm (0.5").

D. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 5mm in 3m (3/16 inch in ten feet).

E. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

**3.5 PLACEMENT OF ASPHALTIC CONCRETE PAVING**

A. Remove all loose materials from the compacted base.

B. Apply the specified prime coat, and tack coat where required, and allow to dry in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.

C. Receipt of asphaltic concrete materials:

1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 130 degrees C (280 degrees F).
2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (50 degrees F), not during fog, rain, or other unsuitable conditions.

D. Spreading:

1. Spread material in a manner that requires the least handling.
2. Where thickness of finished paving will be 76mm (3") or less, spread in one layer.

E. Rolling:

1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown on the drawings.
2. Roll in at least two directions until no roller marks are visible.
3. Finished paving smoothness tolerance:
  - a. No depressions which will retain standing water.
  - b. No deviation greater than 3mm in 1.8m (1/8" in six feet).

### **3.6 APPLICATION OF SEAL COAT**

- A. Prepare the surfaces, mix the seal coat material, and apply in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.
- B. Achieve a finished surface seal which, when dry and thoroughly set, is smooth, tough, resilient, of uniform black color, and free from coarse textured areas, lap marks, ridges, and other surface irregularities.
- C. When sealing new asphalt paving wait an entire year to allow for the expansion and contraction of a year's cycle of both warm and cool temperatures. This allows for the asphalt's oils to properly cure and begin oxidation before applying a seal coat.
- D. When seal coating in less than a year apply two coats, spray applied. This application method is preferred for less than a year application when there is still plenty of asphalt cement present for the seal coat to bond to.

### **3.7 PROTECTION**

Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

### **3.8 FINAL CLEAN-UP**

Remove all debris, rubbish, and excess material from the work area.

--- E N D ---

**SECTION 32 17 23  
PAVEMENT MARKINGS**

**PART 1- GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Paint on pavement surfaces, in form of traffic lanes, parking bays, areas restricted to handicapped persons, crosswalks, and other detail pavement markings.

**1.2 RELATED REQUIREMENTS**

- A. Paint VOC Limits: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- B. Paint Color: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 APPLICABLE PUBLICATIONS**

- A. Comply with references to extent specified in this section.
- B. Federal Specifications (Fed. Spec.):
  - 1. TT-B-1325D - Beads (Glass Spheres) Retro-Reflective.
  - 2. TT-P-1952F - Paint, Traffic and Airfield Marking, Waterborne.
- C. Master Painters Institute (MPI):
  - 1. No. 97 - Traffic Marking Paint, Latex.

**1.4 SUBMITTALS**

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
  - 1. Show pavement marking configuration and dimensions.
  - 2. Show international symbol of accessibility at designated parking spaces.
- C. Manufacturer's Literature and Data:
  - 1. Description of each product.
  - 2. Application instructions.
- D. Samples:
  - 1. Paint: 200 mm (8 inches) square, each type and color.
- E. Certificates: Certify products comply with specifications.
- F. Qualifications: Substantiate qualifications comply with specifications.

1. Installer with project experience list.

### **1.5 QUALITY ASSURANCE**

#### **A. Installer Qualifications:**

1. Regularly installs specified products.
2. Installed specified products with satisfactory service on five similar installations for minimum five years.
  - a. Project Experience List: Provide contact names and addresses for completed projects.

### **1.6 DELIVERY**

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.
- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

### **1.7 STORAGE AND HANDLING**

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

### **1.8 FIELD CONDITIONS**

#### **A. Environment:**

1. Product Temperature: Minimum 13 degrees C (55 degrees F) for minimum 48 hours before installation.
  - a. Surface to be painted and ambient temperature: Minimum 10 degrees C (50 degrees F) and maximum 35 degrees C (95 degrees F).

- B. Field Measurements: Verify field conditions affecting traffic marking installation. Show field measurements on Submittal Drawings.

### **1.9 WARRANTY**

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

## **PART 2- PRODUCTS**

### **2.1 SYSTEM PERFORMANCE**

A. Design paint complying with specified performance:

1. Application: Fed. Spec. TT-P-1952.

### **2.2 PRODUCTS - GENERAL**

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.

B. Provide each product from one manufacturer and from one production run.

1. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:
  - a. Paints and coatings.

### **2.3 SANDBLASTING EQUIPMENT**

A. Air compressor, hoses, and nozzles of proper size and capacity as required for cleaning painted surfaces. Compressor to provide minimum 0.08 cu. m/s (150 cfm) of air at pressure of minimum 625 kPa (90 psi) at each nozzle used.

### **2.4 PAINT APPLICATOR**

A. Apply marking paint with approved mechanical equipment. Provide equipment with constant agitation of paint and travel at controlled speeds. Synchronize one or more paint "guns" to automatically begin and cut off paint flow in case of skip lines. Equipment to have manual control to apply continuous lines of varying length and marking widths as indicated on Drawings. Provide pneumatic spray guns for hand application of paint in areas where mobile paint applicator cannot be used.

### **2.5 PAINT**

A. Paint: MPI No. 97. For obliterating existing markings comply with Fed. Spec. TT-P-1952. Provide minimum 18 L (5 gallons) containers.

### **2.6 REFLECTIVE GLASS BEADS**

A. Beads: Comply with Fed. Spec. TT-B-1325, Type I, Gradation A. In regions of high humidity, coat beads with silicone or other suitable waterproofing material to ensure free flow. Provide glass beads in containers suitable for handling and strong enough to prevent loss during shipment.

## **PART 3- EXECUTION**

### **3.1 PREPARATION**

- A. Examine and verify substrate suitability for product installation.
  - 1. Allow new pavement surfaces to cure for period of minimum 14 days before application of marking materials.
- B. Protect existing construction and completed work from damage.
- C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.
  - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or combination of these methods.
  - 2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by Contracting Officer's Representative.
  - 3. As an option, comply with Fed. Spec. TT-P-1952 for removal of existing paint markings on asphalt pavement. Apply black paint in as many coats as necessary to completely obliterate existing markings.
  - 4. Scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application, Where oil or grease are present on old pavements to be marked, .
    - a. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through new paint.
  - 5. Clean and dry surface before pavement marking. Do not begin any marking until Contracting Officer's Representative inspected surface and gives permission to proceed.

### **3.2 TEMPORARY PAVEMENT MARKING**

- A. Apply Temporary Pavement Markings of colors, widths and lengths shown on drawings or directed by Contracting Officer's Representative. After temporary marking has served its purpose and when so ordered by Contracting Officer's Representative, remove

temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method to prevent damage on applied surface.

- B. As an option, provide approved preformed pressure sensitive, adhesive tape type of temporary pavement marking of required colors, widths and lengths in lieu of temporary painted marking. Continuous durability and effectiveness of such marking is required during period for which its use is required. Remove any unsatisfactory tape type marking and replace with painted markings.

### **3.3 INSTALLATION - GENERAL**

- A. Install products according to manufacturer's instructions and approved submittal drawings.
  - 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

### **3.4 PAINT APPLICATION**

- A. Apply uniformly painted pavement marking of required colors, length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces.
- B. Comply with details as indicated on drawings and established control points.
- C. Apply paint at wet film thickness of 0.4 mm (0.015 inch). Apply paint in one coat. When directed by Contracting Officer's Representative, apply additional coats at markings showing light spots. Comply with paint manufacturer's maximum drying time requirements to prevent undue softening of asphalt, and pick-up, displacement, or discoloration by tires of traffic.
- D. When deficiency in marking drying occurs, discontinue paint operations until cause of slow drying is determined and corrected.
- E. Remove and replace marking applied less than minimum material rates, deviates from true alignment, exceeds stipulated length and width tolerances, or shows light spots, smears, or other deficiencies or irregularities.
- F. Remove marking by carefully controlled sandblasting, approved grinding equipment, or other approved method to prevent damage on applied surface.

### **3.5 DETAIL PAVEMENT MARKING APPLICATION**

- A. Apply Detail Pavement Markings, exclusive of actual traffic lane marking as follows:
  - 1. At exit and entrance islands and turnouts.
  - 2. On curbs.
  - 3. At crosswalks.
  - 4. At parking bays.
  - 5. Other locations as indicated on drawings.
- B. Apply International Handicapped Symbol at indicated parking spaces. Color as shown on drawings. Apply paint for symbol using suitable template that will provide pavement marking with true, sharp edges and ends.
- C. Install detail pavement markings of colors, widths and lengths, and design pattern at locations indicated on drawings.

### **3.6 TOLERANCES**

- A. Length and Width of Lines: Plus or minus 75 mm (3 inches) and plus or minus 3 mm (1/8 inch), respectively, in case of skip markings.
- B. Length of intervals exceeding line length tolerance are not acceptable.

### **3.7 CLEANING**

- A. Remove excess paint before paint sets.

### **3.8 PROTECTION**

- A. Protect pavement markings from traffic and construction operations.
  - 1. Protect newly painted markings from vehicular traffic until paint is dry and track free.
  - 2. Place warning signs at beginning of wet line, and at points well in advance of marking equipment for alerting approaching traffic from both directions.
  - 3. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
- B. Repair damage.

--- E N D ---



**SECTION 32 84 00  
PLANTING IRRIGATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Automatically-controlled lawn irrigation system, controls and all other appurtenances.

**1.2 RELATED REQUIREMENTS**

- A. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- B. Metering: SECTION 25 10 10, ADVANCED UTILITY METERING SYSTEM.

**1.3 ABBREVIATIONS**

- A. HDPE: High-density polyethylene plastic.
- B. NPT: National pipe thread.
- C. PTFE: Polytetrafluoroethylene.
- D. PVC: Polyvinyl chloride plastic.

**1.4 DEFINITIONS**

- A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves.
- B. Drain Piping: Downstream from circuit-piping drain valves.
- C. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 Volts or for remote-control, signaling power-limited circuits.

**1.5 APPLICABLE PUBLICATIONS**

- A. Comply with references to extent specified in this section.
- B. American Society Of Mechanical Engineers (ASME):

1. B16.18-2012 - Cast Copper Alloy Solder Joint Pressure Fittings.
  2. B16.22-2013 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  3. B16.24-2011 - Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500 and 2500.
  4. B40.100-2013 - Pressure Gauges and Gauge Attachments.
- C. American Society Of Sanitary Engineering (ASSE):
1. 1013-2011 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.
- D. ASTM International (ASTM):
1. B88-14/B88M-13 - Seamless Copper Water Tube.
  2. B813-10 - Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
  3. D1785-15 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120.
  4. D2239-12- Polyethylene (PE) Plastic Pipe (SDR) Based on controlled Inside Diameter.
  5. D2241-15 - Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series).
  6. D2464-15 - Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  7. D2466-15 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
  8. D2564-12 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
  9. D2609-15 - Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
  10. D2683-14 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
  11. D2855-15 - Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
  12. F477-14 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- E. American Water Works Association (AWWA):
1. C504-15 - Rubber-Seated Butterfly Valves.
  2. C906-15 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks.

- F. American Welding Society (AWS):
  - 1. A5.8/A5.8M-04 - Filler Metals for Brazing and Braze Welding.
- G. National Fire Protection Association (NFPA):
  - 1. 70 2011 Edition - National Electrical Code.

## **1.6 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. Contractor.
    - d. Installer.
  - 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.

## **1.7 SUBMITTALS**

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show size, configuration, and installation details.
2. Show complete detailed irrigation layout covering design of system showing pipe sizes and lengths; fittings; locations; types and sizes of sprinklers; controls; backflow preventers; valves; drainage pits; and connections to water supply main.
3. Do not start work before final shop drawing approval.

C. Manufacturer's Literature and Data:

1. Description of each product.
  - a. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - b. Include zone chart and controller timing schedule showing each irrigation zone and its control valve; and show time settings for each automatic controller zone.
2. Installation instructions.
3. Warranty.

D. Extra Materials: Show labels describing contents.

E. Certificates: Certify each product complies with specifications.

1. Control systems.
2. Show control system is UL Listed for specified application.

F. Qualifications: Substantiate qualifications comply with specifications.

1. Irrigation Installer
2. Service provider

G. Delegated Design Drawings and Calculations: Signed and sealed by responsible design professional.

H. Operation and Maintenance Data:

1. Start-up, maintenance, troubleshooting, emergency, and shut-down instructions for each operational product.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Regularly installs specified products.
2. Installed specified products with satisfactory service on five similar installations for minimum five years.

#### **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.
- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.
- D. Store plastic piping protected from direct sunlight. Support pipe to prevent sagging and bending.

#### **1.10 WARRANTY**

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

### **PART 2 - PRODUCTS**

#### **2.1 SYSTEM DESCRIPTION**

- A. Provide system that operates with minimum water pressure of 65 psi at connection to meter backflow prevention device
- B. Irrigation Zone Control: Automatic operation with controller and automatic control valves.

#### **2.2 SYSTEM PERFORMANCE**

- A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.
- B. Design piping, valves, and specialties complying with following maximum pressure performance requirements:
  1. Irrigation Main Piping: 640 kPa (100 psi)
  2. Circuit Piping: 520 kPa (80 psi)

## 2.3 MATERIALS

### A. Piping Materials:

1. Polyvinyl Chloride (PVC) Pipe: ASTM D1785 PVC 1120, Schedule 40; or ASTM D2241, PVC 1120 compound, SDR 21 or SDR 26
  - a. Fittings:
    - 1) Socket Type: ASTM D2466, Schedule 40
    - 2) Threaded Type: ASTM D2464, Schedule 80.
    - 3) Swing Joints: Threaded fittings with elastomeric seals and minimum 1380 kPa (200 psi) working pressure.
  - b. Solvent Cement: ASTM D2564.
  - c. Flange Gaskets, Bolts, and Nuts: Type as recommended by manufacturer.

### B. Valves:

1. Underground Shut-Off Valves:
  - a. Butterfly Valves 50 mm (2 Inches) and Larger: AWWC504, iron body, bronze mounted, double disc with parallel or inclined seats, non-rising stem turning clockwise to close, 150 psi (1025 kPa) minimum working pressure.
  - b. Ball Valves, Isolation valves, 38 mm (1-1/2 Inch) and Smaller: Full-port ball valves with bronze body, PTFE seats, and 90 degree on/off handle. Ball valves to have NPT female end connections.
  - c. Operations:
    - 1) Underground Applications: Use valves with 50 mm (2 inch) nut for T-Handle socket wrench operation.
    - 2) Aboveground and Valve Pit Applications: Use valves with handwheels.
    - 3) Provide enclosed gear drive operators for all butterfly valves 150 mm (6 inches) and larger.
    - 4) Valve ends: Accommodate type of main pipe adjacent to valve.
2. Swing Check Valves:
  - a. Valves Smaller than 100 mm (4 inches): ASTM B61 or ASTM B62 850 kPa (125 psi) bronze body and bonnet.

- b. Valves 100 mm (4 inches) and Larger: ASTM B61 or ASTM B62, 1380 kPa (200 psi), iron body, bronze trim, vertical or horizontal installation, flange connection.
  - 3. Pressure Reducing Valve: Cast steel body with renewable seats and stainless steel trim. Design flow passages and all parts to withstand high velocity applications, flange connected.
  - 4. Remote Control Valves: Solenoid actuated valves, 24 Volt AC, installed underground.
    - a. Globe Valves: Heavy duty construction with manual shut-off and flow control adjustment manual operation.
    - b. Straight or Angle Valve:
      - 1) Cast iron valve body with brass bonnet, trim and renewable seat with two inlet taps.
      - 2) Molded-plastic body, normally closed diaphragm type with manual shut off and flow control adjustment.
    - c. Provide valves with unions and housing with minimum working pressure, 1025 kPa (150 psi).
  - 5. Quick Couplers: Brass parts, two-piece unit consisting of coupler water seal valve assembly and removable upper body to allow spring and key track to be serviced without shut down of main.
    - a. Lids: Lockable vinyl cover with springs for positive closure on key removal.
  - 6. Reduced Pressure Principle Backflow Preventer: ASSE 1013. Provide for new connection to water distribution system.
  - 7. Valves Serviceability: From top without removing valve body from system. Provide 750 mm (30 inch) long adjustment keys. Valves to operate at no more than 50 kPa (7 psi) pressure loss at manufacturers maximum recommended flow rate.
- C. Sleeve Material: ASTM D2241, Schedule 40.

## **2.4 AUTOMATIC CONTROL EQUIPMENT - ELECTRIC**

- A. Control Equipment: NEMA ICS 2 with 20-volt single phase service, operating with indicated station, and ground chassis. Provide enclosure NEMA ICS 6 Type 3R, with locking hinge cover, wall mounted.
  - 1. Electric Controller: Programmed for various schedules by operating individual remote control valves, with following manufacturer's standard recommended components:
    - a. Central computer.
    - b. Flow meter.
    - c. Moisture sensor.
    - d. ET (evapotranspiration).
    - e. Measurement device.
    - f. Rain measurement device.
    - g. Wind measurement device.
    - h. Central control software.
    - i. Field controller.
    - j. Accessories required to operate system.
  - 2. Independent Electric Controllers: UL approved. Programmed for various schedules by one or more independent controllers to operate individual remote control valves, with following manufacturer's standard recommended components:
    - a. Flow meter.
    - b. Rain sensor.
    - c. Accessories required to operate system.
  - 3. Independent Electric Controller with No Flow Sensing (For Small Installations): Programmed for various schedules by one controller to operate individual remote control valve, with manufacturer's standard components.
  - 4. Solar-Powered: Programmed for various schedules by one or more independent controllers to operate individual remote control valves, with manufacturer's recommended components.



## **2.5 SPRINKLER HEADS**

- A. Sprinkler Heads: Manufacturer's standard unit designed to provide uniform coverage over entire area of spray as indicated on Drawings. Internal assembly includes filter screen, capable of removal from top without removing sprinkler case from riser.
  - 1. Rotary Pop-Up Sprinklers: Gear-driven, impact resistant heavy-duty ABS with gears and pinions assembled on stainless steel spindles.
    - a. Full circle sprinklers, dual or tri-nozzle combination type with positive water-driven gear assembly.
    - b. Part circle sprinklers, variable arc type.
  - 2. Shrub Spray: Pop-up or fixed spray type with heavy-duty, ultraviolet resistant plastic sprinkler body, stem, nozzle, and screen and stainless steel retract spring and ratcheting system for alignment of pattern.
  - 3. Drip Emitters: Pressure compensating, permanently assembled type with 13 mm (1/2 inch) FPT inlet, capable of providing 3.8 L/min. (1 gpm) at inlet pressures between 100 and 340 kPa (15 and 50 psi).
  - 4. Emitter Distribution Tubing: Constructed of UV resistant vinyl material, 5.5 mm (0.22 inch) O.D. and 4 mm (0.16 inch) I.D., manufactured by same manufacturer as drip emitters.

## **2.6 LOW VOLTAGE CONTROL VALVE WIRE**

- A. Wire: NFPA 70, solid copper wire, minimum 1.8 mm (14 gage), UL LLC approved for direct burial in ground.

## **2.7 LOW VOLTAGE CONTROLLER CABLE**

- A. Multi-strand cable, UL-approved for direct burial in ground, size and wire type according to manufacturer's recommendations.

## **2.8 TRACER WIRES**

- A. Tracer Wires: Plastic-coated copper tracer wire, 1.8 mm (14 gage), green, Type TW, installed with non-metallic irrigation main lines.

## **2.9 SPLICING MATERIALS**

- A. Epoxy waterproof sealing packet.

## **2.10 ACCESSORIES**

- A. Valve Box: Precast concrete with compressive strength in excess of 30 MPa (4,000 psi).  
Provide valve boxes suitable and adjustable for valve used.
  - 1. Cast word "Irrigation" on cover.
  - 2. Provide "T" handle socket wrenches, 15 mm (5/8 inch) round stock with sufficient length to extend 600 mm (2 feet) above top of deepest valve box cover.
  - 3. Stencil controller and circuit numbers with permanent white epoxy paint. Letters minimum 75 mm (3 inches) height.
  - 4. Provide 760 mm (30 inches) long valve adjustment keys.
  - 5. Valve Box in Plant Bed Areas: HDPE structural foam Type A, Class III.
    - a. Color: Tan.
    - b. Size: Minimum 480 (19 inches) long by 355 mm (14 inches) deep with key-lockable hinged cast iron cover.
- B. Backflow Preventer: ASSE 1013. Provide reduced pressure principle backflow preventer at each new connection to water distribution system.
- C. Water Meters:
  - 1. Meters: Comply with Section 25 10 10, ADVANCED UTILITY METERING SYSTEM.  
Connect irrigation system as follows:
    - a. Use existing building water meter.
- D. Pressure Gages: ASME B40.100, 113 mm (4-1/2 inches) diameter, all metal case, with bottom connection.
  - 1. Dial: Dead black throughout with maximum graduations of 13.8 kPa (2 psi). Provide shut-off cocks.
- E. Concrete Pit: Reinforced poured in place concrete structure as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE or approved precast concrete unit.
  - 1. Frames And Covers for Concrete Pit:

- a. For roadway applications, traffic rated frame and cover, AASHTO H20-44 loading.
- b. For non-roadway applications, provide:
  - 1) Cast-iron cover with cast-in identification symbol "IRR-WATER".
  - 2) Frame: Type I, Straight Traffic Frame, Style A, Size 30A.
  - 3) Cover: Type B, Size 30A.
- F. Strainers:
  - 1. Brass Strainer Basket:
    - a. Bodies smaller than 63 mm (2-1/2 inches), brass or bronze.
    - b. Bodies 63 mm (2-1/2 inches) and larger, cast iron or semi-steel.
    - c. Provide strainer cover with blow-off connection and shut-off valve to accommodate 18 mm (3/4 inch) diameter hose connection.
- G. Warning Tape: Polyethylene film warning tape, 0.1 mm (4 mils) thick, 75 mm (3 inches) wide, detectable, imprinted with "CAUTION BURIED IRRIGATION WATER LINE BELOW", colored as follows:
  - 1. Blue with Black Letters: Potable water.
  - 2. Purple with Black Letters: Reclaimed or untreated well water.

### **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. Examine proposed irrigation areas for compliance with requirements and conditions affecting installation and performance.
- D. Set stakes to identify locations of proposed irrigation system. Obtain Contracting Officer's Representative's approval before excavation.

#### **3.2 INSTALLATION - GENERAL**

- A. Install products according to manufacturer's instructions

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

### **3.3 PIPE INSTALLATION - GENERAL**

- A. Layout work as indicated on drawings. Lines are to be in common trench wherever possible.
- B. Install sprinkler lines to avoid HVAC trenches, electric ducts, storm and sanitary sewer lines, and existing water and gas mains; all of which have right of way.
- C. Cut existing sidewalks and curbs during trenching and installation of pipe. Install pipe under sidewalks and curbs by jacking, auger boring, or by tunneling. Repair or replace any cracked concrete, due to settling, during warranty period.
- D. Do not lay pipe on unstable material, in wet trenches or, in opinion of Contracting Officer's Representative, when trench or weather conditions are unsuitable for work.
- E. Allow minimum of 75 mm (3 inches) between parallel pipes in same trench.
- F. Clean interior portion of pipe and fittings of foreign matter before installation. Securely close open ends of pipe and fittings with caps or plugs to protect fixtures and equipment against dirt, water and chemical or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- G. Install full length of each section of pipe resting upon pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipe on wood blocking.
- H. Hold pipe securely in place while joint is being made.
- I. Do not work over, or walk on, pipe in trenches until covered by layers of earth, well tamped, in place to depth of 300 mm (12 inches) over pipe.
- J. Install irrigation lines and control wire at designated utility lanes or beside roadways where possible.
- K. Connect new system to existing mains.
- L. Install concrete thrust blocks where irrigation main changes direction at "L" and "T" locations and where irrigation main terminates. Delay pressure tests until minimum 36 hours after completing thrust blocks. Size and place concrete thrust blocks for supply mains according to pipe manufacturer's instructions.

- M. Minimum cover over water mains, 760 mm (30 inches). Cover laterals to minimum depth of 600 mm (24 inches).
- N. Place warning tape 300 mm (12 inches) above sprinkler system water mains and laterals.

### **3.4 PLASTIC PIPE INSTALLATION**

- A. Install plastic pipe snaked in trench at least 1 m per 30 m (1 foot per 100 feet) to allow for thermal construction and expansion and to reduce strain on connections.
- B. Joints:
  - 1. Solvent Welded Socket Type: ASTM D2855.
  - 2. Threaded Type: Apply liquid Polytetrafluoroethylene (PTFE) thread lubricant or PTFE thread tape. After joint is made hand tight (hard), strap wrench should be used to make up to two additional full turns.
  - 3. Elastomeric Gasket: ASTM F477.

### **3.5 VALVE INSTALLATION**

- A. Group remote control valves wherever possible and aligned at set dimension back of curb along roads.
- B. Do not install valves under roads, pavement or walks.
- C. Clean interior of valves of foreign matter before installation.
- D. House pressure control valves installed adjacent to remote control valve in same valve box.
- E. Install valve box with cover flush with finished grade.
- F. Install control valves minimum 75 mm (3 inches) below finished grade.

### **3.6 SLEEVE INSTALLATION**

- A. Install sleeves where pipe and control wires are installed under walks, paving, walls, and other similar areas.
- B. Install sleeves twice line size or greater extend 300 mm (12 inches) beyond edges of paving or construction.

- C. Bed sleeves with minimum 100 mm (4 inches) sand backfill above top of pipe in areas where pipe is placed before hardscape is installed.

### **3.7 EMITTER HOSE INSTALLATION**

- A. Joint: Solvent weld connection.
- B. Install line size by 9 mm (3/8 inch) insert bushings adapters from PVC Schedule 40 fittings to flex vinyl hose.

### **3.8 SPRINKLER AND QUICK COUPLER INSTALLATION**

- A. Install sprinkler heads and quick couplers on temporary nipples extending at least 75 mm (3 inches) above finished grade. After turf is established, remove temporary nipples, install sprinkler heads and quick couplers at ground surface.
- B. Locate part circle heads to maintain maximum distance of 150 mm (6 inches) from edges and other boundaries.
- C. Provide swing joint assembly in all sprinklers, shrub sprays and quick couplers.
- D. Set shrub spray heads 200 mm (8 inches) above grade and 300 mm (12 inches) from edge of curb or pavement. Place adjacent to walls. Stake heads before backfilling trenches. Support stakes parallel to riser.
- E. Install entire system for manual and automatic draining. Equip low point of each underground line with drain valve draining into an excavation containing gravel. Backfill with excavated material and cover with 50 mm (2 inches) precast concrete cover.

### **3.9 DRIP IRRIGATION SPECIALTY INSTALLATION**

- A. Install drip heads in plastic drip box. Connect drip head to rigid PVC nipple. Attach tubing to barbed fitting and daylight distribution tubing at root ball secured with stake. Add bug cap at end of secured distribution tubing. After installing drip heads and before operating system, open end of drop lateral and flush lines clean. Limit number of drip heads on line according to manufacturer's recommendations for hose or distribution tubing size and length.

### **3.10 AUTOMATIC IRRIGATION - CONTROL SYSTEM INSTALLATION**

- A. Determine exact location of controllers in field before installation. Coordinate electrical service to these locations. Install according to manufacturer's instructions and NFPA 70.

### **3.11 CONTROL WIRE INSTALLATION**

- A. Install electric control cable in trenches with new mains or in separate trench at back of curb, unless cross-country route is indicated on Drawings. Locate in trench with mains when possible on cross-country routes.
- B. Install wiring bundles located with piping 50 mm (2 inches) below bottom of pipe. Color code each wire in bundle differently. Bundle multiple wires and tape together at 4570 mm (15 foot) intervals. Tag wires at controllers and control valve location with plastic tie wire tags. Provide same number and color of wire at each ends.
- C. Hold splicing to minimum. Provide pullbox at each splice. No splices will be allowed between field located controllers and remote control valves.
- D. Provide 300 mm (12 inch) expansion loops in wiring at each wire connection or change in wire direction. Provide 600 mm (24 inches) loop at remote control valves.
- E. Do not install power wires for operation of irrigation system in same conduit as irrigation control wires.

### **3.12 TRACER WIRE INSTALLATION**

- A. Install tracer wire on bottom of trench, adjacent to vertical pipe projections, and continuous throughout length of pipe, with spliced joints soldered and covered with insulation type tape.
- B. Install tracer wire following main line pipe and branch lines and terminate in yard box with gate valve controlling these main irrigation lines. Provide sufficient length of wire to reach finish grade, bend back end of wire to make loop and attach plastic label with designation "Tracer Wire."
- C. Record locations of tracer wires and their terminations on project record documents.

### **3.13 FRAMED INSTRUCTIONS**

- A. Post framed instructions, containing wiring and control diagrams under glass or in laminated plastic, where directed by Contracting Officer. Condensed operating instructions, prepared in typed form, framed and posted beside diagrams. Post framed instructions before acceptance testing of system. Submit labels, signs, and templates of operating instructions that are required to be mounted or installed on or near product for normal, safe operation. Prepare controller charts and programming schedule after as-built drawings are approved by Contracting Officer. Provide one black-line chart for each controller as reduced drawing of actual as-built system that will fit maximum dimensions inside controller housing. Indicate each station coverage area with different pastel or transparent color on chart. After chart is completed and approved for final acceptance, laminate chart, sealed between two 0.5 mm (20 mil) pieces of clear plastic.

### **3.14 FIELD QUALITY CONTROL**

- A. Special Inspections and Tests:
- B. Field Tests and Inspections: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
  - 1. Pressure test lines before joint areas are backfilled. Backfill minimum of 300 mm (12 inches) over pipe to maintain pipe stability during test period. Test piping at hydraulic pressure of 1030 kPa (150 psi) for two hours.
    - a. Maximum Loss: 3 L/25 mm pipe diameter/300 m (0.8 gallons per inch pipe diameter per 1,000-feet). Locate pump at low point in line and apply pressure gradually. Install pressure gage shut-off valve and safety blow-off valve between pressure source and piping. Inspect each joint and repair leaks. Repeat test until satisfactory results are achieved and accepted by Contracting Officer's Representative.
  - 2. After testing, flush system with minimum 150 percent of operating flow passing through each pipe beginning with larger mains and continuing through smaller mains in sequence. Flush lines before installing sprinkler heads and quick couplers.



3. Charge system and test for leaks after installation. Repair leaks and retest until no leaks exist.
4. After electrical circuitry has been energized and final adjustment of sprinkler heads is complete, test each sprinkler section by pan test and visual test to indicate uniform distribution within any one sprinkler head area and over entire area. Operate controllers and automatic control valves to demonstrate complete and successful installation and operation of all equipment.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Any irrigation product will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.15 PROTECTION**

- A. Protect irrigation system from construction operations.
- B. Remove protective materials immediately before acceptance.
- C. Repair damage.

--- E N D ---

**SECTION 32 90 00  
PLANTING**

**1. GENERAL**

**1. SUMMARY**

**A. Section Includes:**

1. Plants, soils, edging, turf, and landscape materials.

**2. DEFINITIONS**

- A.** Pesticide: Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and is specifically labeled for use by U.S. Environmental Protection Agency (EPA). Also, any substance used as plant regulator, defoliant, disinfectant, or biocide.
- B.** Planter Bed: An area containing one or combination of following plant types: shrubs, vines, wildflowers, annuals, perennials, ground cover, and mulch topdressing excluding turf. Trees may also be found in planter beds.
- C.** Stand of Turf: 95 percent of established species.

**3. APPLICABLE PUBLICATIONS**

- A.** Comply with references to extent specified in this section.
- B.** American National Standards Institute (ANSI):
1. Z60.12014 - Nursery Stock.
- C.** American Society for Testing And Materials (ASTM):
1. B22114 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  2. B221M13 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  3. C33/C33M16 Concrete Aggregates.
  4. C136/C136M14 - Sieve Analysis of Fine and Coarse Aggregates.
  5. C60213a - Agricultural Liming Materials.

6. D97713e1 - Emulsified Asphalt.
7. D526813 - Topsoil Used for Landscaping Purposes.
- D.** Hortus Third: Concise Dictionary of Plants Cultivated in United States and Canada.
- E.** Tree Care Industry Association (TCIA):
  1. A300P12008 - Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices (Pruning).
  2. Z133.12012 - Arboricultural Operations - Safety Requirements.
- F.** Turfgrass Producers International (TPI):
  1. 2006 Guideline Specifications to Turfgrass Sodding.
- G.** United States Department of Agriculture (USDA):
  1. DOA SSIR 422014 - Soil Survey Laboratory Methods Manual.
  2. Handbook No. 60 - Diagnosis and Improvement of Saline and Alkali Soils.

#### **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. Landscape Architect or Representative.
    - c. Contractor.
    - d. Installer.
  2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
    - a. Inspection of planting materials.
    - b. Installation schedule.
    - c. Installation sequence.
    - d. Preparatory work.
    - e. Protection before, during, and after installation.
    - f. Installation.
    - g. Inspecting.

- h. Environmental procedures.
- 3. Document and distribute meeting minutes to participants to record decisions affecting installation.

## **5. SUBMITTALS**

### **A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.**

### **B. Manufacturer's Literature and Data:**

- 1. Description of each product.
- 2. Photographs: Color photographs of each plant species showing actual size and condition of plants to be provided with measuring device included for scale. Where more than 20 plants are required of any species, submit minimum three photographs of average, best, and worst quality plant to be provided. Include on each photograph, plant full scientific name, size, and source nursery.
- 3. Installation instructions.
- 4. Warranty.

### **C. Samples:**

- 1. Trees and Shrubs: Full sized of each variety and size. Deliver samples to project site and maintain samples for duration of construction period.
- 2. Organic and Compost Mulch: 1 L. (1 quart) sealed plastic bag of each required mulch, including label with percentage weight of each material and source representing material to be provided. Samples to match color, texture, and composition of installed material.
- 3. Filter Fabric: 300 by 300 mm (12 by 12 inches).
- 4. Edging Materials and Accessories: Manufacturer's standard sizes.
- 5. Tree Wrap: Width of panel by 300 mm (12 inches).

### **D. Sustainable Construction Submittals:**

- 1. Recycled Content: Identify postconsumer and preconsumer recycled content percentage by weight.
- 2. Biobased Content:

- a. Show type and quantity for each product.
  - E. Test reports: Certify products comply with specifications.
  - F. Certificates: Certify products comply with specifications.
    - 1. Plant Materials: Department of Agriculture certification by State Nursery Inspector declaring material to be free from insects and disease.
    - 2. Seed and Turf Materials: Notarized certificate of product analysis.
  - G. Qualifications: Substantiate qualifications comply with specifications.
    - 1. Installer, including supervisor with project experience list.
  - H. Operation and Maintenance Data:
    - 1. Care instructions for each plant material.
- 6. QUALITY ASSURANCE**
- A. Installer Qualifications:
    - 1. Regularly installs specified products.
    - 2. Installed specified products with satisfactory service on five similar installations for minimum five years.
      - a. Project Experience List: Provide contact names and addresses for completed projects.
    - 3. Member in good standing of either Professional Landcare Network or American Nursery and Landscape Association.
    - 4. Personnel assigned to Work certified in all of following categories from Professional Landcare Network and submit one copy of certificate to Contracting Officer's Representative:
      - a. Certified Landscape Technician (CLT) - Exterior, with, installation, maintenance, irrigation, specialty areas, designated CLTExterior.
      - b. Certified Landscape Technician (CLT) - Interior, designated CLTInterior.
      - c. Certified Ornamental Landscape Professional, designated COLP.
  - B. Licensed Arborist required to submit one copy of license to Contracting Officer's Representative.

- C. Independent or university laboratory, recognized by State Department of Agriculture, with experience and capability to conduct testing indicated and that specializes in types of tests to be performed.
- D. Measure plants according to ANSI Z60.1. Pruning to obtain required sizes will not be permitted.
- E. Contracting Officer's Representative may review plant materials either at place of growth or project site before planting for compliance with requirements. Contracting Officer's Representative retains right to inspect trees and shrubs to determine if any unacceptable conditions exist and to reject any trees or shrubs at any time during Project. All rejected trees and shrubs must be immediately removed from Project site.
  - 1. Submit plant material source information to Contracting Officer's Representative seven days in advance of delivery to Project site.
- F. Material Test Reports: For existing native surface topsoil, existing in-place surface soil, and imported or manufactured topsoil.
  - 1. For each unamended soil type, provide soil analysis and written report by qualified soil testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant nutrient content of soil.
  - 2. Comply with USDA's Handbook No. 60 testing methods and written recommendations.
  - 3. Soil testing laboratory to oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Contracting Officer's Representative. Take minimum 3 representative samples from varied locations for each soil to be used or amended for planting purposes.
  - 4. Report suitability of tested soil for plant growth.
  - 5. Based on test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 92.9 sq. m (1000 sq. ft.) or volume per 0.76 cu. m (1 cu. yd.) for nitrogen, phosphorus, and

potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

6. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

## **7. DELIVERY**

- A.** Deliver packaged products in manufacturer's original sealed packaging.
- B.** Bulk Products:
  1. Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.
  2. Install erosion control materials to prevent erosion or displacement of bulk products.
- C.** Apply antidesiccant to trees and shrubs according to manufacturer's instructions to protect during digging, handling, and transportation.
  1. For deciduous trees or shrubs in full leaf, spray with antidesiccant at nursery before transporting and again two weeks after planting.
- D.** Wrap trees and shrubs with tree wrap according to manufacturer's instructions to protect from wind and other damage during digging, handling, and transportation.
- E.** Deliver bareroot stock plants freshly dug with root system packed in wet straw, hay, or similar material.
- F.** Deliver branched plants with branches tied and exposed branches covered with material that allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves.
- G.** Use of equipment such as "tree spades" is permitted provided plant balls are sized according to ANSI Z60.1 and tops are protected from damage.

## **8. STORAGE AND HANDLING**

- A.** Store bulbs, corms, and tubers in dry location at 16 to 18 degrees C (60 to 65 degrees F) until planting.
- B.** Store seeds and other packaged materials in dry locations away from contaminants.
- C.** Plant Storage and Protection: Store and protect plants not planted on day of arrival at Project site as follows:
  - 1. Shade and protect plants in outdoor storage areas from wind and direct sunlight until planted.
  - 2. Heelin bare root plants.
  - 3. Protect balled and burlapped plants from freezing or drying out by covering balls or roots with moist burlap, sawdust, wood chips, shredded bark, peat moss, or other approved material. Provide covering that allows air circulation.
  - 4. Keep plants in moist condition until planted by watering with fine mist spray.
  - 5. Do not store plant materials directly on concrete or bituminous surfaces.
- D.** Topsoil: Before stockpiling topsoil, eradicate on site undesirable growing vegetation. Clear and grub existing vegetation three to four weeks before stockpiling existing topsoil.
- E.** Root Control Barrier and Weed Control Fabric: Store materials in site in enclosures or under protective covering in dry location out of direct sunlight. Do not store materials directly on ground.
- F.** Handling: Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle balled and burlapped, balled and potted, container plants carefully to avoid damaging or breaking earth ball or root structure. Do not handle plants by trunk or stem. Remove damaged plants from Project site.

## **9. FIELD CONDITIONS**

- A.** Environment:
  - 1. Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.



2. Planting Dates:
  - a. Deciduous Material: From spring planting and from fall planting.
  - b. Evergreen Material: spring planting and fall planting.
3. Restrictions: Do not plant when ground is frozen, snow covered, muddy, or when air temperature exceed 32 degrees C (90 degrees F).
- B. Weather Limitations: Install plantings only during current and forecasted weather conditions that are comply with plant requirements. Apply associated products in compliance with manufacturers' instructions.

## **10. WARRANTY**

- A. Construction Warranty: FAR clause 52.24621, "Warranty of Construction."
- B. Manufacturer's Warranty: Warrant plantings and against material defects.
  1. Warranty Period: Two years.
  2. Plant and Turf Warranty Periods will begin from date of Government acceptance of project or phase for beneficial use and occupancy.
  3. Contracting Officer's Representative will reinspect plants and turf at end of Warranty Period. Replace any dead, missing, or defective plant material and turf immediately. Warranty Period will end on date of this inspection provided Contractor has complied with warranty work required by this specification. Comply with following requirements:
    - a. Replace any plants more than 25 percent dead, missing or defective plant material before final inspection.
    - b. Only one replacement of each plant will be required except when losses or replacements are due to failure to comply with these requirements.
    - c. Complete remedial measures directed by Contracting Officer's Representative to ensure plant and turf survival.
    - d. Repair damage caused while making plant or turf replacements.

## **2.PRODUCTS**

### **1. PRODUCTS - GENERAL**

- A.** Provide each product from one source or manufacturer.
- B.** Sustainable Construction Requirements:
  - 1. Select products with recycled content to achieve overall Project recycled content requirement.
    - a. Fertilizer.
    - b. Weed control fabric.
    - c. Root control barrier.
  - 2. Steel Recycled Content: 30 percent total recycled content, minimum.
  - 3. Aluminum Recycled Content: 80 percent total recycled content, minimum.
  - 4. Biobased Content:
    - a. Organic Mulch: 100 percent.
    - b. Peat: 100 percent.

### **2. PLANT MATERIALS**

- A.** Plant Materials: ANSI Z60.1, conforming to varieties specified and be true to scientific name as listed in Hortus Third. Well branched, well formed, sound, vigorous, healthy planting stock free from disease, sun scald, windburn, abrasion, and harmful insects or insect eggs and having healthy, normal, and undamaged root system.
  - 1. Trees Deciduous and Evergreen: Single trunked with single leader, unless otherwise indicated; symmetrically developed deciduous trees and shrubs of uniform habit of growth; straight boles or stems; free from objectionable disfigurements; evergreen trees and shrubs with well developed symmetrical tops, with typical spread of branches for each particular species or variety. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk; crossing trunks; cutoff limbs more than 19 mm (3/4 inch) in diameter; or with stem girdling roots will be rejected.

2. Ground Cover and Vine Plants: Provide number and length of runners for size specified on drawings, together with proper age for grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Provide plants grown under climatic conditions similar to those in locality of project. Spray all plants budding into leaf or having soft growth with an antidesiccant at nursery before digging.
3. Provide plants of sizes indicated, measured before pruning with branches in normal position. Plants larger in size than specified is acceptable with approval of Contracting Officer's Representative, with no change in contract price. When larger plants are used, increase ball of earth or spread of roots according to ANSI Z60.1.
4. Provide nursery grown plant material conforming to requirements and recommendations of ANSI Z60.1. Dig and prepare plants for shipment in manner that will not cause damage to branches, shape, and future development after planting.
5. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with burlap or strong cloth and tied.
6. Container grown plants to have sufficient root growth to hold earth intact when removed from containers, but not be root bound.
7. Make substitutions only when plant (or alternates as specified) is not obtainable and Contracting Officer's Representative authorizes change order providing for use of nearest equivalent obtainable size or variety of plant with same essential characteristics and an equitable adjustment of contract price.
8. Existing plants to be relocated: Ball sizes to conform to requirements for collected plants in ANSI Z60.1, and plants dug, handled, and replanted according to applicable articles of this Section.
9. Only plants grown in nursery are permitted.

- B. Label plants with durable, waterproof labels in weather resistant ink. Provide labels stating correct botanical and common plant name and variety and size as specified in list of required plants. Groups of plants may be labeled by tagging one plant. Labels to be legible for minimum 60 days after delivery to planting site.

### 3. SOD

- A. Sod: Nursery grown, certified and classified in TPI's "Guideline Specifications to Turf grass Sodding" as GSS. Machine cut sod at uniform thickness of 19 mm (3/4 inch) within tolerance of 6 mm (1/4 inch), excluding top growth and thatch. Each individual sod piece to be strong enough to support its own weight when lifted by ends. Broken pads, irregularly shaped pieces, and torn or uneven ends will not be permitted.
- B. Sod Species: Genetically pure, free of weeds, pests, and disease.
  - 1. Full Sun: Match existing

### 4. TURF SELECTIONS

- A. Grasses for Cool Regions:
  - 1. Bentgrasses: Redtop (*Agrostis alba*) and Colonial (*Agrostis tenuis*).
  - 2. Bluegrasses: Kentucky (*Poa pratensis*), Roughstalked (*Poa trivialis*) and Canada (*Poa compressa*).
  - 3. Fescue: Red (*Festuca rubra*), Meadow (*Festuca pratensis*) and Tall (*Festuca arundinacea*).
  - 4. Ryegrasses: Perennial (*Lolium perenne*).
- B. Grasses for Warm Regions:
  - 1. Bermuda grass (*Cynodon dactylon*).
  - 2. Carpetgrass (*Axonopus affinis*).
  - 3. Centipedegrass (*Eremochloa phylloides*).
  - 4. St. Augustinegrass (*Stenotaphrum secundatum*).
  - 5. Zoysiagrass (*Zoysia matrella*).

### 5. SPRIGS

- A. Sod Sprigs: Healthy living stems, stolons, or rhizomes and attached roots of locally adapted grass without adhering soil, including two to three nodes and from 100 to

150 mm (4 to 6 inches) long. Obtain from heavy, dense certified sod classified as TPI GSS. Obtain sprigs from designated area on project site. Provide sprigs grown under climatic conditions similar to those of project site. Coordinate harvesting and planting to prevent sun exposure for more than 30 minutes before covering and moistening. Sprigs containing weeds or other detrimental material or that are heat damaged will be rejected.

## **6. PLUGS**

- A.** Plugs: Nursery grown sod, certified and classified in TPI's "Guideline Specifications to Turf grass Sodding" as GSS.
- B.** Square or round sections with deep, mature root system.
  - 1. Species to match adjacent sod.
  - 2. Plug Size: 50 mm (2 inches), 75 mm (3 inches), 100 mm (4 inches), by 50 mm (2 inches).

## **7. PLANTING SOILS**

- A.** Planting Soil: Evaluate soil for use as topsoil according to ASTM D5268. From 5 to 10 percent organic matter as determined by topsoil composition tests of Organic Carbon, 6A, Chemical Analysis Method described in USDA DOA SSIR 42. Maximum particle size, 19 mm (3/4 inch), with maximum 3 percent retained on 6 mm (1/4 inch) screen. Mix topsoil with following soil amendments and fertilizers as recommended by soils analysis.
- B.** Existing Planting Soil: Existing, native surface topsoil formed under natural conditions retained during excavation process and stockpiled onsite. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
  - 1. Supplement with another specified planting soil when quantities are insufficient.
  - 2. Mix existing, native surface topsoil with soil amendments and fertilizers as recommended by soils analysis.
- C.** Imported Planting Soil: Imported topsoil or manufactured topsoil from offsite sources are acceptable if sufficient topsoil is not available on site to meet specified depth. At

least 10 days before topsoil delivery, notify Contracting Officer's Representative of topsoil sources. Obtain imported topsoil displaced from naturally well drained construction or mining sites where topsoil is at least 100 mm (4 inches) deep. Topsoil from agricultural land, bogs, or marshes will be rejected.

## **8. INORGANIC SOIL AMENDMENTS**

- A.** Lime: Commercial grade hydrated or burnt limestone containing calcium carbonate equivalent (CCE) specified in ASTM C602 of minimum 80 percent.
- B.** Sulfur: 100 percent elemental.
- C.** Iron Sulfate: 100 percent elemental.
- D.** Aluminum Sulfate: Commercial grade.
- E.** Perlite: Horticultural grade.
- F.** Agricultural Gypsum: Coarsely ground from recycled scrap gypsum board comprised of calcium sulfate dehydrate 91 percent, calcium 22 percent, sulfur 17 percent, minimum 96 percent passing through 850 micrometers 20 mesh screen, 100 percent passing through 970 micrometers 16 mesh screen.
- G.** Coarse Sand: ASTM C33/C33M, clean and free of materials harmful to plants.
- H.** Vermiculite: Horticultural grade for planters.
- I.** Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- J.** Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

## **9. ORGANIC SOIL AMENDMENTS**

- A.** Organic Matter: Commercially prepared compost. Free of substances toxic to plantings and as follows:
  - 1.** Organic Matter Content: Wood cellulose fiber, wood chips, ground or shredded bark, shredded hardwood, bark peelings, pine straw mulch, pine needles from project site when available. Biobased content 100 percent. Wood cellulose fiber processed to contain no growth or germinationinhibiting factors, dyed with

nontoxic, biodegradable dye to appropriate color to facilitate visual metering of materials application.

2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source separated or compostable mixed solid waste.
- B. Peat: Natural product of sphagnum moss peat, peat moss, hypnum moss, peat reed sedge peat, peat humus, derived from freshwater site, conforming to, ASTM D4427, ASTM D5539, and containing no invasive species, including seeds. Shred and granulate peat to pass 12.5 mm (1/2 inch) mesh screen and condition in storage pile for minimum 6 months after excavation. Biobased content minimum 100 percent.
- C. Composted Derivatives: Ground bark, nitolized sawdust, humus, or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having following properties:
  1. Particle Size: Minimum percent by weight passing:
    - a. 4.75 mm (No. 4) mesh screen: 95.
    - b. 2.36 mm (No. 8) mesh screen: 80.
  2. Nitrogen Content: Minimum percent based on dry weight:
    - a. Fir sawdust: 0.7.
    - b. Fir or pine bark: 1.0.
  3. Biobased Content: 100 percent.
- D. Manure: Well rotted, horse or cattle manure containing maximum 25 percent by volume of straw, sawdust, or other bedding materials; free of seeds, stones, sticks, soil, and other invasive species.

## **10. PLANT FERTILIZERS**

- A. Soil Test: Evaluate existing soil conditions and requirements before fertilizer selection and application to minimize use of all fertilizers and chemical products. Obtain approval of Contracting Officer's Representative for allowable products, product alternatives, scheduling and application procedures. Evaluate existing weather and site conditions before application. Apply products during favorable weather and site conditions according to manufacturer's instructions and warranty requirements. Fertilizers to be

registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer applicable to specific areas as required for Project conditions and application. Provide commercial grade plant and turf fertilizers, free flowing, uniform in composition and conforms to applicable state and federal regulations.

- B.** Fertilizer for groundcover, wildflowers, and grasses is not acceptable. Provide fertilizer for trees, plants, and shrubs as recommended by plant supplier, except synthetic chemical fertilizers are not acceptable. Fertilizers containing petrochemical additives or that have been treated with pesticides or herbicides are not acceptable.
- C.** Granular Fertilizer: Organic, granular controlled release fertilizer containing minimum percentages, by weight, of plant food nutrients.
  - 1. Composition: Nitrogen, phosphorous, potassium, sulfur, and iron in amounts recommended in soil reports from qualified soiltesting laboratory.
- D.** Fertilizer Tablets: Organic plant tablets composed of tightly compressed fertilizer chips, insoluble in water, to provide continuous release of nutrients for minimum 24 months and containing following minimum percentages, by weight, of plant food nutrients:
  - 1. Nutrient Composition: 20 percent available nitrogen, 20 percent available phosphorous, and 5 percent available potassium.

## **11. WEED CONTROL FABRIC**

- A.** Roll Type Polypropylene or Polyester Mats: Woven, needle punched, or nonwoven fabric treated for protection against deterioration due to ultraviolet radiation. Minimum 99 percent opaque to prevent photosynthesis and seed germination, fabric allows air, water, and nutrients to pass through to plant roots.
  - 1. Minimum weight: 0.11 kg per square meter (5 ounces per square yard).
  - 2. Minimum thickness: 0.50 mm (20 mils).

## **12. MULCH**

- A.** Organic Mulch:



1. Ground or shredded bark or shredded hardwood for project site when available.  
Biobased content minimum 100 percent. Wood cellulose fiber processed to contain no growth or germination inhibiting factors, dyed with nontoxic, biodegradable dye to an appropriate color to facilitate visual metering of application.
  - a. Straw for Lawn Seed Bed Mulch: Stalks from oats, wheat, rye, barley, or rice free of noxious weeds, mold or other objectionable material. Air dried and suitable for placing with blower equipment.
  - b. Wood cellulose fiber for hydraulic application of grass seed and fertilizer:  
Specially prepared wood cellulose fiber, processed to contain no growth or germination inhibiting factors, and dyed an appropriate color to facilitate visual metering of application of materials. Maximum 12 percent moisture dry weight, plus or minus 3 percent at time of manufacture. pH range from 3.5 to 5.0. Manufacturer wood cellulose fiber for application as follows:
    - 1) After addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other approved additives, fibers will become uniformly suspended to form a homogeneous slurry.
    - 2) When hydraulically sprayed, material will form blotterlike cover impregnated uniformly with grass seed.
    - 3) Cover will allow absorption of moisture and allow rainfall or applied water to percolate to underlying soil.
2. Color: Natural.

### **13. EDGING**

- A.** Steel Edging: Commercialgrade steel product with rolled edge, in standard lengths, with steel loops for installation with stakes.
  1. Edging Size: 3.2 mm (1/8 inch) wide by 150 mm (6 inches) deep.
  2. Stakes: Steel to match edging, tapered, minimum 380 mm (15 inches) long.
  3. Accessories: End pieces, end stakes, corner stakes, and splicing stakes.
  4. Finish: Painted.
  5. Paint Color: Green

**14. ANTIDESICCANT**

- A. Antidesiccant: An emulsion specifically manufactured for agricultural use that will provide protective film over plant surfaces permeable enough to permit transpiration.

**15. EROSION CONTROL**

- A. Erosion Control Blankets: 70 percent agricultural straw and 30 percent coconut fiber matrix stitched with degradable nettings, designed to degrade within 18 months.
- B. Erosion Control Fabric: Knitted construction of polypropylene yarn with uniform mesh openings 19 to 25 mm (3/4 to 1 inch) square with strips of biodegradable paper. Minimum filler paper strip life of six months.
- C. Erosion Control Net: Heavy, twisted jute mesh weighing approximately 605 grams per meter (1.22 pounds per linear yard) and 1200 mm (4 feet) wide with mesh openings approximately 25 mm (1 inch) square.
- D. Erosion Control Material Anchors: As recommended by erosion control material manufacturer.

**16. ROOT CONTROL BARRIER**

- A. Root Control Barrier: Flexible and permeable geotextile fabric with permanently attached timerelease nodules. Preformed as required barrier with integral vertical root deflecting ribs constructed of ultraviolet resistant polypropylene material.

**17. STAKING AND GUYING MATERIALS**

- A. Staking Material:
  - 1. Tree Support Stakes: Rough sawn hardwood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Minimum 50 mm (2 inches) square by 2.4 m (8 feet) long, pointed at one end.
  - 2. Ground Stakes: 50 mm (2 inches) square by 0.91 m (3 feet) long wood or plastic, pointed at one end.
- B. Guying Material:
  - 1. Guying Wire: ASTM A580/A580M, galvanized steel wire.
  - 2. Guying Cable: Minimum fivestrand, 5 mm (3/16 inch) galvanized steel cable.

- C. Hose Chafing Guards: New or used 2 ply 19 mm (3/4 inch) reinforced rubber or plastic hose, black or dark green, all of same color.
- D. Flags: White surveyor's plastic tape 150 mm (6 inches) long, fastened to guying wires or cables.
- E. Turnbuckles: Galvanized or cadmiumplated steel with minimum 75 mm (3 inch) long openings fitted with screw eyes and galvanized or cadmiumplated steel eye bolts with 25 mm (1 inch) diameter eyes and 38 mm (1 1/2 inches) minimum screw length.

## **18. WATER**

- A. Water: Source approved by Contracting Officer's Representative and suitable quality for irrigation, containing no elements toxic to plant life, including acids, alkalis, salts, chemical pollutants, and organic matter. Use collected storm water or graywater when available.

## **19. PESTICIDES**

- A. Consider IPM (Integrated Pest Management) practices to minimize use of all pesticides and chemical products. Obtain Contracting Officer's Representative's approval for allowable products, product alternatives, scheduling and application procedures. Evaluate existing weather and site conditions before application. Apply products during favorable weather and site conditions according to manufacturer's instructions and warranty requirements.

## **20. FINISHES**

- A. Steel Paint Finish:
  - 1. PowderCoat Finish: Manufacturer's standard twocoat finish system consisting of following:
    - a. One coat primer.
    - b. One coat thermosetting topcoat.
    - c. Dryfilm Thickness: 0.05 mm (2 mils) minimum.
    - d. Color: Refer to Section 09 06 00, SCHEDULE FOR FINISHES.
- B. Aluminum Anodized Finish: NAAMM AMP 500.

1. Color Anodized Finish: AAC22A32 or AAC22A34; Class II Architectural, 0.01 mm (0.4 mil) thick.

### **3.EXECUTION**

#### **1. EXAMINATION**

- A.** Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
  1. Verify that no materials that would inhibit plant growth are present in planting area. If such materials are present, remove soil and contaminants as directed by Contracting Officer's Representative and provide new planting soil.
  2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
  3. Suspend soil spreading, grading, and tilling operations if soil moisture becomes excessive. Resume soil preparations when moisture content returns to acceptable level.
  4. If soil is excessively dry, not workable, and too dusty, moisten uniformly.
  5. Special conditions may exist that warrant variance in specified planting dates or conditions. Submit written request to Contracting Officer's Representative stating special conditions and proposed variance.
- B.** Proceed with planting operations only after unsatisfactory conditions have been corrected.

#### **2. PREPARATION**

- A.** Protect existing and proposed landscape features, elements, and site construction and completed work from damage. Protect trees, vegetation, and other designated features by erecting high visibility, reusable construction fencing. Locate fence no closer to trees than drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on drawings.
- B.** Install erosion control materials at all areas inside or outside limits of construction that are disturbed by planting operations. Provide erosion control and seeding with native plant species to protect slopes.

- C. Stake out approved plant material locations and planter bed outlines on project site before digging plant pits or beds. Contracting Officer's Representative reserves right to adjust plant material locations to meet field conditions. Do not plant closer than 36 inches to building wall, pavement edge, fence or wall edge, and other similar structures. Provide onsite locations for excavated rock, soil, and vegetation.

### **3. PLANT BED PREPARATION**

- A. Verify location of underground utilities before excavation. Protect existing adjacent turf before excavations are made. Do not disturb topsoil and vegetation in areas outside those indicated on Drawings. Where planting beds occur in existing turf areas, remove turf to depth that will ensure removal of entire root system. Measure depth of plant pits from finished grade. Provide depth of plant pit excavation and relation of top of root ball and finish grade as indicated on drawings. Install plant materials as specified in Article 3.8. Do not plant trees within 3 m (10 feet) of any utility lines or building walls.
- B. For newly graded subgrades, loosen subgrade to minimum 100 mm (4 inches) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Government's property.
  - 1. Apply fertilizer, lime, and soil amendments directly to subgrade before loosening, at rates recommended by soils analysis.
  - 2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
  - 3. Spread planting soil 150 mm (6 inches) deep but minimum required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
    - a. Spread approximately 1/2 thickness of planting soil over loosened subgrade. Mix thoroughly into top 50 mm (2 inches) of subgrade. Spread remainder of planting soil.
    - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Finish grade planting areas to smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 13 mm (1/2 inch) of finish elevation. Roll and

rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in immediate future.

**4. GROUND COVER AND PLANT INSTALLATION**

- A. Place ground cover and plants, not including trees, shrubs, and vines, as indicated on drawings in even rows and with triangular spacing.
- B. Use prepared soil mixture for backfill.
- C. Place so roots are in natural position.
- D. Do not remove plants from flats or containers until immediately before planting. Plant at depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Water plants at sufficient rate to ensure thorough wetting of soil to 150 mm (6 inches) deep without runoff or puddling. Smooth planting areas after planting to provide even, smooth finish.
- E. Plant ground cover in areas to receive erosion control materials through material after erosion control materials are in place.

**5. TREE, SHRUB, AND VINE PLANTING**

- A. Move plant materials only by supporting, root ball, container. Set plants on hand compacted layer of prepared backfill soil mixture 150 mm (6 inches) thick and hold plumb in center of pit until soil has been tamped firmly around root ball.
- B. Set plant materials in relation to surrounding finish grade 25 to 50 mm (1 to 2 inches) above depth at which they were grown in nursery, collecting field, or container. Replace plant material whose root balls are cracked or damaged either before or during planting process.
- C. Place backfill soil mixture on previously scarified subsoil to completely surround root balls and bring to smooth and even surface, blending into existing areas.
- D. Balled and Burlapped Stock: Backfill with topsoil to approximately half ball depth then tamp and water. Carefully remove or fold back excess burlap and tying materials from top to minimum 1/3 depth from top of root ball. Tamp and complete backfill, place

mulch topdressing, and water. Remove wires and non-biodegradable materials from plant pit before backfilling.

## **6. MECHANIZED TREE SPADE PLANTING**

- A.** At designated locations and with approved equipment, trees may be planted by mechanized tree spade. Tree spade is not acceptable for moving trees that are larger than maximum size of similar field grown, balled and burlapped rootball diameter recommended by ANSI Z60.1, or that are larger than manufacturer's recommended maximum size for tree spade to be used, whichever is smaller.
- B.** For tree extraction, center trunk in tree spade and move tree and solid root ball.
- C.** Cut any exposed roots with sharp instruments.
- D.** Excavate planting hole with same tree spade used to extract and move tree.
- E.** If possible, place trees with same orientation as at location from which they were extracted.

## **7. TREE AND SHRUB PRUNING**

- A.** Pruning: Performed by trained and experience personnel according to TCIA A300P1.
- B.** Remove dead and broken branches. Prune only to correct structural defects.
- C.** Retain typical growth shape of individual plants with as much height and spread as practical. Do not central leader on trees. Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars to remain in place.
- D.** Do not apply tree wound dressing to cuts.

## **8. STAKING AND GUYING**

- A.** Staking: Stake plants with number of stakes indicated on drawings with double strand of guy wire. Attach guy wire at half tree trunk height but maximum 1.5 m (5 feet) high. Drive stakes to depth of 0.80 to 0.91 m (21/2 to 3 feet) into the ground outside plant pit. Do not injure root ball. Install hose chaffer guards where wire is in contact with tree trunk.
- B.** Guying: Guy plants as indicated on drawings. Attach two strands of guy wire around tree trunk at 0.785 rad (45 degrees) at half tree trunk height. Install hose chaffer guards

where wire is in contact with tree trunk. Anchor guys to ground stakes. Fasten flags to each guying wire at 2/3 of the distance above ground level. Provide turnbuckles as indicated on drawings.

## **9. ROOT CONTROL BARRIER INSTALLATION**

- A.** At trees planted within 1500 mm (60 inches) of paving, walls, curbs, and walkways, install root control barrier, unless otherwise shown on Drawings.
- B.** Install geotextile fabric in soil for surrounding application with appropriate holding device to ensure fabric position. For vertical and horizontal application, provide minimum 50 mm (2 inch) soil cover over top surface. Extend fabric minimum 450 mm (18 inches) beyond structure area to be protected to prevent root growth around fabric edges.
- C.** Install linear polypropylene barrier minimum 25 mm (1 inch) above finished grade to prevent root growth over barrier. Backfill outside barrier with 19 to 25 mm (3/4 to 1 inch) of gravel for minimum 50 mm (2 inches). For linear application, use device recommended by barrier manufacturer to connect two pieces.

## **10. MULCH INSTALLATION**

- A.** Provide specified mulch over entire planting bed surfaces and individual plant surfaces, including earth mount watering basin around plants, to 75 mm (3 inches) depth after plant installation and before watering. Do not place mulch in crowns of shrubs. Place mulch minimum 50 to 75 mm (2 to 3 inches) away from tree or shrub trunks. Place mulch on all weed control fabric.

## **11. EDGING INSTALLATION**

- A.** Metal Edging: Install steel edging material according to manufacturer's instructions. Install edging material in perfect (6 foot) diameter circle inside (6 1/2 foot) watering basin, around specimen trees and shrubs not planted in close group. Install edging with minimum 25 mm (1 inch) visible above ground level.



- B. Natural Cut Edging: Provide uniform 'V' cut with one vertical side adjacent to turf areas 125 mm (5 inches) deep and second side angled 250 mm (10 inches) toward center of plant bed for clear cut division line between plant bed and adjacent lawn.

## **12. SODDING**

- A. Place sod maximum 36 hours after initial harvesting according to TPI GSS, except as modified herein.
- B. For slopes 2 to 1 and greater, lay sod with long edge perpendicular to contour. For ditches and flat bottomed ditches, lay sod with long edge perpendicular to water flow. Anchor each piece of sod with wood pegs or wire staples maximum 600 mm (24 inches) on center. On sloped areas, start sodding at bottom of slope.
- C. Finishing: After sodding, blend edges of sodded area smoothly into surrounding area. Eliminate air pockets and provide true and even surface. Trim frayed areas and patch holes and missing areas with sod.
- D. Rolling: Immediately after sodding, firm entire area, except slopes in excess of 3: 1, with roller maximum 134 kg (90 lbs.) for each foot of roller width.
- E. Watering: Start watering sodded areas as required by daily temperature and wind conditions. Water at rate sufficient to ensure thorough wetting of soil to minimum 150 mm (6 inches) deep. Prevent runoff, puddling, and wilting. Do not drive watering trucks over turf areas, unless otherwise directed. Prevent watering of other adjacent areas or plant materials.

## **13. SPRIGGING**

- A. Plant sod sprigs after finish grade is properly prepared and thoroughly soaked day in advance. Plant sprigs in rows spaced maximum 300 mm (12 inches) apart with springs placed in rows at maximum 150 mm (6 inches) apart. Firm entire area with roller not exceeding 130 kg/m (90 lb./ft.) of roller width. Do not roll slopes over maximum 3: 1. Water thoroughly and keep soil moist. Weed by hand or hoe. Do not treat sprig area with herbicide.

**14. PLUGGING**

- A. Plant fresh sod plugs after finish grade is properly prepared. Plant plugs in rows, spaced (18 inches) apart in both directions. On slopes, contour rows to near level. Water thoroughly and keep soil moist. Weed by hand or hoe. Do not treat plug area with herbicide.

**15. TURF RENOVATION**

- A. General: Restore to original condition existing turf areas damaged during turf installation and construction operations. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. Clean other paving when work in adjacent areas is complete.
- B. Aeration: Eradicate weeds and, with Contracting Officer's Representative's approval to proceed, aerate turf areas with approved device. Core, by pulling soil plugs. Leave all soil plugs that are produced, in turf area. After aeration operations are complete, topdress entire area 6.35 mm (1/4 inch) deep. Blend all parts of topdressing mixture too uniform consistency. Clean all soil plugs off of other paving when work is complete.
- C. Vertical Mowing: At completion of aerating and, with Contracting Officer's Representative's approval to proceed, vertical mow turf areas indicated on drawings with approved device to 13 mm (1/2 inch) deep above existing soil level to reduce thatch buildup, grain, and surface compaction. Remove all debris generated during this operation off site.
- D. Dethatching: At completion of aerating and, with Contracting Officer's Representative's approval to proceed, dethatch turf areas indicated on drawings with approved device to 6 mm (1/4 inch) deep below existing soil level to reduce thatch buildup, grain, and surface compaction. Remove all debris generated during this operation off site.
- E. Overseeding: Apply seed according to applicable portions of "Seed Application Method" at rates specified in "Seed Composition."

## **16. PLANT MAINTENANCE**

- A.** Frequency: Begin maintenance immediately after plants have been installed. Inspect plants at least once week and perform required maintenance promptly.
- B.** Promotion of Plant Growth and Vigor: Water, prune, fertilize, mulch, eradicate weeds, and perform other operations necessary to promote plant growth and vigor.
- C.** Planter Beds: Weed, fertilize, and irrigate planter beds and keep pest free, pruned, and mulch levels maintained. Do not permit planter beds encroach into turf areas. Maintain edging breaks between turf areas and planter beds. Fertilize plant materials to promote healthy growth without encouraging excessive top foliar growth. Remove noxious weeds common to area from planter beds by mechanical means.
- D.** Shrubs: In addition to planter bed maintenance requirements, selectively prune and shape shrubs for health and safety when following conditions exist:
  - 1. Remove growth in front of windows, over entrance ways or walks, and any growth which will obstruct vision at street intersections or of security personnel.
  - 2. Remove dead, damaged, or diseased branches or limbs where shrub growth obstructs pedestrian walkways, where shrub growth is growing against or over structures, and where shrub growth permits concealment of unauthorized persons.
  - 3. Properly dispose of all pruning debris.
- E.** Trees: Adjust stakes, ties, guy supports, and turnbuckles, and water, fertilize, control pests, mulch, and prune for health and safety, and provide fall leaf cleanup.
  - 1. Fertilize trees to promote healthy plant growth without encouraging excessive top foliar growth. Inspect and adjust stakes, ties, guy supports and turnbuckles to avoid girdling and promote natural development.
  - 2. Selectively prune all trees within project boundaries, regardless of caliper, for safety and health reasons, including, but not limited to, removal of dead and broken branches and correction of structural defects. Prune trees according to their natural growth characteristics leaving trees well shaped and balanced.
  - 3. All pruning, including palm tree pruning, must be by or in presence of certified member of International Society of Arboriculture and according to TCIA Z133.1.

4. Properly dispose of all pruning debris.

#### **17. SLOPE EROSION CONTROL MAINTENANCE**

- A.** Provide slope erosion control maintenance to prevent undermining of all slopes in newly landscaped and natural growth areas. Maintenance tasks include immediate repairs to weak spots in sloped areas and maintaining clean, clear culverts to intercept and direct water flow to prevent development of large gullies and slope erosion and securing irrigation systems during periods of extended rainfall.
  1. Fill eroded areas with amended topsoil and replant with same plant species.
  2. Reinstall erosion control materials damaged due to slope erosion.

#### **18. REMOVAL OF DYING OR DEAD PLANTS**

- A.** Remove dead and dying plants and provide new plants immediately upon commencement of specified planting season and replace stakes, guys, mulch, and eroded earth mound water basins. No additional correction period will be required for replacement plants beyond original warranty period. Plants will be considered dead or dying as follows:
  1. Tree: Main leader died back or minimum 20 percent of crown died.
  2. Shrub and Ground Cover: Minimum 20 percent of plant died.
  3. Determination: Scrape on maximum 2 mm (1/16 inch) square branch area to determine dying plant material cause and provide recommendations for replacement.

#### **19. TURF MAINTENANCE**

- A.** Mow turf to uniform finished height measured from soil. Perform mowing in manner that prevents scalping, rutting, bruising, uneven and rough cutting. Before mowing, remove and dispose of all rubbish, debris, trash, leaves, rocks, paper, and limbs or branches on turf areas. Sweep or vacuum clean adjacent paved areas.
- B.** Apply fertilizer in manner that promotes health, growth, vigor, color and appearance of cultivated turf areas. Determine method of application, fertilizer type and frequencies

by results of laboratory soil analysis. Apply fertilizer by approved methods and according to manufacturer's instructions.

- C. Watering: Perform irrigation in manner that promotes health, growth, color, and appearance of cultivated vegetation, complying with Federal, State, and local water agency and authority directives. Prevent overwatering, water runoff, erosion, and ponding due to excessive quantities or rate of application.

**20. CLEANING**

- A. Remove and legally dispose of all excess soil and planting debris.

**21. PROTECTION**

- A. Protect plants from traffic and construction operations.
- B. Provide temporary fences or enclosures and signage, at planted areas. Maintain fences and enclosures during maintenance period.
- C. Remove protective materials immediately before acceptance.
- D. Repair damage.

--- E N D ---

**SECTION 33 10 00**  
**WATER UTILITIES**

**PART 1- GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies materials and procedures for construction of underground water distribution for domestic and/or fire supply systems outside the building that are complete and ready for operation. This includes piping, structures, appurtenances and all other incidentals.

**1.2 RELATED WORK**

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. Concrete: Section 03 30 00, CAST IN-PLACE CONCRETE.
- C. Fire Protection System connection: Section 21 12 00, FIRE-SUPPRESSION STANDPIPES.
- D. General plumbing: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- F. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

**1.3 DEFINITIONS**

- A. Water distribution system: Pipelines and appurtenances which are part of the distribution system outside the building for potable water and fire supply.
- B. Water service line: Pipeline from main line to 5 feet outside of building.

**1.4 ABBREVIATIONS**

- A. PVC: Polyvinyl chloride plastic.
- B. DI: Ductile iron pipe.
- C. WOG: Water, Oil and Gas.

**1.5 DELIVERY, STORAGE AND HANDLING**

- A. Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends and flange faces.

- B. Use a sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- D. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.
- E. Store plastic piping protected from direct sunlight and support to prevent sagging and bending.
- F. Cleanliness of Piping and Equipment Systems:
  - 1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
  - 2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.

## **1.6 COORDINATION**

- A. Coordinate connection to water main with Public Utility company.
- B. Coordinate water service lines with building contractor.

## **1.7 QUALITY ASSURANCE:**

- A. Products Criteria:
  - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
  - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least three years. Digital electronic

devices, software and systems such as controls, instruments or computer work stations shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.

C. Regulatory requirements:

1. Comply with the rules and regulations of the public utility company having jurisdiction over the connection to public water lines and the extension and/or modifications to public utility systems.
2. Comply with the rules and regulations of the Local Health Department having jurisdiction for potable water-service.
3. Comply with rules and regulations of Local authorities having jurisdiction for fire-suppression water-service piping including materials, hose threads, installation and testing.

D. Provide certification of factory hydrostatic testing of not less than 500 psi (3.5 MPa) in accordance with AWWA C151. Piping materials shall bear the label, stamp or other markings of the specified testing agency.

E. Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:

1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
4. All welds shall be stamped according to the provisions of the American Welding Society.

F. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation.

G. Applicable codes:



1. Plumbing Systems: IPC, International Plumbing Code.
2. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
3. Fire-service main products shall be listed in the FM Global "Approval Guide" or Underwriters Laboratories (UL) "Fire Protection Equipment Directory".

## 1.8 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced.

The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI):

MSS SP-60-2004 .....Connecting Flange Joint Between Tapping Sleeves and  
Tapping Valves

MSS SP-108-2002 .....Resilient-Seated Cast Iron, Eccentric Plug Valves

MSS SP-123-1998(R2006) .....Non-Ferrous Threaded and Solder-Joint Unions for Use  
With Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

A112.1.2-2004.....Air Gaps in Plumbing Systems (for Plumbing Fixtures and  
Water-Connected Receptors))

A112.6.3-2001.....Floor Drains

B16.1-2010.....Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125,  
250

B16.18-2001.....Cast Copper Alloy Solder Joint Pressure Fittings

B16.22-2001.....Wrought Copper and Copper Alloy Solder Joint Pressure  
Fittings

B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged Fittings;  
Classes 150, 300, 600, 900, 1500 and 2500

B31 .....Code for Pressure Piping Standards

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

A36/A36M-08.....Carbon Structural Steel

A48/A48M-08(2008) .....Gray Iron Castings

A536-84(2009) .....Ductile Iron Castings

A674-10.....Polyethylene Encasement for Ductile Iron Pipe for Water  
or Other Liquids

B61-08.....Steam or Valve Bronze Castings

B62-09 .....Composition Bronze or Ounce Metal Castings

B88/B88M-09.....Seamless Copper Water Tube

C651-05 .....Disinfecting Water Mains

C858-10e1 .....Underground Precast Utility Structures

D1785-06.....Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80,  
and 120

D2239-03.....Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on  
Controlled Inside Diameter

D2464-06.....Threaded Poly (Vinyl Chloride) PVC Pipe Fittings, Schedule  
80

D2466-06.....Poly (Vinyl Chloride) (PVC) Pipe Fittings, Schedule 40

D2467-06.....Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule  
80

D2609-02(2008) .....Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe

D3350-10a.....Polyethylene Plastics Pipe and Fittings Materials

F714-10 .....Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside  
Diameter

F1267-07 .....Metal, Expanded, Steel

E. American Water Works Association (AWWA):

B300-10 .....Hypochlorites

B301-10 .....Liquid Chlorine

C104-08 .....Cement–Mortar Lining for Ductile Iron Pipe and Fittings

C105/A21.5-10 .....Polyethylene Encasement for Ductile Iron Pipe Systems

C110-08 .....Ductile Iron and Gray-Iron Fittings

C111/A21.11-07 .....Rubber-Gasket Joints for Ductile Iron Pressure Pipe and  
Fittings

C115/A21.11-11 .....Flanged Ductile Iron Pipe with Ductile Iron or Gray-Iron  
Threaded Flanges

C151/A21.51-09 .....Ductile Iron Pipe, Centrifugally Cast

C153/A21.53-11 .....Ductile Iron Compact Fittings for Water Service

C502-05 .....Dry-Barrel Fire Hydrants

C503-05 .....Wet-Barrel Fire Hydrants

C504-10 .....Rubber-Seated Butterfly Valves

C508-09 .....Swing-Check Valves for Waterworks Service, 2-In. Through  
24-In. (50-mm Through 600-mm) NPS

C509-09 .....Resilient-Seated Gate Valves for Water Supply Service

C510-07 .....Double Check Valve Backflow Prevention Assembly

C511-07 .....Reduced-Pressure Principle Backflow Prevention Assembly

C512-07 .....Air Release, Air/Vacuum and Combination Air Valves

C550-05 .....	Protective Interior Coatings for Valves and Hydrants
C600-10 .....	Installation of Ductile Iron Mains and Their Appurtenances
C605-11 .....	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
C606-11 .....	Grooved and Shouldered Joints
C651-05 .....	Disinfecting Water Mains
C700-09 .....	Cold-Water Meters, "Displacement Type," Bronze Main Case
C800-05 .....	Underground Service Line Valves and Fittings
C900-09 .....	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
C906-07 .....	Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 64 In. (1,600 mm), for Water Distribution and Transmission
C907-04 .....	Injection-Molded PVC Pressure Fittings, 4 Inch through 12 Inch (100 mm through 300 mm), for Water Distribution
M23-2nd Ed.....	PVC Pipe, Design and Installation
M44-2nd Ed.....	Distribution Valves: Selection, Installation, Field Testing and Maintenance

F. National Fire Protection Association (NFPA):

NFPA 24-2022 Ed. ....	Installation of Private Fire Service Mains and Their Appurtenances
NFPA 1963-2019 Ed. ....	Fire Hose Connections

G. NSF International (NSF):

NSF/ANSI 14 (2013).....Plastics Piping System Components and Related Materials

NSF/ANSI 61-2012.....Drinking Water System Components - Health Effects

NSF/ANSI 372-2011.....Drinking Water System Components – Lead Content

H. American Welding Society (AWS):

A5.8/A5.8M-2004 .....Filler Metals for Brazing and Braze Welding

I. American Society of Safety Engineers (ASSE):

1003-2009 .....Water Pressure Reducing Valves

1015-2009 .....Double Check Backflow Prevention Assemblies and Double  
Check Fire Protection Backflow Prevention Assemblies

1020-2004 .....Pressure Vacuum Breaker Assembly

1047-2009 .....Performance Requirements for Reduced Pressure Detector  
Fire Protection Backflow Prevention Assemblies

1048-2009 .....Performance Requirements for Double Check Detector Fire  
Protection Backflow Prevention Assemblies

1060-2006 .....Performance Requirements for Outdoor Enclosures for  
Fluid Conveying Components

J. Underwriters' Laboratories (UL):

246 .....Hydrants for Fire-Protection Service

262 .....Gate Valves for Fire-Protection Service

312 .....Check Valves for Fire-Protection Service

405 .....Fire Department Connection Devices

753 .....Alarm Accessories for Automatic Water-Supply Control  
Valves for Fire Protection Service

789 .....Indicator Posts for Fire-Protection Service

- 1091 .....Butterfly Valves for Fire-Protection Service
- 1285 .....Pipe and Couplings, Polyvinyl Chloride (PVC), and Oriented  
Polyvinyl Chloride (PVCO) for Underground Fire Service

## **1.9 WARRANTY**

- A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will furnish all manufacturers' and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

## **PART 2- PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended.

### **2.2 FACTORY-ASSEMBLED PRODUCTS**

- A. Standardization of components shall be maximized to reduce spare part requirements. The contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

### **2.3 SAFETY GUARDS**

- A. All equipment shall have moving parts protected to prevent personal injury. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gauge sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 1/4 inch (6 mm) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

## **2.4 LIFTING ATTACHMENTS**

- A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

## **2.5 DUCTILE IRON PIPE AND FITTINGS**

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

- C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, round-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances: ASTM A47, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe, 350 psi (3400 kPa).
2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions, Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
3. Gaskets: AWWA C111.

- D. Flanged Ductile Iron Pipe: AWWA C115/A21.11, with factory applied screwed long hub flanges.

1. Flanges: ASME B16.1 for 125 psi (850 kPa) pressure ratings, as necessary.

2. Wall Sleeve Castings, size and types shown on the drawings, shall be hot dipped galvanized per ASTM A123.
  3. Pipe and fittings exposed to view in the finished work are to be painted in accordance with Section 09 91 00, PAINTING. Pipe shall be shop primed with one coat of rust inhibitive primer. Final paint color shall match the final wall color.
- E. Cement Mortar Internal Lining: Cement mortar lining and bituminous seal coat as per AWWA C104.
- F. Exterior Pipe Coating: The exterior of pipe shall have the standard asphaltic coating.

## **2.6 PE PIPE AND FITTINGS**

- A. PE, ASTM Pipe: ASTM D2239, SDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 160 psi (1100 kPa).
1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
  2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
- B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 160 psi (1100 kPa).
1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 160 psi (1100 kPa).
- C. PE, Fire-Service Pipe: ASTM F714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150.
1. Molded PE Fittings: ASTM D3350, PE resin, socket-or butt-fusion type, made to match PE pipe dimensions and class.

## **2.7 COPPER TUBE AND FITTINGS**

- A. Soft Copper Tubing: ASTM B88, Type K water tube, annealed temper.
- B. Hard Copper Tubing: ASTM B88, Type K water tube, drawn temper.
- C. Fittings: ASME B16.18, cast copper alloy or solder joint pressure fittings.
- D. Brazing Alloy: AWS A5.8/A5.8M, Classification BCuP.



E. Bronze Flanges: ASME B16.24, Class 150, with solder joint ends. ASME B16.24, Class 300 flanges if required to match piping.

F. Copper Unions: ANSI MSS SP-123, cast copper alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

## **2.8 VALVES**

A. Gate Valves: AWWA C509, Non-rising Stem, Resilient Seat, 200 psi (1380 kPa).

1. Valves 3 inches (75 mm) and larger: Resilient seat valve with gray- or ductile iron body and bonnet; cast iron or bronze double-disc gate; bronze gate rings; non-rising bronze stem and stem nut.
2. Interior and exterior coating: AWWA C550, thermo-setting or fusion epoxy.
3. Underground valve nut: Furnish valves with 2 inch (50 mm) nut for socket wrench operation.
4. Aboveground and pit operation: Furnish valves with hand wheels.
5. End connections shall match main line pipe.

B. Gate Valve Accessories and Specialties

1. Tapping-Sleeve Assembly: ANSI MSS SP-60; sleeve and valve to be compatible with the drilling matching.
  - a. Tapping Sleeve: Ductile Iron, two-piece bolted sleeve. Sleeve to match the size and type of pipe material being tapped.
  - b. Valve shall include one raised face flange mating tapping-sleeve flange.
2. Valve Boxes: AWWA M44 with top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel.
3. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut. (Provide two wrenches for Project.)
4. Indicator Posts: UL 789, FMG approved, vertical-type, cast iron body with operating wrench, extension rod, and adjustable cast iron barrel of length required for depth of burial of valve.

C. Corporation Valves and Curb Valves

1. Service-Saddle Assemblies: AWWA C800.
  - a. Service Saddle: Copper alloy with seal and threaded outlet for corporation valve.
  - b. Corporation Valve: Bronze body and ground-key plug, with threaded inlet and outlet matching service piping material.
  - c. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
2. Curb Valves: AWWA C800, bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material, minimum pressure of 200 psi (1375 kPa).
3. Service Boxes for Curb Valves: AWWA M44, cast iron telescoping top section; plug shall include lettering "WATER"; bottom section with base that fits over curb valve.
4. Shutoff Rods: Steel, tee-handle with one pointed end. Stem length shall extend 2 feet (600 mm) above top of valve box for operation of deepest buried valve, with slotted end matching curb valve.

D. Post-Indicator: NFPA 24 and be fully compatible with the valve and supervisory switches.

1. .

**2.9 WATER METER BOXES**

- A. Cast iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.
  1. Base section may be cast iron, PVC, PE, or other pipe.
- B. Cast iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
- C. Polymer-concrete body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping, vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 mm by 254 mm) square.

## **2.10 DISINFECTION CHLORINE**

- A. Liquid chlorine: AWWA B301.
- B. Sodium Hypochlorite: AWWA B300 with 5 percent to 15 percent available chlorine.
- C. Calcium hypochlorite: AWWA B300 supplied in granular form of 5 g. tablets, and shall contain 65 percent chlorine by weight.

## **2.11 WARNING TAPE**

- A. Warning tape shall be standard, 4 mil. Polyethylene, 3 inch (76 mm) wide tape, detectable type, blue with black letters and imprinted with "CAUTION BURIED WATER LINE BELOW".

## **PART 3- EXECUTION**

### **3.1 PIPING APPLICATIONS**

- A. Use pipe, fittings, and joining methods for piping systems according to the following applications.
  - 1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
  - 2. Do not use flanges or unions for underground piping.
  - 3. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- B. Underground water-service piping less than 3-inches shall be the following:
  - 1. Soft copper tube with wrought-copper, solder-joint fittings; and brazed copper, pressure-seal fittings; and pressure-sealed joints.
  - 2. PE, ASTM pipe; insert fittings for PE pipe; and clamped molded PE fittings; and heat-fusion joints.
- C. Underground water-service piping 4" and larger shall be the following:
  - 1. Ductile iron, mechanical-joint pipe; ductile iron, mechanical-joint fittings; and mechanical joints.
- D. Underground Fire-Service-Main Piping 4-inches and larger shall be the following:
  - 1. Ductile iron, mechanical-joint pipe; ductile iron, mechanical-joint fittings; and mechanical joints.

### 3.2 VALVE APPLICATIONS

- A. Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, non-rising-stem, metal resilient -seated gate valves with valve box.
  - 2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast iron, non-rising-stem gate valves with indicator post.

### 3.3 DUCTILE IRON PIPE

- A. Install Ductile Iron, water-service piping according to AWWA C600 and AWWA M41-3rd Edition.
  - 1. Install PE corrosion-protection encasement according to ASTM A674 or AWWA C105/A21.5.
- B. Pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other approved means.
- C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Bevel cut ends of pipe to be used with push-on bell to conform to the manufactured spigot end. Cement lining shall be undamaged.
- D. Push on joints shall be made in strict accordance with the manufacturer's instruction. Pipe shall be laid with bell ends looking ahead.

### 3.4 COPPER PIPE

- A. Copper piping shall be installed in accordance with the Copper Development Association's Copper Tube Handbook and manufacturer's recommendations.
- B. Copper piping shall be bedded in 6 inches (150 mm) of sand.

### **3.5 ANCHORAGE INSTALLATION**

- A. Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include: concrete thrust blocks, locking mechanical joints,.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  - 1. Gasketed-Joint, Ductile Iron, Water-Service Piping: According to AWWA C600.
  - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
  - 3. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### **3.6 VALVE INSTALLATION**

- A. AWWA Valves: Install each underground valve with stem pointing up and with valve box.
- B. UL/FMG, Valves: Install each underground valve and valves in vaults with stem pointing up and with vertical cast iron indicator post.
- C. MSS Valves: Install as component of connected piping system.
- D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- E. Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

### **3.7 CONNECTIONS**

- A. Drawings indicate general arrangement of piping, fittings, and specialties. Install water service lines to a point of connection within approximately 5 feet (1500 mm) outside of building(s) to which service is to be connected and make connections thereto. If building services have not been installed provide temporary caps and mark for future connection.

### **3.8 FIELD QUALITY CONTROL**

- A. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

- B. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.
- C. Perform hydrostatic tests at not less than one-and-one-half times working pressure for two hours.
  - 1. Increase pressure in 50-psi (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psi (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- D. Prepare reports of testing activities.

### **3.9 IDENTIFICATION**

- A. Install continuous underground warning tape 12 inches (300 mm) directly over piping.

### **3.10 CLEANING**

- A. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
- B. Use purging and disinfecting procedure prescribed by local utility provider or other authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
  - 1. Fill the water system with a water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
  - 2. Drain the system of the previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow system to stand for 3 hours.
  - 3. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
  - 4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- C. Flush fire service underground piping at 880 GPM as specified in NFPA 24.

D. Prepare reports of purging and disinfecting activities.

--- E N D ---

## **SECTION 33 30 00**

### **SANITARY SEWER UTILITIES**

#### **PART 1- GENERAL**

##### **1.1 DESCRIPTION**

- A. This section specifies materials and procedures for construction of outside, underground sanitary sewer systems that are complete and ready for operation. This includes piping, structures and all other incidentals.

##### **1.2 RELATED WORK**

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- C. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATION.
- D. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- E. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

##### **1.3 DEFINITIONS**

##### **1.4 ABBREVIATIONS**

- A. PVC: Polyvinyl chloride plastic
- B. DI: Ductile iron pipe

##### **1.5 DELIVERY, STORAGE AND HANDLING**

- A. Store plastic piping protected from direct sunlight and support to prevent sagging and bending. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.
- B. Handle manholes according to manufacturer's written rigging instructions.

##### **1.6 COORDINATION**

- A. Coordinate connection to sanitary sewer main with Public Utility company. (Approval from public utility has been obtained indicating that the downstream sanitary systems have sufficient capacity to handle the sanitary discharge from the facility.)



- B. Contractor to obtain approval from the Public Agency that the existing sanitary sewer systems have the capacity to handle the discharge from the facility.
- C. Coordinate exterior utility lines and connections to building lines up to 5 feet of building wall.
- D. Coordinate connection to public sewer system with Public Utility Company.

#### **1.7 QUALITY ASSURANCE:**

- A. Products Criteria:
  - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
  - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Sanitary Sewer lines and the extension, and/or modifications to Public Utility Systems.

#### **1.8 SUBMITTALS:**

- A. Manufacturers' Literature and Data shall be submitted for the following as one package:
  - 1. Pipe, Fittings, and, Appurtenances.
  - 2. Jointing Material.
  - 3. Manhole and Structure Material.
  - 4. Frames and Covers.
  - 5. Steps and Ladders.

#### **1.9 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - A74-09 .....Cast Iron Soil Pipe and Fittings
  - A185/A185M-07 .....Steel Welded Wire Reinforcement, Plain, for Concrete

A615/A615M-09b .....	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A746-99 .....	Ductile-Iron Gravity Sewer Pipe
C478-09 .....	Precast Reinforced Concrete Manhole Sections
C857-11 .....	Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
C890-11 .....	Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
C913-08 .....	Precast Concrete Water and Wastewater Structures
C923-08 .....	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
C924-02(2009) .....	Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
C990-09 .....	Joints for Concrete Pipe, Manholes, and precast Box Sections using Preformed Flexible Joint Sealants
C1173-10 .....	Flexible Transition Couplings for Underground Piping Systems
C1440-08 .....	Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems
C1460-08 .....	Shielded Transition Couplings for Use With Dissimilar DWV Pipe and Fittings Above Ground

- C1461-08 .....Mechanical Couplings Using Thermoplastic Elastomeric  
(TPE) Gaskets for Joining Drain, Waste and Vent (DWV),  
Sewer, Sanitary and Storm Plumbing systems for Above  
and below Ground Use
- D2321-11.....Underground Installation of Thermoplastic Pipe for Sewers  
and Other Gravity-Flow Applications
- D3034-08.....Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and  
Fittings
- F477-10 .....Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- F679-08 .....Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity  
Sewer Pipe and Fittings
- F891-10 .....Coextruded Poly(vinyl Chloride) (PVC) Plastic Pipe With a  
Cellular Core
- F949-10 .....Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a  
Smooth Interior and Fittings
- F1417-11 .....Standard Test Method for Installation Acceptance of  
Plastic Gravity Sewer Lines Using Low-Pressure Air
- F1668-08 .....Construction Procedures for Buried Plastic Pipe
- C. American Water Works Association (AWWA):
- C105/A21.5-10 .....Polyethylene Encasement for Ductile-Iron Pipe Systems
- C110-08 .....Ductile-Iron and Gray-Iron Fittings
- C111/A21.11-06 .....Rubber Gasket Joints for Ductile Iron Pressure Pipe and  
Fittings
- C151/A21.51-09 .....Ductile Iron Pipe, Centrifugally Cast
- C153/A21.53-06 .....Ductile Iron Compact Fittings for Water Service

- C219-11 ..... Bolted, Sleeve-Type Couplings for Plain-End Pipe
- C512-07 ..... Air Release, Air/Vacuum and Combination Air Valves for  
Water Works Service
- C600-10 ..... Installation of Ductile-Iron Mains and Their Appurtenances
- C900-07 ..... Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated  
Fittings, 4 In. Through 12 In. (100 mm Through 300 mm),  
for Water Transmission and Distribution

D. American Society of Mechanical Engineers:

- A112.14.1-2003 ..... Backwater Valves
- A112.36.2M-1991 ..... Cleanouts

## **1.10 WARRANTY**

- A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will provide all manufacturers' and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

## **PART 2- PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. All pipe and fittings used in the construction of force mains shall be rated to meet the system maximum operating pressure with a minimum of 150 psi (1035 kPa).
- C. The Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

### **2.2 PVC, GRAVITY SEWER PIPE AND FITTINGS**

- A. PVC Gravity Sewer Piping:
1. Pipe and Fittings shall conform to ASTM D3034.

2. Gaskets: ASTM F477.
3. .

## **2.3 CLEANOUTS**

### **A. Cast-Iron Cleanouts:**

1. Cleanouts shall be as per ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Valve loadings shall be designed for Medium Duty.
3. Cleanout Riser: Sewer pipe fitting on main line pipe and riser shall be as per ASTM A74, service class.

### **B. PVC Cleanouts:**

1. PVC body with PVC threaded plug: Cleanout shall be as per ASTM D3034. PVC sewer pipe fitting and riser to cleanout.
2. Cleanout Riser: Sewer pipe fitting on main line sewer and riser shall match main line piping.

## **2.4 WARNING TAPE**

- A. Warning tape shall be standard, 4 mil (0.1 mm) polyethylene 3 inch (76 mm) wide tape detectable type, green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

## **PART 3- EXECUTION**

### **3.1 PIPING INSTALLATION**

- A. Drawing plans and details indicate the general location and arrangement of underground sanitary sewer piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at the low point, true to grades and alignment indicated on the drawings, with unbroken continuity of invert. Place bell ends of piping facing upstream.

Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

- C. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- D. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- E. Inspect pipes and fittings for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- G. Do not walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 12 inches (300 mm) over the crown of the pipe.
- H. Warning tape shall be continuously placed 12 inches (300 mm) above sewer pipe
- I. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- J. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- K. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process or microtunneling.
- L. Install gravity-flow, non-pressure, drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
  - 2. Install piping with minimum cover as shown on Drawings.
  - 3. Install ductile iron, gravity sewer piping according to AWWA C600.
  - 4. Install PVC cellular-core, PVC corrugated sewer, PSM sewer and PVC gravity sewer according to ASTM D2321 and ASTM F1668.

### **3.2 BUILDING SERVICE LINES**

- A. Install sanitary sewer service lines to point of connection within approximately 5 feet (1500 mm) outside of building(s) where service is required and make connections. Coordinate the invert and location of the service line with the Contractor installing the building lines.

### **3.3 CLEANOUT INSTALLATION**

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Cleanouts should be 6 inches (150 mm) in diameter and consist of a ductile iron 45 degree fitting on end of run, or combination Y fitting and 1/8 bend in the run with ductile iron pipe extension, water tight plug or cap and cast frame and cover flush with finished grade. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
  2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
  3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
  4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete, 18 by 18 by 12 inches (450 by 450 by 300 mm) 1 inch (25 mm) above surrounding grade.
- C. Where cleanout is in force main, provide a blind flange top connection. The center of the flange shall be equipped with a 2 inches (50 mm) base valve to allow the pressure in the line to be relieved prior to removal of the blind flange. Frames and covers for pressure (force) mains shall be 24 inches (600 mm) in diameter.
- D. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.
- E. The top of the cleanout assembly shall be 2 inches (50 mm) below the bottom of the cover to prevent loads being transferred from the frame and cover to the piping.

### 3.4 CONNECTIONS

- A. Make connections to existing piping and underground manholes by coring and installing the pipe at the design invert. Install an elastomeric gasket around the pipe, and grout the interstitial space between the pipe and the core.
- B. Connection to an existing manhole: The bench of the manhole shall be cleaned and reshaped to provide a smooth flowline for all new pipes connected to the manhole.
- C. Use commercially manufactured wye fittings for piping branch connections. Encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - 1. Make branch connections from the side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500), by removing a section of the existing pipe.
  - 2. Make branch connections from the side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting an opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in concrete to provide additional support of collar from connection to undisturbed ground.
  - 3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

### 3.5 REGRADING

- A. Raise or lower existing manholes and structures frames and covers, cleanout frames and covers and valve boxes in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Adjust the elevation of the cleanout pipe riser, and reinstall the cap or plug. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.



- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.

### **3.6 PIPE SEPARATION**

A. Horizontal Separation - Water Mains and Sewers:

1. Existing and proposed water mains shall be at least 10 feet (3 m) horizontally from any proposed gravity flow and pressure (force main) sanitary sewer or sewer service connection.
2. Gravity flow mains and pressure (force) mains may be located closer than 10 feet (3 m) but not closer than 6 feet (1.8 m) to a water main when:
  - a. Local conditions prevent a lateral separation of 10 feet (3 m); and
  - b. The water main invert is at least 18 inches (450 mm) above the crown of the gravity sewer or 24 inches (600 mm) above the crown of the pressure (force) main; and the water main is in a separate trench separated by undisturbed earth.
3. When it is impossible to meet (1) or (2) above, both the water main and sanitary sewer main shall be constructed of push-on or mechanical joint ductile iron pipe.

B. Vertical Separation - Water Mains and Sewers at Crossings:

1. Water mains shall be separated from sewer mains so that the invert of the water main is a minimum of 24 inches (600 mm) above the crown of gravity flow sewer or 48 inches (1200 mm) above the crown of pressure (force) mains. The vertical separation shall be maintained within 10 feet (3 m) horizontally of the sewer and water crossing. When these vertical separations are met, no additional protection is required.
2. In no case shall pressure (force) sanitary main cross above, or within 24 inches (600 mm) of water lines.

3. When it is impossible to meet (1) above, the gravity flow sewer may be installed 18 inches (450 mm) above or 12 inches (300 mm) below the water main, provided that both the water main and sewer shall be constructed of push-on or mechanical ductile pipe. Pressure (Force) sewers may be installed 24 inches (600 mm) below the water line provided both the water line and sewer line are constructed of ductile iron pipe.
4. The required vertical separation between the sewer and the water main shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer line is at least 10 feet (3 m).

### **3.7 IDENTIFICATION**

- A. Install green warning tape directly over piping and at outside edges of underground manholes.

### **3.8 FIELD QUALITY CONTROL**

- A. All systems shall be inspected and obtain the Resident Engineer's approval. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.
- B. To inspect, thoroughly flush out the lines and manholes before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade. Lips at joints on the inside of gravity sewer lines are not acceptable.
  1. Submit separate report for each system inspection.
  2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

4. Re-inspect and repeat procedure until results are satisfactory.
- C. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
1. Test plastic gravity sewer piping according to ASTM F1417.
  2. Test concrete gravity sewer piping according to ASTM C924.
  3. Clean and isolate the section of sewer line to be tested. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. The line shall be pressurized to 4 psi (28 kPa) and allowed to stabilize. After pressure stabilization, the pressure shall be dropped to 3.5 psi (24 kPa) greater than the average back-pressure of any groundwater above the sewer.
  4. For force mains, perform testing after supports and anchors are installed. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psi (1035 kPa).
  5. Testing of Fiberglass Sewage Holding Tanks shall show no leakage during a 5 psi (35 kPa) air pressure test with 5:1 safety factor.
  6. Testing of Concrete Wet Well shall show no leakage with the wet well completely filled with water for a duration of 4 hours.

### **3.9 CLEANING**

- A. Clean dirt and superfluous material from interior of piping.

--- E N D ---

## **SECTION 33 40 00**

### **STORM SEWER UTILITIES**

#### **PART 1- GENERAL**

##### **1.1 DESCRIPTION**

This section specifies materials and procedures for construction of outside, underground storm sewer systems that are complete and ready for operation. This includes piping, structures and all other incidentals.

##### **1.2 RELATED WORK**

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATIONS.
- E. Materials and Testing Report Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- F. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

##### **1.3 DEFINITIONS**

##### **1.4 ABBREVIATIONS**

- A. HDPE: High-density polyethylene
- B. PE: Polyethylene

##### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Handle manholes catch basins and stormwater inlets according to manufacturer's written rigging instructions.

## 1.6 COORDINATION

- A. Coordinate connection to storm sewer main with the Public Agency providing storm sewer off-site drainage.
- B. Coordinate exterior utility lines and connections to building services up to the actual extent of building wall.

## 1.7 QUALITY ASSURANCE:

- A. Products Criteria:
  - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
  - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

## 1.8 SUBMITTALS

- A. Manufacturers' Literature and Data shall be submitted, as one package, for pipes, fittings and appurtenances, including jointing materials, hydrants, valves and other miscellaneous items.

## 1.9 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - A185/A185M-07 .....Steel Welded Wire Reinforcement, Plain, for Concrete
  - A242/A242M-04(2009) .....High-Strength Low-Alloy Structural Steel
  - A536-84(2009) .....Ductile Iron Castings
  - A615/A615M-09b .....Deformed and Plain Carbon-Steel Bars for Concrete  
Reinforcement
  - A760/A760M-10 .....Corrugated Steel Pipe, Metallic-Coated for Sewers and  
Drains

A798/A798M-07 .....	Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
A849-10 .....	Post-Applied Coatings, Paving, and Linings for Corrugated Steel Sewer and Drainage Pipe
A929/A929M-01(2007) .....	Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
B745/B745M-97(2005) .....	Corrugated Aluminum Pipe for Sewers and Drains
B788/B788M-09 .....	Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe
C14-07 .....	Non-reinforced Concrete Sewer, Storm Drain, and Culvert Pipe
C33/C33M-08 .....	Concrete Aggregates
C76-11 .....	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C139-10 .....	Concrete Masonry Units for Construction of Catch Basins and Manholes
C150/C150M-11 .....	Portland Cement
C443-10 .....	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C478-09 .....	Precast Reinforced Concrete Manhole Sections
C506-10b .....	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
C507-10b .....	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
C655-09 .....	Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

C857-07 .....	Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
C891-09 .....	Installation of Underground Precast Concrete Utility Structures
C913-08 .....	Precast Concrete Water and Wastewater Structures
C923-08 .....	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
C924-02(2009) .....	Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
C990-09 .....	Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
C1103-03(2009) .....	Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
C1173-08 .....	Flexible Transition Couplings for Underground Piping Systems
C1433-10 .....	Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
C1479-10 .....	Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
D448-08 .....	Sizes of Aggregate for Road and Bridge Construction
D698-07e1 .....	Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> ))
D1056-07 .....	Flexible Cellular Materials—Sponge or Expanded Rubber
D1785-06 .....	Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D2321-11.....	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2751-05.....	Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
D2774-08.....	Underground Installation of Thermoplastic Pressure Piping
D3034-08.....	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3350-10.....	Polyethylene Plastics Pipe and Fittings Materials
D3753-05e1.....	Glass-Fiber-Reinforced Polyester Manholes and Wetwells
D4101-11.....	Polypropylene Injection and Extrusion Materials
D5926-09.....	Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
F477-10 .....	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F679-08 .....	Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
F714-10 .....	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F794-03(2009).....	Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
F891-10 .....	Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
F894-07 .....	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
F949-10 .....	Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings



F1417-11 .....Installation Acceptance of Plastic Gravity Sewer Lines  
Using Low-Pressure Air

F1668-08 .....Construction Procedures for Buried Plastic Pipe

C. American Association of State Highway and Transportation Officials (AASHTO):

M190-04.....Bituminous-Coated Corrugated Metal Culvert Pipe and  
Pipe Arches

M198-10.....Joints for Concrete Pipe, Manholes, and Precast Box  
Sections Using Preformed Flexible Joint Sealants

M252-09.....Corrugated Polyethylene Drainage Pipe

M294-10.....Corrugated Polyethylene Pipe, 12 to 60 In. (300 to 1500  
mm) Diameter

D. American Water Works Association (AWWA):

C105/A21.5-10 .....Polyethylene Encasement for Ductile iron Pipe Systems

C110-08 .....Ductile-Iron and Gray-Iron Fittings

C219-11 .....Bolted, Sleeve-Type Couplings for Plain-End Pipe

C600-10 .....Installation of Ductile iron Mains and Their Appurtenances

C900-07 .....Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated  
Fittings, 4 In. Through 12 In. (100 mm Through 300 mm),  
for Water Transmission and Distribution

M23-2nd ed.....PVC Pipe "Design And Installation"

E. American Society of Mechanical Engineers (ASME):

A112.6.3-2001.....Floor and Trench Drains

A112.14.1-2003.....Backwater Valves

A112.36.2M-1991 .....Cleanouts

F. American Concrete Institute (ACI):

318-05 .....Structural Commentary and Commentary

350/350M-06 .....Environmental Engineering Concrete Structures and  
Commentary

G. National Stone, Sand and Gravel Association (NSSGA): Quarried Stone for Erosion and  
Sediment Control

**1.10 WARRANTY**

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will furnish all manufacturers' and suppliers' written guarantees and warranties covering materials and equipment furnished under this Contract.

**PART 2- PRODUCTS**

**2.1 FACTORY-ASSEMBLED PRODUCTS**

A. Standardization of components shall be maximized to reduce spare part requirements.

The Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

**2.2 PE PIPE AND FITTINGS**

A. Profile Wall PE Pipe: Pipe shall comply with ASTM F894, Class 160.

1. Profile Wall PE Plastic Pipe Joints: Joints shall be as per ASTM F894, gasket or thermal weld type with integral bell.

B. PVC Pipe And Fittings

1. PVC Cellular-Core Pipe And Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.

2. Fittings: ASTM D3034, SDR 35 PVC socket-type fittings.

C. PVC Corrugated Sewer Piping

1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

D. PVC Profile Sewer Piping

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

E. PVC Type PSM Sewer Piping

1. Pipe: ASTM D3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

F. PVC Gravity Sewer Piping

1. Pipe and fittings shall be ASTM F679, , PVC gravity sewer pipe with bell-and-spigot ends.
2. Gaskets: ASTM F477, elastomeric seals for gasketed joints.

## **2.3 NONPRESSURE TRANSITION COUPLINGS**

- A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials
  1. For concrete pipes: ASTM C443, rubber.
  2. For plastic pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
  3. For dissimilar pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings: Couplings shall be an elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

- D. Shielded, flexible couplings shall be elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- E. Ring-Type, flexible couplings shall be elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

## **2.4 CLEANOUTS**

- A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
  - 1. Top-Loading Classification(s): Medium Duty Pipe fitting and riser to cleanout shall be same material as main pipe line.
- B. Plastic Cleanouts shall have PVC body with PVC threaded plug. Pipe fitting and riser to cleanout shall be of same material as main line pipe.

## **2.5 MANHOLES AND CATCH BASINS**

- A. Standard Precast Concrete Manholes:
  - 1. Description: ASTM C478 (ASTM C478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  - 2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
  - 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
  - 4. Base Section: 6 inch (150 mm) minimum thickness for floor slab and 4-inch (102 mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
  - 5. Riser Sections: 4 inch (102 mm) minimum thickness, and lengths to provide depth indicated.
  - 6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
  - 7. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
  9. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). Individual FRP steps or FRP ladder width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
  10. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
- B. Designed Precast Concrete Manholes:
1. Description: ASTM C913; designed for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
  2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
  3. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.
  4. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
  5. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). Individual FRP steps or FRP ladder.
  6. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
  - 7.
- C. Manhole Frames and Covers:
1. Description: Ferrous; 24 inch (610 mm) ID by 7 to 9 inch (175 to 225 mm) riser with 4 inch (102 mm) minimum width flange and 26-inch (600 mm) diameter cover.  
Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
  2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

## **2.6 CONCRETE FOR MANHOLES AND CATCH BASINS**

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
  - 1. Cement: ASTM C150, Type II.
  - 2. Fine Aggregate: ASTM C33, sand.
  - 3. Coarse Aggregate: ASTM C33, crushed gravel.
  - 4. Water: Potable.
- B. Concrete Design Mix: 4000 psi (27.6 MPa) minimum, compressive strength in 28 days.
  - 1. Reinforcing Fabric: ASTM A185, steel, welded wire fabric, plain.
  - 2. Reinforcing Bars: ASTM A615, Grade 60 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Channels shall be the main line pipe material. Include benches in all manholes and catch basins.
  - 1. Channels: Main line pipe material or concrete invert. Height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope. Invert Slope: Same slope as the main line pipe. Bench to be concrete, sloped to drain into channel. Minimum of 6 inch slope from main line pipe to wall sides.

## **2.7 STORMWATER DISPOSAL SYSTEMS**

- A. Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M252 for NPS 10 (DN 250) and smaller, AASHTO M294 for NPS 12 to NPS 60 (DN 300 to DN 1500). Include fittings, couplings, seals, and filter fabric.

## **2.8 WARNING TAPE**

- A. Standard, 4-Mil polyethylene 3 inch (76 mm) wide tape detectable type, green with black letters, and imprinted with "CAUTION BURIED STORM DRAIN LINE BELOW".

## **PART 3- EXECUTION**

### **3.1 PIPE BEDDING**

- A. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Concrete pipe requirements are such that when no bedding class is specified, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform with the lowest one-fourth of the outside portion of

circular pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material. Corrugated metal pipe bedding requirements shall conform to ASTM A798.

### **3.2 PIPING INSTALLATION**

- A. Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping with minimum cover as shown on the Drawings.
- C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  - 1. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
  - 2. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
  - 3. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
  - 4. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
  - 5. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.

6. Do not walk on pipe in trenches until covered by layers of shading to a depth of 12 inches (300 mm) over the crown of the pipe.
  7. Warning tape shall be continuously placed 12 inches (300 mm) above storm sewer piping.
- D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- F. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- G. Install gravity-flow, nonpressure drainage piping according to the following:
1. Install piping pitched down in direction of flow.
  2. Install ductile iron piping and special fittings according to AWWA C600.
  3. .
  4. Install PE corrugated sewer piping according to ASTM D2321 with gasketed joints.
  5. Install PVC cellular-core piping, PVC sewer piping, and PVC profile gravity sewer piping, according to ASTM D2321 and ASTM F1668.
  6. to ASTM C1479.

### **3.3 REGRADING**

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow



elevation within the structure, and shall prevent debris from entering the wastewater stream.

### **3.4 CONNECTIONS TO EXISTING VA-OWNED MANHOLES**

- A. Make pipe connections and alterations to existing manholes so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting, and shaping.

### **3.5 MANHOLE INSTALLATION**

- A. Install manholes, complete with appurtenances and accessories indicated. Install precast concrete manhole sections with sealants according to ASTM C891.
- B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
- C. Circular Structures:
  - 1. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 1/2 inch (15 mm) or cement mortar applied with a trowel and finished to an even glazed surface.
  - 2. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
  - 3. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.
- D. Rectangular Structures:
  - 1. Precast concrete structures shall be placed on a 8 inch (200 mm) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on an 8 inch (200 mm) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by

- ASTM D698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.
2. Do not build structures when air temperature is 32 deg F (0 deg C), or below.
  3. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
    - a. Forming directly in concrete base of structure.
    - b. Building up with brick and mortar.
  4. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1 to 12 or more than 1 to 6. Bottom slab and benches shall be concrete.
  5. The wall that supports access rungs or ladder shall be 90 deg vertical from the floor of structure to manhole cover.
  6. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
  7. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 2 inches (50 mm) above the adjacent finish grade. Install an 8 inch (203 mm) thick, by 12 inch (300 mm) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

### **3.6 CATCH BASIN INSTALLATION**

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

### **3.7 STORMWATER INLET AND OUTLET INSTALLATION**

- A. Construct inlet head walls, aprons, and sides of reinforced concrete.
- B. Construct riprap of broken stone.
- C. Install outlets that spill onto grade, anchored with concrete.
- D. Install outlets that spill onto grade, with flared end sections that match pipe.
- E. Construct energy dissipaters at outlets.
- F. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, according to piping manufacturer's written instructions.

### **3.8 CONNECTIONS**

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section FACILITY STORM DRAINAGE PIPING.
- B. Encase entire connection fitting, plus 6 inch (150 mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
- C. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping.
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping.
  - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  - 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

- D. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
  - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - a. flexible couplings for same or minor difference OD pipes.
    - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
  - 2. Use pressure-type pipe couplings for force-main joints.
- E.

### **3.9 IDENTIFICATION**

- A. Install green warning tape directly over piping and at outside edge of underground structures.

### **3.10 FIELD QUALITY CONTROL**

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.
  - 1. Submit separate reports for each system inspection.
  - 2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

4. Reinspect and repeat procedure until results are satisfactory.

### **3.11 TESTING OF STORM SEWERS:**

- A. Submit separate report for each test.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  1. Do not enclose, cover, or put into service before inspection and approval.
  2. Test completed piping systems according to requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
  4. Submit separate report for each test.
  5. Air test gravity sewers. Concrete Pipes conform to ASTM C924, Plastic Pipes conform to ASTM F1417, all other pipe material conform to ASTM C828 or C924, after consulting with pipe manufacturer. Testing of individual joints shall conform to ASTM C1103.
- C. Leaks and loss in test pressure constitute defects that must be repaired. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

### **3.12 CLEANING**

- A. Clean interior of piping of dirt and superfluous materials. Flush with potable water..

--- E N D ---

**SECTION 34 71 13**  
**PASSIVE VEHICLE BARRIERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Stationary anti-ram rated vehicle barriers at building entrances.

**1.2 RELATED REQUIREMENTS**

- A. Pipe Bollards: Section 05 50 00, METAL FABRICATIONS.

**1.3 APPLICABLE PUBLICATIONS**

- A. Comply with references to extent specified in this section.
- B. ASTM International (ASTM):
  - 1. F2656/F2656M-15 - Crash Testing of Vehicle Security Barriers.
  - 2. F3016/F3016M-19 - Standard Test Method for Surrogate Testing of Vehicle Impact Protective Devices at Low Speeds
- C. United States Department of State (DS):
  - 1. SD-STD02.01-Revision A - Vehicle Crash Testing of Perimeter Barriers and Gates.

**1.4 SUBMITTALS**

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
  - 1. Show size, configuration, and fabrication and installation details.
  - 2. Show dimensions and clearances between barriers and other adjacent permanent construction.
  - 3. Include setting drawings and templates for anchors, sleeves, and other items embedded into concrete foundations.
- C. Delegated Design Drawings and Calculations: Signed and sealed by registered design professional.
- D. Manufacturer Vehicle Impact Performance Certification

## **1.5 QUALITY ASSURANCE**

- A. Manufacturer and Installer Qualifications:
  - 1. Regularly manufactures and installs specified products.
  - 2. Manufactured and installed specified products with satisfactory service on five similar installations for minimum five years.
    - a. Provide contact names and addresses for completed projects when requested by Contracting Officer's Representative.

## **1.6 FIELD CONDITIONS**

- A. Field Measurements: Verify field conditions affecting vehicle barrier fabrication and installation. Show field measurements on Submittal Drawings.
  - 1. Coordinate field measurement and fabrication schedule to avoid delay.
- B. Bollard anti-ram rating shall consider site conditions, top of foundation shall be a minimum 12 inches below grade. (frost depth)

## **1.7 WARRANTY**

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

# **PART 2 - PRODUCTS**

## **2.1 SYSTEM DESCRIPTION**

- A. Structural Vehicle Barriers:
  - 1. Bollards: Steel pipe, concrete filled as indicated in manufacturer's shop drawings.
  - 2. Foundations: Permanent concrete as indicated in manufacturer's shop drawings.

## **2.2 SYSTEM PERFORMANCE**

- A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.
- B. Barrier shall be pretested, manufactured and installed to provide resistance to the following vehicle impact loading and performance parameters:
  - 1. Weight  $\geq$  4,000-lb (1,800-kg)
  - 2. Speed  $\geq$  30-mph (48-km/hr)

3. Penetration Distance  $\leq$  3.3-ft. (1-m) as defined in ASTM F2656

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Examine and verify foundation suitability for product installation.
- B. Coordinate delivery and installation of anchors, sleeves, and other items embedded in concrete foundations.
- C. Coordinate barrier system layout and installation with site grading and paving requirements including:
  1. Concrete paving, see Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

#### **3.2 INSTALLATION**

1. Bollard Installation: In accordance with Manufacturers pretested and certified barrier shop drawings.

--- E N D ---



**SECTION 48 14 00**  
**SOLAR ENERGY ELECTRICAL POWER GENERATION SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, testing, and commissioning of solar energy electrical power generation systems.
- B. The requirements of this Section apply to all sections of Division 48 related to solar energy electrical power generation systems.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS: General construction practices.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Submittals.
- C. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS: General requirements for commissioning.
- D. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirement for seismic restraint for nonstructural components.
- E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- F. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Requirements for low-voltage conductors.
- G. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and requirements for providing a low impedance path for possible ground fault currents.
- H. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Requirements for boxes, conduits, and raceways.
- I. Section 26 08 00, COMMISSIONING OF ELECTRICAL SYSTEMS: Requirements for commissioning the electrical system, subsystems, and equipment.
- J. Section 26 29 21, ENCLOSED SWITCHES AND CIRCUIT BREAKERS: Requirements for enclosed disconnect switches.

### 1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, electrical and electronics terminology used in these specifications, and on the drawings, shall be as defined in IEEE 100 CD.
- B. Unless otherwise specified or indicated, solar energy conversion and solar photovoltaic energy system terminology used in these specifications, and on the drawings, shall be as defined in ASTM E772.

### 1.4 QUALITY ASSURANCE

- A. Products and Services pertaining to this specification shall comply with Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Solar Energy Electrical Power Generation System installer(s) shall demonstrate that they have successfully installed at least four projects within the past five years that, in aggregate, equal or exceed the size of the proposed project. References shall be provided for each of the referenced qualified projects.
- C. Supports and racking for solar photovoltaic system designs shall be prepared under the seal of a licensed Professional Structural Engineer (PE). Where applicable, such as roof top installations, the engineer shall also provide adequate review and structural analysis of the existing structure that will be supporting the proposed solar photovoltaic system. Among the documents that shall be submitted by the engineer are environmental loading analyses (including wind, snow, hail, and where applicable, seismic) and the rack and substrate's ability to withstand these environmental forces. In the instance where the rack is installed on the ground, adequate information shall be presented to demonstrate the earth's ability to support the proposed design.
- D. If the system will be a tracking system, the mechanical and control systems shall be approved by the using entity. Preference shall be given to closed or hybrid-open/closed logic control for the tracking system.
- E. If paralleling arrangement is desired, the system shall have anti-islanding capability such that it is incapable of exporting power to the utility distribution system in the absence of utility power. Paralleling must be approved by serving electric utility. Provide written correspondence from the utility confirming its requirements.

- F. Investigate whether the Resident Engineer, Contracting Officer's Representative (COR), or local environmental entities require environmental impact studies which may include, but are not limited to, effects upon wildlife. The Contractor shall determine which entity has jurisdiction over environmental matters and shall make appropriate inquiry and comply with all applicable regulations.
- G. Investigate any other local ordinances that may apply to installation of a solar energy electrical generating system in the proposed location. Bring any conflicts with the drawings and specifications to the attention of the Resident Engineer or COR.
- H. Warranties: The solar energy electrical generating system shall be subject to the terms of FAR Clause 52.246-21, except that the warranty period shall be as noted for the items below:
  - 1. Solar photovoltaic modules and inverter: 12-year manufacturer's warranty against defects in materials and workmanship.
  - 2. Power output: 25-year manufacturer's power output warranty, with the first 10 years at 93.1% minimum rated power output and the balance of the 25 years at 85% minimum rated power output with a maximum of 0.54% degradation per year.

### **1.5 SUBMITTALS**

- A. Where proposed system shall be a Net Meter project, prepare appropriate applications and submittals to the Resident Engineer or COR. Where proposed system shall be connected before the serving electric utility's meter and tied directly to the grid, prepare appropriate applications and submittals to the Resident Engineer or COR. In all cases, the serving electric utility may have a requirement for further electrical studies, which may include or not be limited to power factor analysis, short circuit protection studies, grid wiring adequacy, or capacities of upstream equipment. If such requirements exist and are required by the serving electric utility, these requirements shall be fulfilled by the Contractor. Provide written documentation confirming the utility's approval of the interconnection of the solar energy electrical power generation system with the utility system.

B. Submittals shall comply with paragraph, SUBMITTALS, in Section 26 05 11,  
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:

- a. Submit sufficient information to demonstrate compliance with drawings and specifications.
- b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, wiring and connection diagrams, accessories, and nameplate data.
- c. Include shop drawings for foundations and other support structures.

2. Product Data:

- a. Include detailed information for components of the solar energy electrical generation system.
  - 1. Wiring.
  - 2. Inverter.
  - 3. Photovoltaic modules.
  - 4. Rack and support assemblies.
  - 5. Instrumentation.
  - 6. Switchgear.
  - 7. DC and AC disconnects.
  - 8. Combiner boxes.
  - 9. Monitoring systems including appropriate interfacing with existing facility data collection systems.
- b. Certification from the manufacturer that the system has been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.

3. Manuals:

- a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
    1. Safety precautions.
    2. Operator restart.
    3. Startup, shutdown, and post-shutdown procedures.
    4. Normal operations.
    5. Emergency operations.
    6. Environmental conditions.
    7. Preventive maintenance plan and schedule.
    8. Troubleshooting guides and diagnostic techniques.
    9. Wiring and control diagrams.
    10. Maintenance and repair procedures.
    11. Removal and replacement instructions.
    12. Tracking systems (where applicable).
    13. Spare parts and supply list.
    14. Parts identification.
    15. Testing equipment and special tool information.
    16. Warranty information.
    17. Testing and performance data.
    18. Contractor information.
  - b. If changes have been made to the maintenance and operating manuals originally submitted, then submit updated maintenance and operating manuals two weeks prior to the final inspection.
4. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the manufacturers of all major items of the solar energy electric generation system that the system conforms to the requirements of the drawings and specifications, and that they have jointly coordinated and properly integrated their equipment and controls to provide a complete and functional installation.

- b. Certification by the Contractor that the solar energy electric generation system has been properly installed, adjusted, tested, commissioned, and warrantied. Contractor shall make all necessary field measurements and investigations to ensure that the equipment and assemblies meet contract requirements.
- 5. Estimated Annual Power Output: Submit calculated annual power output for each of the proposed solar photovoltaic systems. Provide independent calculations for each fixed, single-axis tracking, or double-axis tracking system.
- C. If equipment submitted differs in arrangement from that shown on the drawings, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract and acceptable to the Resident Engineer or COR.
- D. Submittals and shop drawings for independent but related items shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group. Final review and approval will be made only by groups.

#### **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. American Society for Testing and Materials (ASTM):
  - E772-15 .....Standard Terminology of Solar Energy Conversion
  - E1038-15 .....Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls
- C. Institute of Electrical and Electronics Engineers (IEEE):
  - 100 CD-13.....The Authoritative Dictionary of IEEE Standards Terms
  - 519-14 .....Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

- 937-07 .....Recommended Practice for Installation and Maintenance of  
Lead-Acid Batteries for Photovoltaic (PV) Systems
- 1013-07 .....Recommended Practice for Sizing Lead-Acid Batteries for  
Stand-Alone Photovoltaic (PV) Systems
- 1361-14 .....Guide for Selection, Charging, Test and Evaluation of Lead-  
Acid Batteries Used in Stand-Alone Photovoltaic (PV)  
Systems
- 1526-03 .....Recommended Practice for Testing the Performance of  
Stand-Alone Photovoltaic Systems
- 1547-03 .....Standard for Interconnecting Distributed Resources with  
Electric Power Systems
- 1561-07 .....Guide for Optimizing the Performance and Life of Lead-Acid  
Batteries in Remote Hybrid Systems
- 1562-07 .....Guide for Array and Battery Sizing in Stand-Alone  
Photovoltaic (PV) Systems
- 1661-07 .....Guide for Test and Evaluation of Lead-Acid Batteries Used  
in Photovoltaic (PV) Hybrid Power Systems
- D. International Code Council (ICC):
- IBC-15 .....International Building Code
- IFC-15 .....International Fire Code
- E. National Electrical Manufacturer’s Association (NEMA):
- 250-14 .....Enclosures for Electrical Equipment (1,000 Volts Maximum)
- F. National Fire Protection Association (NFPA):
- 70-17 .....National Electrical Code (NEC), 2020
- G. Underwriters Laboratories (UL):
- 6-07 .....Electrical Rigid Metal Conduit – Steel
- 94-13 .....Tests for Flammability of Plastic Materials for Parts in  
Devices and Appliances; Ed 6
- 797-07 .....Electrical Metallic Tubing – Steel

969-17 .....	Standard for Marking and Labeling Systems
1242-14 .....	Standard for Electrical Intermediate Metal Conduit – Steel
1703-02 .....	Standard for Flat-Plate Photovoltaic Modules and Panels
1741-10 .....	Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Provide materials to fabricate functioning photovoltaic system in accordance with ASTM, IEEE, NEMA, NFPA, and UL, as specified in this section, and as shown on the drawings.
- B. Factory-prefabricated solar equipment packages which include photovoltaic modules, batteries or other energy storage, inverters, and controls and which meet the requirements of this section are acceptable.

### **2.2 GROUNDING**

- A. All applicable components of the solar energy electrical power generating system must be grounded per latest NEC requirements.
- B. DC Ground-Fault Protector:
  - 1. Shall be listed per UL 1703.
  - 2. Shall comply with requirements of the NEC.

### **2.3 PHOTOVOLTAIC ARRAY CIRCUIT COMBINER BOX**

- A. Shall be listed to UL 1741.
- B. Shall include internal overcurrent protection devices with dead front.
- C. Shall be contained in non-conductive NEMA Type 4X enclosure.
- D. Up to 48 volts DC: Shall use UL-listed DC breakers that meet NEC requirements for overcurrent protection.
- E. Up to 600 volts DC, paralleling system: Shall use fuses instead of breakers.
- F. Ground and pole-mounted arrays shall have a separate combiner box mounted to the pole itself.
- G. Where applicable, combiner box shall be a disconnecting combiner box.



## **2.4 SWITCH/DISCONNECTING MEANS**

- A. Shall be UL-listed, in accordance with the NEC, as shown on the drawings, and as specified.
- B. Utility External Disconnect Switch (UEDS): Refer to Resident Engineer or COR, as several states do not require UEDS for small solar photovoltaic systems if the inverter provides the same function per NEC. Coordinate requirements with serving electric utility.

## **2.5 WIRING SPECIALTIES**

- A. Direct Current Conductors:
  - 1. If Exposed: Shall be USE-2, UF (inadequate at 60°C [140°F]), or SE, 90°C [194°F] wet-location rated and sunlight-resistant (usually for tracking modules).
  - 2. If in Conduit: Shall be RHW-2, THWN-2, or XHHW-2 90°C [194°F], wet-location rated.
- B. Conduits and Raceways:
  - 1. Shall use steel conduit listed per UL 6, UL 1242, UL 797 (as appropriate), except for tracking modules. Weathertight EMT installations shall be allowed for DC wiring in weather-protected areas.
  - 2. Shall use expansion joints on long conduit runs.
  - 3. Shall not be installed on photovoltaic modules.
- C. Enclosures subject to weather shall be rated NEMA 3R or better.
- D. Cable Assemblies and Junction Boxes:
  - 1. Shall be UL-listed.
  - 2. Shall be rated to 5VA flammability per UL 94.
- E. Prohibited Wiring Materials: Those which are not UL-listed, or listed materials used in environments outside those covered in their listing.

## **2.6 DC-AC INVERTER**

- A. Shall be listed to UL 1741.
- B. Shall comply with IEEE 519 and IEEE 1547.
- C. Shall be listed per FCC Part 15 Class A.1.
- D. Shall have stand-alone, utility-interactive, or combined capabilities.
- E. Shall include maximum power point tracking (MPPT) features.

- F. Shall include anti-islanding protection if paralleling arrangement is required.
- G. Shall meet NEC requirements for arc fault protection (AFCI) and Photovoltaic Rapid Shutdown (PVRSS).
- H. Shall offer built-in module level monitoring.

## **2.7 POWER OPTIMIZERS**

- A. Shall be listed to UL 1741.
- B. Shall meet NEC requirements for arc fault protection (AFCI) and Photovoltaic Rapid Shutdown System (PVRSS).
- C. Shall offer built-in module level monitoring.

## **2.8 SOLAR PHOTOVOLTAIC (PV) MODULES**

- A. Minimum Performance Parameters as per IBC 1509.7.4, IRC M2302.3, UL 1703.
- B. Photovoltaic Panel Types:
  - 1. Monocrystalline: Listed to UL 1703.
  - 2. Polycrystalline: Listed to UL 1703.
  - 3. Thin-Film/Flexible: Listed to UL 1703.
  - 4. Building-Integrated & Solar Shingles: Listed to UL 1703.
- C. Module and System Identification
  - 1. Module or Panel:
    - a. Listed to UL 969 for weather resistance.
    - b. Listed to UL 1703 for marking contents and format.
  - 2. Main Service Disconnect: per NEC.
  - 3. Identification Content and Format: per NEC.
  - 4. Identification for DC Conduit, Raceways, Enclosures, Cable Assemblies, and Junction Boxes: IFC 605.
  - 5. Identification for Inverter: per NEC.
- D. Bypass diodes shall be built into each PV module either between each cell or each string of cells.
- E. Other Components: per UL 1703.
- F. Hail Protection: Compliant with testing procedure per ASTM E-1038.

- G. Lightning Protection: Shall ground according to manufacturer instructions per UL 1703.
- H. Access, Pathways, and Smoke Ventilation: Per IFC 605.3, access and spacing requirements must be observed in order to: ensure access to the roof, provide pathways to specific areas of the roof, provide for smoke ventilation opportunities area, and, where applicable, provide emergency access egress from the roof.
- I. Fire Classification:
  - 1. IBC 1505.8 for building-integrated photovoltaic and solar shingles.
  - 2. IBC 1509.7.2: Although not technically enforceable, every effort shall be made to ensure the solar photovoltaic module is not combustible.

## **2.9 COLLECTOR SUPPORTS**

- A. Wind Resistance Requirement:
  - 1. For rack-mounted: per IBC 1509.7.1.
  - 2. For building-integrated photovoltaic and solar shingles: IBC 1507.17.3.
- B. Mechanical Load Requirement: per UL 1703.

## **2.10 INSTRUMENTATION**

- A. Meters: If applicable and system is grid-connected, use net smart meter provided by the serving electric utility.
- B. Sensors:
  - 1. Temperature sensor shall be a component in the MPPT control system.
  - 2. May install additional data acquisition sensors to measure irradiance, wind speed, and ambient and PV module temperatures. Any additional sensors shall require a conduit separate from the current conductor conduit.
- C. Data logger/Monitoring System: Shall be a packaged system capable of string-level monitoring or in the case of micro-inverters, capable of monitoring and logging an individual module's information.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Install the solar photovoltaic system in accordance with the NEC, this section, and the printed instructions of the manufacturer.

- B. Prior to system start-up, ensure no copper wire remains exposed with the exception of grounding wire as allowed in certain circumstances per manufacturer's instructions.
- C. In seismic areas, systems shall be adequately anchored and braced per details on structural contract documents to withstand seismic forces at the locations where installed.
- D. Wiring Installation: Workers shall be made aware that photovoltaic modules will be live and generating electricity when there is any ambient light source and shall take appropriate precautions. Utilize on-site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections. Locate wires out of the way of windows, doors, openings, and other hazards. Ensure wires are free of snags and sharp edges that have the potential to compromise the wire insulation. All cabling shall be mechanically fastened. If the system is roof-mounted it shall have direct current ground fault protection according to NEC. Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring.
- E. Instrumentation: Install instruments as recommended by the manufacturer. Locate control panels inside a room accessible only to qualified persons.
- F. Rack-Mounted Photovoltaic Installations: Rack-mounted photovoltaic modules shall be installed in accordance with the manufacturer's installation instructions.
- G. Provide safety signage per NEC.

### **3.2 FIELD QUALITY CONTROL**

- A. Field Inspection: Perform in accordance with manufacturer's recommendations. Prior to initial operation, inspect the solar energy electrical power generation system for conformance to drawings, specifications, and NEC. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Verify required area clearances.

- d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method or performing thermographic survey after energization.
  - e. Verify the correct operation of all sensing devices, alarms, and indicating devices.
  - f. Verify that all cable entries from top of junction boxes are sealed per junction box rating.
  - g. Verify all connections and integrity of printed circuit boards in all applicable junction boxes.
- B. Tests: Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct tests in the presence of the Resident Engineer or COR.
- 1. Module String Voltage Test: Prior to connecting wiring to the combiner box, use a digital multi-meter to ensure each series string's polarity is correct.
  - 2. Operational Tests: Perform tests in accordance with the manufacturer's written recommendations. Tests for stand-alone systems shall be performed per IEEE 1526.

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

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the solar photovoltaic electrical power generation system is in good operating condition and properly performing the intended function.

### **3.4 COMMISSIONING**

- A. Comply with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- B. If the system is grid-tied, the Contractor shall coordinate with the serving electric utility to establish an interconnection agreement.
- C. Connect the solar photovoltaic electrical power generation system to the serving electric utility grid only after receiving prior approval from the utility company.
- D. Only qualified personnel shall connect the solar photovoltaic electrical power generation system to the serving electric utility grid.

### 3.5 INSTRUCTION

- A. A complete set of operating instructions for the solar photovoltaic electrical power generation system shall be laminated or mounted under acrylic glass and installed in a frame near the equipment.
- B. Furnish the services of a factory-trained technician for one, 4-hour training period for instructing personnel in the maintenance and operation of the solar photovoltaic electrical power generation system, on the date requested by the Resident Engineer or COR.

---END---