

PROJECT MANUAL

CONSTRUCT ADDITIONAL ELEVATOR Building B1

PROJECT NO. 589A7-16-103

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Volume 2 of 2

Department of Veterans Affairs
Robert J. Dole VA Medical Center
5500 E. Kellogg
Wichita, Kansas



**Construct Additional Elevator, Building B1
Project No. 589A7-16-103
Wichita VA Medical Center**

**DEPARTMENT OF VETERANS AFFAIRS
VHA MASTER SPECIFICATIONS**

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SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Design, installation and testing shall be in accordance with NFPA 13.
- B. The design and installation of an automatic wet-pipe system complete and ready for operation, for elevator lobbies and renovated areas indicated for Building 1.

1.2 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Section 07 84 00, FIRESTOPPING.
- C. Section 09 91 00, PAINTING.
- D. Section 28 31 00, FIRE DETECTION AND ALARM.

1.3 DESIGN CRITERIA

- A. Design Basis Information: Provide design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system in accordance with the requirements of NFPA 13.
 - 1. Perform hydraulic calculations in accordance with NFPA 13 utilizing the Area/Density method.
 - 2. Sprinkler Protection: Sprinkler hazard classifications shall be in accordance with NFPA 13. To determine spacing and sizing, apply the following coverage classifications:
 - a. Light Hazard Occupancies: Corridors and elevator lobbies.
 - b. Ordinary Hazard Group 1 Occupancies: Storage and mechanical rooms.
 - 3. Hydraulic Calculations: Calculated demand including hose stream requirements shall fall no less than 10 percent below the available water supply curve.
 - 4. Water Supply: Contractor shall use a fire flow test or fire pump test as the basis of design. If existing test results less than one year old are not available, contractor shall perform a new flow test at the site.

1.4 SUBMITTALS

- A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Prepare detailed working drawings that are signed by a NICET Level III or Level IV Sprinkler Technician or stamped by a Registered Professional Engineer licensed in the field

of Fire Protection Engineering. As the Government review is for technical adequacy only, the installer remains responsible for correcting any conflicts with other trades and building construction that arise during installation. Partial submittals will not be accepted. Material submittals shall be approved prior to the purchase or delivery to the job site. Suitably compile submittals and provide an index referencing the appropriate specification section. Provide submittal items in Paragraphs 1.4(A)1 through 1.4(A)4 electronically in pdf format on a compact disc or as directed by the COR. Submittals shall include, but not be limited to, the following:

1. Qualifications:

- a. Provide a copy of the installing contractor's state contractor's license.
- b. Provide a copy of the NICET certification for the NICET Level III or Level IV Sprinkler Technician who prepared and signed the detailed working drawings unless the drawings are stamped by a Registered Professional Engineer licensed in the field of Fire Protection Engineering.
- c. Provide documentation showing that the installer has been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past ten years.

2. Drawings: Submit detailed 1/8 inch scale (minimum) working drawings conforming to the Plans and Calculations chapter of NFPA 13.

Drawings shall include graphical scales that allow the user to determine lengths when the drawings are reduced in size. Include a plan showing the piping to the water supply test location.

3. Manufacturer's Data Sheets: Provide data sheets for all materials and equipment proposed for use on the system. Include listing information and installation instructions in data sheets. Where data sheets describe items in addition to those proposed to be used for the system, clearly identify the proposed items on the sheet.

4. Calculation Sheets:

- a. Submit hydraulic calculation sheets in tabular form conforming to the requirements and recommendations of the Plans and Calculations chapter of NFPA 13.

5. Final Document Submittals: Provide as-built drawings, testing and maintenance instructions in accordance with the requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. In

addition, submittals shall include, but not be limited to, the following:

- a. A complete set of as-built drawings showing the installed system with the specific interconnections between the system switches and the fire alarm equipment. Provide a complete set in the formats as follows. Submit items 2 and 3 below on a compact disc or as directed by the COR.
 - 1) One full size (or size as directed by the COR) printed copy.
 - 2) One complete set in electronic pdf format.
 - 3) One complete set in AutoCAD format or a format as directed by the COR.
- b. Material and Testing Certificate: Upon completion of the sprinkler system installation or any partial section of the system, including testing and flushing, provide a copy of a completed Material and Testing Certificate as indicated in NFPA 13. Certificates shall be provided to document all parts of the installation.
- c. Operations and Maintenance Manuals that include the manufacturer's name, model number, parts list, and tools that should be kept in stock by the owner for routine maintenance, including the name of a local supplier, and recommended service organization, including address and telephone number, for each item of equipment.
- d. One paper copy of the Material and Testing Certificates and the Operations and Maintenance Manuals above shall be provided in a binder. In addition, these materials shall be provided in pdf format on a compact disc or as directed by the COR.
- e. Provide one additional copy of the Operations and Maintenance Manual covering the system in a flexible protective cover and mount in an accessible location adjacent to the riser or as directed by the COR.

1.5 QUALITY ASSURANCE

- A. Installer Reliability: The installer shall possess a valid State of Kansas contractor's license. The installer shall have been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past ten years.
- B. Materials and Equipment: All equipment and devices shall be of a make and type listed by UL or approved by FM, or other nationally recognized

testing laboratory for the specific purpose for which it is used. All materials, devices, and equipment shall be approved by the VA. All materials and equipment shall be free from defect. All materials and equipment shall be new unless specifically indicated otherwise on the contract drawings.

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. National Fire Protection Association (NFPA):
 - 13-16.....Installation of Sprinkler Systems
 - 101-15.....Life Safety Code
- C. Underwriters Laboratories, Inc. (UL):
 - Fire Protection Equipment Directory (2011)
- D. Factory Mutual Engineering Corporation (FM):
 - Approval Guide

PART 2 - PRODUCTS

2.1 PIPING & FITTINGS

- A. Piping and fittings for sprinkler systems shall be in accordance with NFPA 13.
 - 1. Plain-end pipe fittings with locking lugs or shear bolts are not permitted.
 - 2. Piping sizes 2 inches and smaller shall be black steel Schedule 40 with threaded end connections.
 - 3. Piping sizes (2 ½ inches) and larger shall be black steel Schedule 40 with grooved connections. Grooves shall be rolled grooved only.
 - 3. Flexible sprinkler hose shall be FM Approved and limited to hose with threaded end fittings with a minimum inside diameter or 1-inch and a maximum length of 6-feet.

2.2 NOT USED

2.3 NOT USED

2.4 SPRINKLERS

- A. All sprinklers shall be FM approved quick response. Provide FM approved quick response sprinklers in all areas.
- B. Temperature Ratings: In accordance with NFPA 13.
- C. Provide sprinkler guards in accordance with NFPA 13 and when the elevation of the sprinkler head is less than 7 above finished floor.

The sprinkler guard shall be UL listed or FM approved for use with the corresponding sprinkler.

2.5 SPRINKLER CABINET

- A. Provide sprinkler cabinet with the required number of sprinkler heads of all ratings and types installed, and a sprinkler wrench for each type of sprinkler in accordance with NFPA 13. Locate near existing sprinkler cabinets.
- B. Provide a list of sprinklers installed in the property in the cabinet. The list shall include the following:
 - 1. Manufacturer, model, orifice, deflector type, thermal sensitivity, and pressure for each type of sprinkler in the cabinet.
 - 2. General description of where each sprinkler is used.
 - 3. Quantity of each type present in the cabinet.
 - 4. Issue or revision date of list.

2.6 NOT USED

2.7 NOT USED

2.8 GAUGES

Provide gauges as required by NFPA 13. Provide gauges where the normal pressure of the system is at the midrange of the gauge.

2.9 PIPE HANGERS, SUPPORTS AND RESTRAINT OF SYSTEM PIPING

Pipe hangers, supports, and restraint of system piping shall be in accordance with NFPA 13.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be accomplished by the licensed contractor. Provide a qualified technician, experienced in the installation and operation of the type of system being installed, to supervise the installation and testing of the system.
- B. Installation of Piping: Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. In any situation where bending of the pipe is required, use a standard pipe-bending template. Conceal piping in spaces that have finished ceilings. Piping shall not obstruct the minimum means of egress clearances required by NFPA 101. Pipe hangers, supports, and restraint of system piping shall be installed accordance with NFPA 13.
- C. Welding: Conform to the requirements and recommendations of NFPA 13.
- D. Drains: Provide drips and drains, including low point drains, in accordance with NFPA 13 for new trapped piping. Pipe drains to

discharge at safe points outside of the building or to sight cones attached to drains of adequate size to readily carry the full flow from each drain under maximum pressure. Do not provide a direct drain connection to sewer system or discharge into sinks. Install drips and drains where necessary and required by NFPA 13. The drain piping shall not be restricted or reduced and shall be of the same diameter as the drain collector.

- E. Sleeves: Provide for pipes passing through masonry or concrete. Provide space between the pipe and the sleeve in accordance with NFPA 13. Seal this space with a UL Listed through penetration fire stop material in accordance with Section 07 84 00, FIRESTOPPING. Where core drilling is used in lieu of sleeves, also seal space. Seal penetrations of walls, floors and ceilings of other types of construction, in accordance with Section 07 84 00, FIRESTOPPING.
- F. Firestopping shall be provided for all penetrations of fire resistance rated construction. Firestopping shall comply with Section 07 84 00, FIRESTOPPING.
- G. Painting of Pipe: Exercise care to avoid painting sprinklers. Painting of sprinkler systems above suspended ceilings and in crawl spaces is not required. Painting shall comply with Section 09 91 00, PAINTING. Any painted sprinkler shall be replaced with a new sprinkler.
- H. Sprinkler System Signage: Provide rigid sprinkler system signage in accordance with NFPA 13 and NFPA 25. Sprinkler system signage shall include, but not limited to, the following:
 - 1. Identification Signs:
 - a. Provide signage for each drain valve, sprinkler cabinet, and inspector's test.
 - 2. Instruction/Information Signs:
 - a. Provide signage indicating the number and location of low point drains.
- I. Repairs: Repair damage to the building or equipment resulting from the installation of the sprinkler system by the installer at no additional expense to the Government.
- J. Interruption of Service: There shall be no interruption of the existing sprinkler protection, water, electric, or fire alarm services without prior permission of the COR. Contractor shall develop an interim fire protection program where interruptions involve occupied

spaces. Request in writing at least one week prior to the planned interruption.

3.2 INSPECTION AND TEST

- A. Preliminary Testing: Flush newly installed systems prior to performing hydrostatic tests in order to remove any debris which may have been left as well as ensuring piping is unobstructed. Hydrostatically test system as specified in NFPA 13, in the presence of the Contracting Officers Representative (COR) or his designated representative.
- B. Final Inspection and Testing: Subject system to tests in accordance with NFPA 13, and when all necessary corrections have been accomplished, advise COR to schedule a final inspection and test. Connection to the fire alarm system shall have been in service for at least ten days prior to the final inspection, with adjustments made to prevent false alarms. Furnish all instruments, labor and materials required for the tests and provide the services of the installation foreman or other competent representative of the installer to perform the tests. Correct deficiencies and retest system as necessary, prior to the final acceptance. Include the operation of all features of the systems under normal operations in test

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**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.
- C. Abbreviations/Acronyms:
 - 1. ABS: Acrylonitrile Butadiene Styrene
 - 2. AC: Alternating Current
 - 3. ACR: Air Conditioning and Refrigeration
 - 4. AI: Analog Input
 - 5. AISI: American Iron and Steel Institute
 - 6. AO: Analog Output
 - 7. AWG: American Wire Gauge
 - 8. BACnet: Building Automation and Control Network
 - 9. BAg: Silver-Copper-Zinc Brazing Alloy
 - 10. BAS: Building Automation System
 - 11. BCuP: Silver-Copper-Phosphorus Brazing Alloy
 - 12. BSG: Borosilicate Glass Pipe
 - 13. CDA: Copper Development Association
 - 14. C: Celsius
 - 15. CLR: Color
 - 16. CO: Carbon Monoxide
 - 17. COR: Contracting Officer's Representative
 - 18. CPVC: Chlorinated Polyvinyl Chloride
 - 19. CR: Chloroprene
 - 20. CRS: Corrosion Resistant Steel
 - 21. CWP: Cold Working Pressure
 - 22. CxA: Commissioning Agent
 - 23. db(A): Decibels (A weighted)
 - 24. DDC: Direct Digital Control
 - 25. DI: Digital Input
 - 26. DISS: Diameter Index Safety System
 - 27. DO: Digital Output
 - 28. DVD: Digital Video Disc

- 29. DN: Diameter Nominal
- 30. DWV: Drainage, Waste and Vent
- 31. ECC: Engineering Control Center
- 32. EPDM: Ethylene Propylene Diene Monomer
- 33. EPT: Ethylene Propylene Terpolymer
- 34. ETO: Ethylene Oxide
- 35. F: Fahrenheit
- 36. FAR: Federal Acquisition Regulations
- 37. FD: Floor Drain
- 38. FED: Federal
- 39. FG: Fiberglass
- 40. FNPT: Female National Pipe Thread
- 41. FPM: Fluoroelastomer Polymer
- 42. GPM: Gallons Per Minute
- 43. HDPE: High Density Polyethylene
- 44. Hg: Mercury
- 45. HOA: Hands-Off-Automatic
- 46. HP: Horsepower
- 47. HVE: High Volume Evacuation
- 48. ID: Inside Diameter
- 49. IPS: Iron Pipe Size
- 50. Kg: Kilogram
- 51. kPa: Kilopascal
- 52. lb: Pound
- 53. L/s: Liters Per Second
- 54. L/min: Liters Per Minute
- 55. MAWP: Maximum Allowable Working Pressure
- 56. MAX: Maximum
- 57. MED: Medical
- 58. m: Meter
- 59. MFG: Manufacturer
- 60. mg: Milligram
- 61. mg/L: Milligrams per Liter
- 62. ml: Milliliter
- 63. mm: Millimeter
- 64. MIN: Minimum
- 65. NF: Oil Free Dry (Nitrogen)
- 66. NPTF: National Pipe Thread Female

- 67. NPS: Nominal Pipe Size
- 68. NPT: Nominal Pipe Thread
- 69. OD: Outside Diameter
- 70. OSD: Open Sight Drain
- 71. OS&Y: Outside Stem and Yoke
- 72. OXY: Oxygen
- 73. PBPU: Prefabricated Bedside Patient Units
- 74. PH: Power of Hydrogen
- 75. PLC: Programmable Logic Controllers
- 76. PP: Polypropylene
- 77. PPM: Parts per Million
- 78. PSIG: Pounds per Square Inch
- 79. PTFE: Polytetrafluoroethylene
- 80. PVC: Polyvinyl Chloride
- 81. PVDF: Polyvinylidene Fluoride
- 82. RAD: Radians
- 83. RO: Reverse Osmosis
- 84. RPM: Revolutions Per Minute
- 85. RTRP: Reinforced Thermosetting Resin Pipe
- 86. SCFM: Standard Cubic Feet Per Minute
- 87. SDI: Silt Density Index
- 88. SPEC: Specification
- 89. SPS: Sterile Processing Services
- 90. STD: Standard
- 91. SUS: Saybolt Universal Second
- 92. SWP: Steam Working Pressure
- 93. TEFC: Totally Enclosed Fan-Cooled
- 94. TFE: Tetrafluoroethylene
- 95. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 96. THWN: Thermoplastic Heat & Water Resistant Nylon Coated Wire
- 97. T/P: Temperature and Pressure
- 98. USDA: U.S. Department of Agriculture
- 99. V: Volt
- 100. VAC: Vacuum
- 101. VA: Veterans Administration
- 102. VAMC: Veterans Administration Medical Center
- 103. VAC: Voltage in Alternating Current
- 104. WAGD: Waste Anesthesia Gas Disposal

105. WOG: Water, Oil, Gas

1.2 RELATED WORK

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.
- B. American Society of Mechanical Engineers (ASME):
ASME Boiler and Pressure Vessel Code -
BPVC Section IX-2013....Welding, Brazing, and Fusing Qualifications
B31.1-2012.....Power Piping
- C. American Society for Testing and Materials (ASTM):
A36/A36M-2012.....Standard Specification for Carbon Structural Steel
A575-96(R2013)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
F1760-01(R2011).....Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
- D. International Code Council, (ICC):
IBC-2012.....International Building Code
IPC-2012.....International Plumbing Code
- E. 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-69-2003.....Pipe Hangers and Supports - Selection and Application
- F. Military Specifications (MIL):
P-21035B.....Paint High Zinc Dust Content, Galvanizing Repair (Metric)
- G. National Electrical Manufacturers Association (NEMA):
MG 1-2011.....Motors and Generators

H. National Fire Protection Association (NFPA):

51B-2014.....Standard for Fire Prevention During Welding,
Cutting and Other Hot Work

54-2012.....National Fuel Gas Code

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

I. NSF International (NSF):

5-2012.....Water Heaters, Hot Water Supply Boilers, and
Heat Recovery Equipment

14-2012.....Plastic Piping System Components and Related
Materials

61-2012.....Drinking Water System Components - Health
Effects

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

J. Department of Veterans Affairs (VA):

PG-18-10.....Plumbing Design Manual

PG-18-13-2011.....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 will fit the space available.
- D. If equipment is submitted which differs in arrangement from that shown, 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.
- 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. Manufacturer's Literature and Data: 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. 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.
- I. 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. Include complete list indicating all components of the systems with diagrams of the internal wiring for each item of equipment.

1.5 QUALITY ASSURANCE

A. 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 four 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 products of one manufacturer.
 6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 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 shall not be used.
- B. 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 "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 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 American Welding Society.

C. 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.

D. 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.
3. 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.
4. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or additional time to the Government.

E. Guaranty: Warranty of Construction, FAR clause 52.246-21.

F. 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.

G. 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. 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.
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. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

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 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.

PART 2 - PRODUCTS

2.1 MATERIALS FOR VARIOUS SERVICES

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 ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING

- A. 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 without 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. 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.

C. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal pumps may be split phase or permanent split capacitor (PSC).

D. 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.

E. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

2.5 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Coordinate equipment and valve identification with local VAMC shops. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 7 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 shall be permanently fastened to the equipment. Unit

components such as water heaters, tanks, coils, filters, etc. shall be identified.

C. Control Items: All temperature, pressure, and controllers shall be labeled and the component's function identified. Identify and label each item as they appear on the control diagrams.

D. Valve Tags and Lists:

1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
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 8 mm (1/4 inch) for service designation on 19 gage, 40 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 215 mm (8-1/2 inches) by 275 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. An additional copy of the valve list shall be mounted in picture frames for mounting to a wall. COR shall instruct contractor where frames shall be mounted.
4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided in the 3-ring binder notebook. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling or access door.

2.6 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 23 07 11, PLUMBING INSULATION, for pipe insulation.

2.7 GALVANIZED REPAIR COMPOUND

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

2.8 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

A. Type Numbers Specified: For materials, design, manufacture, selection, application, and installation refer to MSS SP-58. For selection and application refer to MSS SP-69.

B. 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. For Attachment to Wood Construction: Wood screws or lag bolts.
- F. 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.
- G. 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 gage), 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.
- H. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 23 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.
- 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 gage) minimum.
- I. 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-69. 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.

2.9 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 not allowed 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.

2.10 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.

2.11 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.

2.12 ASBESTOS

- A. Materials containing asbestos are not permitted.

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 gages 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 on 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 53, CAST-IN-PLACE CONCRETE, shall be used for all pad or floor mounted equipment.
- J. 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.
- K. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.
- L. 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.
- M. 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 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.

3.3 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 one liter (one 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.

3.4 PLUMBING SYSTEMS DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided after approval for structural integrity by the COR. Such access shall be provided without 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 VA Medical Center, 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. 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 gages 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.

3.5 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 gages 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.

3.6 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.

3.7 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.

3.8 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.

3.9 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.

- - - 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 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- B. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.

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.

D. Detailed shop drawing of clamping device and extensions when required
in connection with the waterproofing membrane.

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

2.2 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
2. Protective Roof Membrane Insulation Assembly: The roof drain shall have a perforated stainless steel extension filter, non-puncturing clamp ring, and 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.
 3. 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.
 4. Roof drains in areas subject to freezing shall have heat tape and shall be insulated.

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 $\frac{1}{4}$ 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. 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"

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

3.3 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.

3.4 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 23 07 11, PLUMBING INSULATION.

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SECTION 22 14 29
SUMP PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Sump pumps. See schedule on Drawings for pump capacity and head.
- 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

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 National Standard Institute (ANSI)/Hydraulic Institute (HI):
 - 1.1-1.2-2014.....Rotodynamic Centrifugal Pumps for Nomenclature and Definitions
 - 1.3-2013.....Rotodynamic Centrifugal Pumps for Design and Application
 - 1.4-2014.....Rotodynamic Centrifugal Pumps for Manuals Describing Installation, Operation, and Maintenance
- C. ASTM International (ASTM):
 - A48/A48M-2003 (R2012)...Standard Specification for Gray Iron Castings
 - A532/A532M-2010 (R2014).Standard Specification for Abrasion-Resistant Cast Irons
 - B584-2014.....Standard Specification for Copper Alloy Sand Castings for General Applications
- D. National Electrical Manufacturers Association (NEMA):
 - ICS 6-1993 (R2001, R2006) Industrial Control and Systems: Enclosures
 - 250-2014.....Enclosures for Electrical Equipment (1000 Volts Maximum)
- E. Underwriters' Laboratories, Inc. (UL):
 - 508-1999 (R2013).....Standards for Industrial Control Equipment

1.4 SUBMITTALS

- A. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 14 29, SUMP PUMPS", with applicable paragraph identification.

- B. 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 (rpm).
 - c. Capacity.
 - d. Characteristic performance curves.
 - 2. Electric Motor:
 - a. Manufacturer.
 - b. Speed.
 - c. Current Characteristics and W (HP).
 - d. Efficiency.
 - 3. Control panel.
 - 4. Sensors.
- C. Certified copies of all the factory and construction site test data sheets and reports.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replacement parts:
 - 1. Include complete list which indicates 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, and troubleshooting.

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, substitutions and construction revisions shall be inserted into a three ring binder. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished.
- 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.

PART 2 - PRODUCTS**2.1 SUMP PUMP**

- A. Centrifugal, vertical, submersible pump and motor, designed for 60 degrees C (140 degrees F) maximum water service. Driver shall be electric motor. Support shall be rigid type. Provide perforated, suction strainer. Systems may include one, two, or more pumps with alternator as required by Contract Documents. Pump shall be capable of continuous duty cycle.
1. Pump housings may be cast iron, bronze, aluminum or stainless steel. Cast iron and aluminum housings for submersible pumps shall be epoxy coated.
- B. Impeller: Statically and dynamically balanced, keyed and secured to shaft, bronze ASTM B584.
- C. Shaft: Stainless steel or other approved corrosion-resisting metal.
- D. Bearings: As required to hold shaft alignment, anti-friction type for thrust permanently lubricated.
- E. Seal: Mechanical.
- F. Motor: Maximum 40 degrees C (104 degrees F) ambient temperature rise above the maximum fluid temperature being pumped , drip-proof hermitically sealed, lifting eye, capacitor start type, voltage and phase as shown in schedule on Electrical drawings conforming to NEMA Type 4X. Size the motor capacity to operate pump without overloading the motor at any point on the pump curve.
- G. Starting Switch: Manually-operated, tumbler type, as specified in Section 26 29 11, MOTOR CONTROLLERS.
- H. Automatic Control and Level Alarm: Furnish a control panel in a NEMA 1 enclosure for indoors or in a NEMA 4X enclosure for outdoors. The controls shall be suitable for operation with the electrical characteristics listed on the Electrical drawings. The control panel shall have a level control system with switches to start and stop pumps automatically, and to activate a high water alarm. The level control system shall include sensors in the sump that detect the level of the liquid. The pump is also connected to a control which has the ability to prevent oil from being pumped. The same unit shall activate an alarm when oil is detected. The sensors may be float type switches, ultrasonic level sensors, or transducers. The high water alarm shall have a red beacon light at the control panel and a buzzer, horn, or bell. The alarm shall have a silencing switch. Provide auxiliary

contacts for remote communication with, and alarm monitoring to, the BAS using a BACnet compatible open-protocol type interface to DDC Controls System.

1. The circuitry of the control panel shall include:
 - a. Power switch to turn on/off the automatic control mechanism
 - b. HOA switches to manually override automatic control mechanism
 - c. Run lights to indicate when pumps are powered up
 - d. Level status lights to indicate when water in sump has reached the predetermined on/off and alarm levels
 - e. Magnetic motor contactors
 - f. Disconnect/breaker for each pump
 - g. Automatic motor overload protection
 - h. Wiring terminal block
 - i. Dead front
 - j. Auxiliary contacts
 - k. Control circuit protection
 - l. Fused control step down transformer
2. Sensors that detect the level of water in the sump shall be so arranged as to allow the accumulation of enough volume of liquid below the normal on-level that the pump will run for a minimum cycle time as recommended by the pump manufacturer. Sensors shall be located to activate the alarm adequately before the water level rises to the inlet pipe.
3. Provide two separate power supplies to the control panel, one for the control/alarm circuitry and one for power to the pump motors. Each power supply is to be fed from its own breaker so that if a pump overload trips a breaker, the alarm system shall still function. Each power supply is to be wired in its own conduit.
4. Wiring from the sump to the control panel shall have separate conduits for the pump power and for the sensor switches. All conduits are to be sealed at the basin and at the control panel to prevent the intrusion of moisture and of flammable and/or corrosive gases.
 - I. Sump: Furnish fiberglass basin. Sump shall be sized to allow an adequate volume of water to accumulate for a minimum one minute cycle of pump operation.
 - J. Provide a check and ball valve in the discharge of each pump.

K. Removal/Disconnect System: In a system utilizing a submersible pump, where sump depth, pump size, or other conditions make removal of the pump unusually difficult or unsafe, a manufacturer's removal/disconnect system shall be provided. The system shall consist of a discharge fitting mounted on vertical guide rails attached to the sump or quick connect pipe fitting connection to piping. The pump shall be fitted with an adapter fitting that easily connects to/disconnects from the discharge fitting as the pump is raised from or lowered into the sump. The discharge piping shall connect to the discharge fitting so that it is disconnected without workers entering the pit. Where the sump depth is greater than five feet or other conditions exist to make the removal of the pump difficult or hazardous, the system shall include a rail guided quick disconnect apparatus to allow the pump to be pulled up out of the sump.

PART 3 - EXECUTION

3.1 STARTUP AND TESTING

- A. Pump installation to comply with ANSI/HI 1.4 for sump pumps.
- B. Leak Test: Charge piping system and test for leaks. Test until there are no leaks. 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.
- C. The tests shall include system capacity and all control and alarm functions.
- D. When any defects are detected, correct defects and repeat test.

3.2 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of units.

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**SECTION 22 40 00
PLUMBING FIXTURES**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Plumbing fixtures, associated trim and fittings necessary to make a complete installation from wall or floor connections to rough piping, and certain accessories.
- 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 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

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
- 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
- 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.

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, substitutions and construction revisions shall be 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 SHOWER BATH FIXTURE

- A. (P-701) Shower Bath Fixture (Detachable, Wall Mounted, Concealed Supplies, Type T/P Combination Valve):
1. Shower Installation: Wall mounted detachable spray assembly, 600 mm (24 inch) wall bar, elevated vacuum breaker, supply elbow and flange and valve. All external trim, chrome plated metal.
 2. Shower Head Assembly: Metallic shower head with flow control to limit discharge to 9.5 l/m (2.5 gpm), 1524 mm (60 inches) length of rubber lined CRS, chrome plated metal flexible, or white vinyl reinforced hose and supply wall elbow. Design showerhead to fit in palm of hand. Provide CRS or chrome plated metal wall bar with an adjustable swivel hanger for showerhead. Fasten wall bar securely to wall for hand support.
 3. Valves: Type T/P combination thermostatic and pressure balancing, with chrome plated metal lever type operating handle adjustable for rough-in variations and chrome plated metal or CRS face plate. Valve body shall be any suitable copper alloy. Internal parts shall be copper, nickel alloy, CRS or thermoplastic material. Valve inlet and outlet shall be 13 mm (1/2 inch) IPS. Provide external screwdriver check stops, vacuum breaker and temperature limit stops. Set stops for a maximum temperature of 50 degrees C (122 degrees F). All

exposed fasteners shall be vandal resistant. Valve shall provide a minimum of 9.5 l/m (2.5 gpm) at 310 kPa (45 psig) pressure drop.

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. Toggle Bolts: For hollow masonry units, finished or unfinished.
- D. 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.
- E. 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.
- F. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- G. 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.

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**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. Option or optional: Contractor's choice of an alternate material or method.
 - 3. RE: Resident Engineer
 - 4. COTR: Contracting Officer's Technical Representative.

1.2 RELATED WORK

- A. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC
- B. Section 23 07 11, HVAC, and BOILER PLANT INSULATION.

1.3 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. 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. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Resident Engineer.
4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. 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.
7. Asbestos products or equipment or materials containing asbestos shall not be used.

D. Equipment Service Organizations:

1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located within 50 miles to the site.

E. 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 "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.

F. 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 drawings and specifications to the

Resident Engineer for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the Resident Engineer at least two weeks prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations is a cause for rejection of the material.

2. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

- G. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.

1.4 SUBMITTALS

- A. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- B. If equipment is submitted which differs in arrangement from that shown, 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.
- C. 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.
- D. 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.
- E. Manufacturer's Literature and Data: 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 Resident Engineer.
 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 load calculations for variable spring and constant support hangers.
 6. Wall, floor, and ceiling plates.
- F. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

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):
430-2009.....Central Station Air-Handling Units
- C. American National Standard Institute (ANSI):
B31.1-2007.....Power Piping
- D. Rubber Manufacturers Association (ANSI/RMA):
IP-20-2007.....Specifications for Drives Using Classical
V-Belts and Sheaves
IP-21-2009.....Specifications for Drives Using Double-V
(Hexagonal) Belts
IP-22-2007.....Specifications for Drives Using Narrow V-Belts
and Sheaves
- E. Air Movement and Control Association (AMCA):
410-96.....Recommended Safety Practices for Air Moving
Devices
- F. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):
Section I-2007.....Power Boilers
Section IX-2007.....Welding and Brazing Qualifications
Code for Pressure Piping:
B31.1-2007.....Power Piping
- G. American Society for Testing and Materials (ASTM):
A36/A36M-08.....Standard Specification for Carbon Structural
Steel
A575-96(2007).....Standard Specification for Steel Bars, Carbon,
Merchant Quality, M-Grades
E84-10.....Standard Test Method for Surface Burning
Characteristics of Building Materials

- E119-09c.....Standard Test Methods for Fire Tests of
Building Construction and Materials
- H. Manufacturers Standardization Society (MSS) of the Valve and Fittings
Industry, Inc:
- SP-58-2009.....Pipe Hangers and Supports-Materials, Design and
Manufacture, Selection, Application, and
Installation
- SP 69-2003.....Pipe Hangers and Supports-Selection and
Application
- SP 127-2001.....Bracing for Piping Systems, Seismic - Wind -
Dynamic, Design, Selection, Application
- I. National Electrical Manufacturers Association (NEMA):
- MG-1-2009.....Motors and Generators
- J. National Fire Protection Association (NFPA):
- 31-06.....Standard for Installation of Oil-Burning
Equipment
- 54-09.....National Fuel Gas Code
- 70-08.....National Electrical Code
- 85-07.....Boiler and Combustion Systems Hazards Code
- 90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems
- 101-09.....Life Safety Code

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.
 2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the Government.
 3. 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.

4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

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 JOB CONDITIONS - WORK IN EXISTING BUILDING

- A. Building Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities that serve the medical center.
- B. Maintenance of Service: Schedule all work to permit continuous service as required by the medical center.
- C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the Resident Engineer during periods when the demands are not critical to the operation of the medical center. These non-critical periods are limited to between 8 pm and 5 am in the appropriate off-season (if applicable). Provide at least one week advance notice to the Resident Engineer.
- D. Phasing of Work: Comply with all requirements shown on drawings or specified.
- E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all equipment being operated by VA.

F. Acceptance of Work for Government Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components 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.
- 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, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

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

2.3 ELECTRIC MOTORS

- A. 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.

2.4 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 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.
- D. Control Items: Label all 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. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 - 2. Valve lists: Typed or printed plastic coated card(s), sized 216 mm(8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
 - 3. 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.

2.5 FIRESTOPPING

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, PLUMBING, AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

2.6 GALVANIZED REPAIR COMPOUND

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

2.7 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69.
- B. 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 102 mm (four inches) thick when approved by the Resident Engineer for each job condition.
 - 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition.
- C. 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 23mm (7/8-inch) outside diameter.
- D. Attachment to existing structure: Support from existing floor/roof frame.
- E. Attachment to Wood Construction: Wood screws or lag bolts.
- F. Hanger Rods: Hot-rolled steel, ASTM A36 or 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 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- G. 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 (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
 - 1. Allowable hanger load: Manufacturers rating less 91kg (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 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- H. Supports for Piping Systems:
 - 1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, 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 or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
3. High and Medium Pressure Steam (MSS SP-58):
 - a. Provide eye rod or Type 17 eye nut near the upper attachment.
 - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
 - c. Piping with Vertical Expansion and Contraction:
 - 1) Movement up to 20 mm (3/4-inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.

- 2) Movement more than 20 mm (3/4-inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.
 4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.
- I. Pre-insulated Calcium Silicate Shields:
1. Provide 360 degree water resistant high density 965 kPa (140 psi) 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 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 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) 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.

2.8 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 (one 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 are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.
- 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.

2.9 DUCT PENETRATIONS

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 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.

2.10 SPECIAL TOOLS AND LUBRICANTS

- A. Furnish, and turn over to the Resident Engineer, 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 Resident Engineer.
- E. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.11 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.

2.12 ASBESTOS

Materials containing asbestos are not permitted.

PART 3 - EXECUTION**3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. 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 gages 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 drawings.
- 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 will not be allowed, except as permitted by Resident Engineer where working area space is limited.
 - 2. Locate holes 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 Resident Engineer. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Resident Engineer for approval.
 - 3. Do not penetrate membrane waterproofing.
- F. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service 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 Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, 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 shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 53, CAST-IN-PLACE CONCRETE.
 - J. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages 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. Install steam piping expansion joints as per manufacturer's recommendations.
 - L. Work in Existing Building:
 1. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
 - M. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and 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 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 ft.) above the equipment of to ceiling structure, whichever is lower (NFPA 70).

N. 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 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 motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. 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 apply.
- C. 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.

3.3 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. Drill or burn holes in structural steel only with the prior approval of the Resident Engineer.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods 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-69. 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. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
 2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. 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.

3.4 MECHANICAL DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the Resident Engineer. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating facility, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VA Medical Center, and Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, 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 gages and thermometers with wells shall remain Government property and shall be removed and delivered to Resident Engineer 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.

3.5 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. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
 - 2. Material And Equipment Not To Be Painted Includes:
 - 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, 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 color as utilized by the pump manufacturer
 - 5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
 - 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 120 degrees C (250 degrees F) on metal pipe surface.

- b. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 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.

3.6 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.

3.7 LUBRICATION

- A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to Resident Engineer in unopened containers that are properly identified as to application.
- C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

3.8 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS and submit the test reports and records to the Resident Engineer.
- 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 system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.9 INSTRUCTIONS TO VA PERSONNEL

Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

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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. Recording and reporting results.

B. Definitions:

1. Basic TAB used in this Section: Chapter 38, "Testing, Adjusting and Balancing" of 2011 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. Hydronic Systems: Includes chilled water, condenser water, heating hot water and glycol-water systems.
6. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flowrate from values (design) in the contract documents.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Section 23 07 11, HVAC, AND BOILER PLANT INSULATION:
- C. Section 23 31 00, HVAC DUCTS AND CASINGS

1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC,
- 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 or certified by the 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 Resident Engineer and submit another TAB firm for approval. Any agency 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 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 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 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.
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 or NEBB
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National 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 or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 38, 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 "HVAC Applications", Chapter 38, 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. 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.
 - d. Chilled water coils: Minus 0 percent to plus 5 percent.

3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and 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 Resident Engineer) 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 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.
- B. For use by the Resident Engineer staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.
- C. 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.
- D. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.

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):
2011HVAC Applications ASHRAE Handbook, Chapter 38,
Testing, Adjusting, and Balancing and Chapter
48, Sound and Vibration Control
- C. Associated Air Balance Council (AABC):
2002.....AABC National Standards for Total System
Balance
- D. National Environmental Balancing Bureau (NEBB):
7th Edition 2005Procedural Standards for Testing, Adjusting,
Balancing of Environmental Systems
2nd Edition 2006Procedural Standards for the Measurement of
Sound and Vibration
3rd Edition 2009Procedural Standards for Whole Building Systems
Commissioning of New Construction
- E. Sheet Metal and Air Conditioning Contractors National Association
(SMACNA):
3rd Edition 2002HVAC SYSTEMS Testing, Adjusting and Balancing

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, 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, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

3.6 TAB REPORTS

- A. 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.
- B. 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 and re-submitted for approval at no additional cost to the owner.
- C. 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 or NEBB.

- 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. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.
- D. Air Balance and Equipment Test: Include air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets.
 - 1. Adjust fan speeds to provide design air flow.
 - 2. Test and balance systems in all specified modes of operation. Verify that dampers and other controls function properly.
- E. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, coolers and condensers:
 - 1. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
 - 2. 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 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.

3.9 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.

- - 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. 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); and piping media and equipment 32 to 230 degrees C (90 to 450 degrees F).
 - 8. Density: 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 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Section 23 21 13, HYDRONIC PIPING.
- C. Section 23 22 13, STEAM and CONDENSATE HEATING 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. 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.

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) - 99.....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
- MIL-A-3316C (2)-90.....Adhesives, Fire-Resistant, Thermal Insulation
- MIL-A-24179A (1)-87.....Adhesive, Flexible Unicellular-Plastic Thermal Insulation

MIL-C-19565C (1)-88.....Coating Compounds, Thermal Insulation, Fire-and
Water-Resistant, Vapor-Barrier

MIL-C-20079H-87.....Cloth, Glass; Tape, Textile Glass; and Thread,
Glass and Wire-Reinforced Glass

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

A167-99 (2004).....Standard Specification for Stainless and
Heat-Resisting Chromium-Nickel Steel Plate,
Sheet, and Strip

B209-07.....Standard Specification for Aluminum and
Aluminum-Alloy Sheet and Plate

C411-05.....Standard test method for Hot-Surface
Performance of High-Temperature Thermal
Insulation

C449-07.....Standard Specification for Mineral Fiber
Hydraulic-Setting Thermal Insulating and
Finishing Cement

C533-09.....Standard Specification for Calcium Silicate
Block and Pipe Thermal Insulation

C534-08.....Standard Specification for Preformed Flexible
Elastomeric Cellular Thermal Insulation in
Sheet and Tubular Form

C547-07.....Standard Specification for Mineral Fiber pipe
Insulation

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

C553-08.....Standard Specification for Mineral Fiber
Blanket Thermal Insulation for Commercial and
Industrial Applications

C585-09.....Standard Practice for Inner and Outer Diameters
of Rigid Thermal Insulation for Nominal Sizes
of Pipe and Tubing (NPS System) R (1998)

C612-10.....Standard Specification for Mineral Fiber Block
and Board Thermal Insulation

C1126-04.....Standard Specification for Faced or Unfaced
Rigid Cellular Phenolic Thermal Insulation

C1136-10.....Standard Specification for Flexible, Low
Permeance Vapor Retarders for Thermal
Insulation

- D1668-97a (2006).....Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
- E84-10.....Standard Test Method for Surface Burning Characteristics of Building Materials
- E119-09c.....Standard Test Method for Fire Tests of Building Construction and Materials
- E136-09b.....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-09.....Standard for the Installation of Air Conditioning and Ventilating Systems
- 96-08.....Standards for Ventilation Control and Fire Protection of Commercial Cooking Operations
- 101-09.....Life Safety Code
- 251-06.....Standard methods of Tests of Fire Endurance of Building Construction Materials
- 255-06.....Standard Method of tests of Surface Burning Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):
- 723.....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):
- SP58-2009.....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 kg/m³ (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 kg/m³ (1 pcf), k = 0.045 (0.31) Class B-5, Density 32 kg/m³ (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) 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 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.

2.3 CELLULAR GLASS CLOSED-CELL

- A. Comply with Standard ASTM C177, C518, density 120 kg/m³ (7.5 pcf) nominal, $k = 0.033$ (0.29) at 24~~0~~ 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.

2.4 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.

2.5 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 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 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. 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.
- 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.
- 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.

2.10 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/m³ (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/m³ (3.0 pcf).

2.11 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.

2.12 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.

2.13 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.

2.14 FIRESTOPPING MATERIAL

Other than pipe and duct insulation, refer to Section 07 84 00
FIRESTOPPING.

2.15 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.

- C. 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).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. 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.
- G. 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. In hot piping: Unions, flexible connectors, control valves, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.
- H. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- I. 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.
- I. 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
- J. Provide vapor barrier jackets over insulation as follows:
1. All interior piping and ducts conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.) below ambient air temperature.
- K. Provide metal jackets over insulation as follows:
1. Piping exposed in building, within 1800 mm (6 feet) of the floor. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
 2. 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.
3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics:
 - a. 40 mm (1-1/2 inch) thick insulation faced with ASJ (white all service jacket): Supply air duct.

- b. 40 mm (1-1/2 inch) 50 mm (2 inch) thick insulation faced with ASJ: Return air duct, mixed air plenums and prefilter housing.

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 1/2 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 or containing steam piping; 40 mm (1-1/2 inch) thick, insulation faced with FSK.
 - b. Concealed return air ductwork in other locations need not be insulated.

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.
- D. Rigid Cellular Phenolic Foam:
1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).
 2. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
 3. Provide secure attachment facilities such as welding pins.
 4. Apply insulation with joints tightly drawn together
 5. Apply adhesives, coverings, neatly finished at fittings, and valves.
 6. Final installation shall be smooth, tight, neatly finished at all edges.
 7. Minimum thickness in millimeters (inches) specified in the schedule at the end of this section.
 8. 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 maximum water vapor permeance of 0.00 perms.

9. Condensation control insulation: Minimum 25 mm (1.0 inch) thick for all pipe sizes.

- a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.

E. Cellular Glass Insulation:

- 1. Pipe and tubing, covering nominal thickness in millimeters and inches as 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.
- 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.

3.3 PIPE INSULATION SCHEDULE

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 Above
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Mineral Fiber (Above ground piping only)	62 (2.5)	62 (2.5)	75 (3.0)	75 (3.0)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Rigid Cellular Phenolic Foam	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-99 degrees C (100-211 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Flexible Elastomeric Cellular Thermal (Above ground piping)	38 (1.5)	38 (1.5)	----	----

	only)				
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
4-16 degrees C (40-60 degrees F) (CH and CHR within chiller room and pipe chase and underground)	Cellular Glass Closed- Cell	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Cellular Glass Closed- Cell	38 (1.5)	38 (1.5)	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 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Water piping to connect HVAC equipment, including the following:
 - 1. Chilled water, condenser water, heating hot water and drain piping.
 - 2. Glycol-water piping.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- B. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION: Piping insulation.

1.3 QUALITY ASSURANCE

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, 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.

1.4 SUBMITTALS

- A. Manufacturer's Literature and Data:
 - 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. Valves of all types.
 - 6. Flexible connectors for water service.
 - 7. All specified hydronic system components.
- B. Submit the welder's qualifications in the form of a current (less than one year old) and formal certificate.

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. American National Standards Institute, Inc.
- B. American Society of Mechanical Engineers/American National Standards Institute, Inc. (ASME/ANSI):
 - B1.20.1-83(R2006).....Pipe Threads, General Purpose (Inch)

- B16.4-06.....Gray Iron Threaded FittingsB16.18-01 Cast
Copper Alloy Solder joint Pressure fittings
- B16.23-02.....Cast Copper Alloy Solder joint Drainage
fittings
- B40.100-05.....Pressure Gauges and Gauge Attachments
- C. American National Standards Institute, Inc./Fluid Controls Institute
(ANSI/FCI):
- 70-2-2006.....Control Valve Seat Leakage
- D. American Society of Mechanical Engineers (ASME):
- B16.1-98.....Cast Iron Pipe Flanges and Flanged Fittings
- B16.3-2006.....Malleable Iron Threaded Fittings: Class 150 and
300
- B16.4-2006.....Gray Iron Threaded Fittings: (Class 125 and
250)
- B16.5-2003.....Pipe Flanges and Flanged Fittings: NPS ½
through NPS 24 Metric/Inch Standard
- B16.9-07.....Factory Made Wrought Butt Welding Fittings
- B16.11-05.....Forged Fittings, Socket Welding and Threaded
- B16.18-01.....Cast Copper Alloy Solder Joint Pressure
Fittings
- B16.22-01.....Wrought Copper and Bronze Solder Joint Pressure
Fittings.
- B16.24-06.....Cast Copper Alloy Pipe Flanges and Flanged
Fittings
- B16.39-06.....Malleable Iron Threaded Pipe Unions
- B16.42-06.....Ductile Iron Pipe Flanges and Flanged Fittings
- B31.1-08.....Power Piping
- E. American Society for Testing and Materials (ASTM):
- A47/A47M-99 (2004).....Ferritic Malleable Iron Castings
- A53/A53M-07.....Standard Specification for Pipe, Steel, Black
and Hot-Dipped, Zinc-Coated, Welded and
Seamless
- A106/A106M-08.....Standard Specification for Seamless Carbon
Steel Pipe for High-Temperature Service
- A126-04.....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe Fittings
- A183-03.....Standard Specification for Carbon Steel Track
Bolts and Nuts

A216/A216M-08.....Standard Specification for Steel Castings,
 Carbon, Suitable for Fusion Welding, for High
 Temperature Service
 A234/A234M-07.....Piping Fittings of Wrought Carbon Steel and
 Alloy Steel for Moderate and High Temperature
 Service
 A307-07.....Standard Specification for Carbon Steel Bolts
 and Studs, 60,000 PSI Tensile Strength
 A536-84 (2004).....Standard Specification for Ductile Iron Castings
 A615/A615M-08.....Deformed and Plain Carbon Steel Bars for
 Concrete Reinforcement
 A653/A 653M-08.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-
 Iron Alloy Coated (Galvannealed) By the Hot-Dip
 Process
 B32-08.....Standard Specification for Solder Metal
 B62-02.....Standard Specification for Composition Bronze or
 Ounce Metal Castings
 B88-03.....Standard Specification for Seamless Copper Water
 Tube
 B209-07.....Aluminum and Aluminum Alloy Sheet and Plate
 C177-04Standard Test Method for Steady State Heat Flux
 Measurements and Thermal Transmission Properties
 by Means of the Guarded Hot Plate Apparatus
 C478-09.....Precast Reinforced Concrete Manhole Sections
 C533-07.....Calcium Silicate Block and Pipe Thermal
 Insulation
 C552-07.....Cellular Glass Thermal Insulation
 D3350-08.....Polyethylene Plastics Pipe and Fittings
 Materials
 C591-08.....Unfaced Preformed Rigid Cellular
 Polyisocyanurate Thermal Insulation
 D1784-08.....Rigid Poly (Vinyl Chloride) (PVC) Compounds and
 Chlorinated Poly (Vinyl Chloride) (CPVC)
 Compound
 D1785-06.....Poly (Vinyl Chloride) (PVC) Plastic Pipe,
 Schedules 40, 80 and 120
 D2241-05.....Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe
 (SDR Series)

- F439-06.....Standard Specification for Chlorinated Poly
(Vinyl Chloride) (CPVC) Plastic Pipe Fittings,
Schedule 80
- F441/F441M-02.....Standard Specification for Chlorinated Poly
(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules
40 and 80
- F477-08.....Elastomeric Seals Gaskets) for Joining Plastic
Pipe
- F. American Water Works Association (AWWA):
- C110-08.....Ductile Iron and Grey Iron Fittings for Water
- C203-02.....Coal Tar Protective Coatings and Linings for
Steel Water Pipe Lines Enamel and Tape Hot
Applied
- G. American Welding Society (AWS):
- B2.1-02.....Standard Welding Procedure Specification
- H. Copper Development Association, Inc. (CDA):
- CDA A4015-06.....Copper Tube Handbook
- I. Expansion Joint Manufacturer's Association, Inc. (EJMA):
- EMJA-2003.....Expansion Joint Manufacturer's Association
Standards, Ninth Edition
- J. Manufacturers Standardization Society (MSS) of the Valve and Fitting
Industry, Inc.:
- SP-67-02a.....Butterfly Valves
- SP-70-06.....Gray Iron Gate Valves, Flanged and Threaded
Ends
- SP-71-05.....Gray Iron Swing Check Valves, Flanged and
Threaded Ends
- SP-80-08.....Bronze Gate, Globe, Angle and Check Valves
- SP-85-02.....Cast Iron Globe and Angle Valves, Flanged and
Threaded Ends
- SP-110-96.....Ball Valves Threaded, Socket-Welding, Solder
Joint, Grooved and Flared Ends
- SP-125-00.....Gray Iron and Ductile Iron In-line, Spring
Loaded, Center-Guided Check Valves
- K. National Sanitation Foundation/American National Standards Institute,
Inc. (NSF/ANSI):
- 14-06.....Plastic Piping System Components and Related
Materials

50-2009a.....Equipment for Swimming Pools, Spas, Hot Tubs
and other Recreational Water Facilities -
Evaluation criteria for materials, components,
products, equipment and systems for use at
recreational water facilities

61-2008.....Drinking Water System Components - Health
Effects

L. Tubular Exchanger Manufacturers Association: TEMA 9th Edition, 2007

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 and STEAM GENERATION.

2.2 PIPE AND TUBING

A. Chilled Water, Condenser Water, Heating Hot Water, and Glycol-Water, and Vent Piping:

1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.
2. Copper water tube option: ASTM B88, Type K or L, hard drawn.

B. Cooling Coil Condensate Drain Piping:

1. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.

C. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

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. 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 gage 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 insure 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: ANSI/ASME B16.18 cast copper or ANSI/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.
- D. Temperature Rating, 99 degrees C (210 degrees F).
- E. Contractor's option: On pipe sizes 2" and smaller, screwed end brass ball valves may be used in lieu of dielectric unions.

2.6 SCREWED JOINTS

- A. Pipe Thread: ANSI B1.20.
- 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. Shut-Off Valves
 1. Ball Valves (Pipe sizes 2" and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at // 2760 kPa (400 psig) // working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
- D. Globe and Angle Valves

1. Globe Valves

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.

- E. Check Valves

1. Swing Check Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.

- F. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. 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 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
2. Brass or ferrous body designed for 2067 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.

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 (0.125 inch) diameter perforations.

PART 3 - EXECUTION

3.1 GENERAL

- A. 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 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.

- B. 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.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one 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 (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. 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, PLUMBING, and BOILER PLANT INSULATION.
- J. 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 B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Screwed: Threads shall conform to ASME B1.20; 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.

3.3 LEAK TESTING ABOVEGROUND PIPING

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.
- 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.

3.4 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals.
 - 1. 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 (6 feet per second), 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 Resident Engineer.
2. 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.

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SECTION 23 22 13
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Steam, condensate and vent piping inside buildings.

1.2 RELATED WORK

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

1.3 QUALITY ASSURANCE

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, which includes welding qualifications.

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. 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. Valves of all types.
6. Strainers.
7. Pipe alignment guides.
8. All specified steam system components.

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 Mechanical Engineers/American National Standards Institute (ASME/ANSI):

B1.20.1-83(R2006).....Pipe Threads, General Purpose (Inch)

B16.4-2006.....Gray Iron Threaded Fittings

C. American Society of Mechanical Engineers (ASME):

B16.1-2005.....Gray Iron Pipe Flanges and Flanged Fittings

B16.3-2006.....Malleable Iron Threaded Fittings

B16.9-2007.....Factory-Made Wrought Buttwelding Fittings

B16.11-2005.....Forged Fittings, Socket-Welding and Threaded

B16.14-91.....Ferrous Pipe Plugs, Bushings, and Locknuts with
Pipe Threads

- B16.22-2001.....Wrought Copper and Copper Alloy Solder-Joint
Pressure Fittings
- B16.23-2002.....Cast Copper Alloy Solder Joint Drainage
Fittings
- B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged
Fittings, Class 150, 300, 400, 600, 900, 1500
and 2500
- B16.39-98.....Malleable Iron Threaded Pipe Unions, Classes
150, 250, and 300
- B31.1-2007.....Power Piping
- B31.9-2008.....Building Services Piping
- B40.100-2005.....Pressure Gauges and Gauge Attachments
Boiler and Pressure Vessel Code: SEC VIII D1-2001, Pressure Vessels,
Division 1
- D. American Society for Testing and Materials (ASTM):
- A47-99.....Ferritic Malleable Iron Castings
- A53-2007.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless
- A106-2008.....Seamless Carbon Steel Pipe for High-Temperature
Service
- A126-2004.....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe Fittings
- A181-2006.....Carbon Steel Forgings, for General-Purpose
Piping
- A183-2003 Carbon Steel Track Bolts and Nuts
- A216-2008 Standard Specification for Steel Castings,
Carbon, Suitable for Fusion Welding, for High
Temperature Service
- A285-01 Pressure Vessel Plates, Carbon Steel, Low-and-
Intermediate-Tensile Strength
- A307-2007 Carbon Steel Bolts and Studs, 60,000 PSI Tensile
Strength
- A516-2006 Pressure Vessel Plates, Carbon Steel, for
Moderate-and- Lower Temperature Service
- A536-84(2004)e1 Standard Specification for Ductile Iron Castings
- B32-2008 Solder Metal
- B61-2008 Steam or Valve Bronze Castings
- B62-2009 Composition Bronze or Ounce Metal Castings
- B88-2003 Seamless Copper Water Tube

F439-06 Socket-Type Chlorinated Poly (Vinyl Chloride)
(CPVC) Plastic Pipe Fittings, Schedule 80

F441-02(2008) Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic
Pipe, Schedules 40 and 80

E. American Welding Society (AWS):

A5.8-2004.....Filler Metals for Brazing and Braze Welding

B2.1-00.....Welding Procedure and Performance

Qualifications

F. Manufacturers Standardization Society (MSS) of the Valve and Fitting
Industry, Inc.:

SP-67-95.....Butterfly Valves

SP-70-98.....Cast Iron Gate Valves, Flanged and Threaded
Ends

SP-71-97.....Gray Iron Swing Check Valves, Flanged and
Threaded Ends

SP-72-99.....Ball Valves with Flanged or Butt-Welding Ends
for General Service

SP-78-98.....Cast Iron Plug Valves, Flanged and Threaded
Ends

SP-80-97.....Bronze Gate, Globe, Angle and Check Valves

SP-85-94.....Cast Iron Globe and Angle Valves, Flanged and
Threaded Ends

G. Military Specifications (Mil. Spec.):

MIL-S-901D-1989.....Shock Tests, H.I. (High Impact) Shipboard
Machinery, Equipment, and Systems

H. National Board of Boiler and Pressure Vessel Inspectors (NB): Relieving
Capacities of Safety Valves and Relief Valves

I. Tubular Exchanger Manufacturers Association: TEMA 18th Edition, 2000

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 AND STEAM GENERATION.

2.2 PIPE AND TUBING

A. Steam Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B,
Seamless; Schedule 40.

B. Steam Condensate and Pumped Condensate Piping:

1. Concealed above ceiling, in wall or chase: Copper water tube ASTM
B88, Type K, hard drawn.

2. All other locations: Copper water tube ASTM B88, Type K, hard drawn; or steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80.

C. Vent Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40, galvanized.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded.

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, except for steam and steam condensate piping. Provide 300 pound malleable iron, ASME B16.3 for steam and steam condensate piping. Cast iron fittings or piping is not acceptable for steam and steam condensate piping. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: ASME B16.39.
5. Steam line drip station and strainer quick-couple blowdown hose connection: Straight through, plug and socket, screw or cam locking type for 15 mm (1/2 inch) ID hose. No integral shut-off is required.

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. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for saturated and superheated steam service 750 degrees F and 1500 psi.
 - 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 gage connections.

2.4 FITTINGS FOR COPPER TUBING

A. Solder Joint:

1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/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.

D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.

E. Contractor's option: On pipe sizes 2" and smaller, screwed end brass gate valves // or dielectric nipples // may be used in lieu of dielectric unions.

2.6 SCREWED JOINTS

A. Pipe Thread: ANSI B1.20.

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 2100 mm (7 feet) or more above the floor or operating platform.

D. Shut-Off Valves

1. Gate Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.

- b. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.

- 1) High pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1

inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.

- 2) All other services: 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, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger:
 - 1) Globe valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
 - 2) All other services: 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, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger:
 - 1) Angle valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
 - 2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle valves.

F. Swing Check Valves

1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 psig), 45 degree swing disc.
2. 65 mm (2-1/2 inches) and Larger:
 - a Check valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system: Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

- b. All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.
- G. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

2.8 STRAINERS

- A. Basket or Y Type. Tee type is acceptable for gravity flow and pumped steam condensate service.
- B. High Pressure Steam: Rated 1034 kPa (150 psig) saturated steam.
 - 1. 50 mm (2 inches) and smaller: Iron, ASTM A116 Grade B, or bronze, ASTM B-62 body with screwed connections (250 psig).
 - 2. 65 mm (2-1/2 inches) and larger: Flanged cast steel or 1723 kPa (250 psig) cast iron.
- C. All Other Services: Rated 861 kPa (125 psig) saturated steam.
 - 1. 50 mm (2 inches) and smaller: Cast iron or bronze.
 - 2. 65 mm (2-1/2 inches) and larger: Flanged, iron body.
- D. 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. 75 mm (3 inches) and smaller: 20 mesh for steam and 1.1 mm (0.045 inch) diameter perforations for liquids.
 - 2. 100 mm (4 inches) and larger: 1.1 mm (0.045) inch diameter perforations for steam and 3.2 mm (0.125 inch) diameter perforations for liquids.

PART 3 - EXECUTION

3.1 GENERAL

- A. 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 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.
- B. 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.

- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. Where copper piping is connected to steel piping, provide dielectric connections.
- J. Pipe vents to the exterior. Where a combined vent is provided, the cross sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping one inch in 40 feet (0.25 percent) in direction of flow. Provide a drip trap elbow on relief valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 0.3 M (12 inches) above the roof or through the wall minimum 2.5 M (8 feet) above grade with down turned elbow.

3.2 PIPE JOINTS

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Screwed: Threads shall conform to ASME B1.20; 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.

3.3 LEAK TESTING

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.
- 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. Avoid excessive pressure on mechanical seals and safety devices.

3.4 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Steam, Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

3.5 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Adjust red set hand on pressure gages to normal working pressure.

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**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.
- 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.

1.2 RELATED WORK

- A. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION
- C. Testing and Balancing of Air Flows: 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 and STEAM GENERATION.
- 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. Manufacturer's Literature and Data:
 - 1. Volume dampers, back draft dampers.
 - 2. Upper hanger attachments.

3. Fire dampers, fire doors, and smoke dampers with installation instructions.
4. Flexible ducts and clamps, with manufacturer's installation instructions.

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):
 - ASCE7-05.....Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
 - A167-99(2009).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
 - A653-09.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
 - A1011-09a.....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
 - B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - C1071-05e1.....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
 - E84-09a.....Standard Test Method for Surface Burning Characteristics of Building Materials
- D. National Fire Protection Association (NFPA):
 - 90A-09.....Standard for the Installation of Air Conditioning and Ventilating Systems
 - 96-08.....Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 2nd Edition - 2005.....HVAC Duct Construction Standards, Metal and Flexible
 - 1st Edition - 1985.....HVAC Air Duct Leakage Test Manual
 - 6th Edition - 2003.....Fibrous Glass Duct Construction Standards

F. Underwriters Laboratories, Inc. (UL):

181-08.....Factory-Made Air Ducts and Air Connectors

555-06Standard for Fire Dampers

555S-06Standard 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. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.

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.

C. 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)

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. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.
 - F. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

2.3 DUCT LINER (WHERE INDICATED ON DRAWINGS)

- A. Duct sizes shown on drawings for lined duct are clear opening inside lining.
- B. Duct liner is only permitted to be used for return, relief and general exhaust ducts. Duct liner is not permitted for outside air ducts, supply air ducts or any other positive pressure ductwork (provide exterior insulation only).
- C. Rectangular Duct or Casing Liner: ASTM C1071, Type I (flexible), or Type II (board), 25 mm (one inch) minimum thickness, applied with mechanical fasteners and 100 percent coverage of adhesive in conformance with SMACNA, Duct Liner Application Standard.

2.4 DUCT ACCESS DOORS, PANELS AND SECTIONS

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
 1. Each fire damper (for link service), smoke damper and automatic control damper.
 2. Each duct mounted smoke detector.

3. 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).

2.5 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.

2.6 SMOKE DAMPERS

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 450 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.13 inch W.G.).
- B. Maximum air leakage, closed damper: 0.32 cubic meters /min/square meter (4.0 CFM per square foot) at 750 Pa (3 inch W.G.) differential pressure.
- C. Minimum requirements for dampers:
 1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
 2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
 3. Blades: Galvanized steel, parallel type preferably, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.

4. Shafts: Galvanized steel.
5. Bearings: Nylon, bronze sleeve or ball type.
6. Hardware: Zinc plated.
7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.

D. Motor operator (actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

Combination fire and smoke dampers: Multi-blade type units meeting all requirements of both fire dampers and smoke dampers shall be used where shown and may be used at the Contractor's option where applicable.

2.8 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.

2.9 FLEXIBLE DUCT CONNECTIONS

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 insure that no vibration is transmitted.

2.10 PREFABRICATED ROOF CURBS

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.

2.11 FIRESTOPPING MATERIAL

Refer to Section 07 84 00, FIRESTOPPING.

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. 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, Section II. 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, Chapter 4.
- 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 hour. 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. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- J. 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. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

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.
- 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.

3.3 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 and STEAM GENERATION

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**SECTION 23 37 00
AIR OUTLETS AND INLETS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Roof Curbs
- B. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. 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 and STEAM GENERATION.
- B. Fire Safety Code: Comply with NFPA 90A.

1.4 SUBMITTALS

- A. Manufacturer's Literature and Data:
 - 1. Air intake/exhaust hoods.
 - 2. Diffusers, registers, grilles and accessories.

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-84.....Certification, Rating, and Test Manual 4th Edition
- C. American Society of Civil Engineers (ASCE):
 - ASCE7-05.....Minimum Design Loads for Buildings and Other Structures
- D. American Society for Testing and Materials (ASTM):
 - A167-99 (2004).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
 - B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- E. National Fire Protection Association (NFPA):
 - 90A-09.....Standard for the Installation of Air Conditioning and Ventilating Systems

F. Underwriters Laboratories, Inc. (UL):

181-08.....UL Standard for Safety Factory-Made Air Ducts
and Connectors

PART 2 - PRODUCTS

2.1 GRAVITY INTAKE/EXHAUST VENTILATORS (ROOF MOUNTED)

- A. Aluminum, ASTM B209, louvered, spun, or fabricated using panel sections with roll-formed edges, 13 mm (1/2 inch) mesh aluminum welded wire bird screen, with gravity or motorized dampers where shown, accessible interior, designed for wind velocity specified in Paragraph 3.3.
 - 1. Spun Intake/Exhaust Ventilators: Spun aluminum structural components shall be constructed of minimum 1.3 mm (16 Gauge) marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The spun aluminum baffle shall have a rolled bead for added strength.
- B. See ventilator schedule on the drawings. Sizes shown on the drawings designate throat size. Area of ventilator perimeter opening shall be not less than the throat area.
- C. Provide Roof Curb by unit manufacturer. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION for additional requirements.

2.2 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.
- 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.
- D. Return and Exhaust Registers and Grilles:
- 1. Finish: Off-white baked enamel for ceiling mounted units.
 - 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.

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.

3.2 TESTING, ADJUSTING AND BALANCING (TAB)

Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

3.3 OPERATING AND PERFORMANCE TESTS

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION

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SECTION 23 82 19
FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ductless fan coil units and accessories.
 - 2. Ducted fan coil units and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
 - 1. Include the following:
 - a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Coil Unit Filters: Furnish spare filters for each filter installed.
 - 2. Fan Belts: Furnish spare fan belts for each unit installed.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

- A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Condenser coil leak.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTLESS FAN COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trane Inc.
 - 2. or equal.
- B. Fan Coil Unit Configurations: Row split.
- C. Coil Section Insulation: 1/2-inch-thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Drain Pans: Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.
- F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
 - 1. Vertical Unit Front Panels: Removable, steel, with steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
- G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
 - 1. MERV Rating: 6 when tested according to ASHRAE 52.2.
- H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of

200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

- I. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board.
 - 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- J. Factory, Hydronic Piping Package: copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. Two-way, modulating control valve for chilled-water coil.
 - 2. Two-way, modulating control valve for hot-water heating coil.
 - 3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 - 4. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
 - 5. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 - 6. Wrought-Copper Unions: ASME B16.22.
 - 7. Risers: copper pipe with hose and ball valve for system flushing.
- K. Building Automation System (BAS) Interface Requirements:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation.
 - 3. Provide BACnet interface for central BAS workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.
- L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.3 DUCTED FAN COIL UNITS

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

1. Trane Inc.
 2. or equal.
- B. Fan Coil Unit Configurations: Row split.
- C. Coil Section Insulation: 1/2-inch-thick, foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Drain Pans: Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- E. Chassis: Galvanized steel.
- F. Cabinets: Steel.
1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
 4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
- H. MERV Rating: 6 when tested according to ASHRAE 52.2.
- I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- J. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- K. Factory, Hydronic Piping Package: copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. Two-way, modulating control valve for chilled-water coil.
 2. Two-way, modulating control valve for heating coil.
 3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 4. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set

to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.

5. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
6. Wrought-Copper Unions: ASME B16.22.
- L. Building Automation System (BAS) Interface Requirements:
 1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation.
 3. Provide BACnet interface for central BAS workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.
- M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan coil units level and plumb.
- B. Install fan coil units to comply with NFPA 90A.
- C. Suspend fan coil units from structure with elastomeric hangers.
- D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 1. Install piping adjacent to machine to allow service and maintenance.
 2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.

3. Connect condensate drain to indirect waste.

a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors. Comply with safety requirements in UL 1995 for duct connections.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

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SECTION 26 05 11
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section applies to all sections of Division 26.
- 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. 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 International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), 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 eight hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

- A. Applicable publications listed in all Sections of Division 26 are 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 the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, 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. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
 2. Before initiating any work, a job specific work plan must be developed by the Contractor with a peer review conducted and documented by the COR and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.
 3. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the COR.
- 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.

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.

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. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 3. Parts list which shall include 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. Repair, replacement, and retesting 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 COR at least 30 days prior to the planned training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

---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.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

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

1.5 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
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.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.
- B. American Society of Testing Material (ASTM):
 - D2301-10.....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):
 - 70-11.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
 - 44-10.....Thermoset-Insulated Wires and Cables
 - 83-08.....Thermoplastic-Insulated Wires and Cables
 - 467-07.....Grounding and Bonding Equipment
 - 486A-486B-03.....Wire Connectors
 - 486C-04.....Splicing Wire Connectors
 - 486D-05.....Sealed Wire Connector Systems
 - 486E-09.....Equipment Wiring Terminals for Use with
Aluminum and/or Copper Conductors
 - 493-07.....Thermoplastic-Insulated Underground Feeder and
Branch Circuit Cables
 - 514B-04.....Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

B. All conductors shall be copper.

C. Single Conductor and Cable:

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

D. Color Code:

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

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

6. Lighting circuit "switch legs", and 3-way and 4-way switch "traveling wires," shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate color coding in the field with the COTR.

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 steel.

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 steel.

2.4 CONTROL WIRING

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

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. Install conductors in accordance with the NEC, as specified, and as shown on the drawings.

- 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 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.

3.3 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.

3.4 EXISTING CONDUCTORS

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

3.5 CONTROL WIRING INSTALLATION

- A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.
- B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

3.6 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.

3.7 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.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 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):
 - B1-07.....Standard Specification for Hard-Drawn Copper Wire
 - B3-07.....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):
 - 81-83.....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):
 - 70-11.....National Electrical Code (NEC)
 - 70E-12.....National Electrical Safety Code
 - 99-12.....Health Care Facilities
- E. Underwriters Laboratories, Inc. (UL):
 - 44-10Thermoset-Insulated Wires and Cables
 - 83-08Thermoplastic-Insulated Wires and Cables
 - 467-07Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.
- B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

- C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.
- D. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

2.2 GROUND CONNECTIONS

- A. 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 steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
 - 2. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install grounding equipment in accordance with the NEC, as shown on the drawings, and as specified herein.
- B. 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.
- C. For patient care area electrical power system grounding, conform to NFPA 99 and NEC.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

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

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

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

3.4 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. 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.

D. 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.

E. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5 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.

3.6 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.

3.7 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 COTR prior to backfilling. The Contractor shall notify the COTR 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 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- B. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 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 National Standards Institute (ANSI):
 - C80.1-05.....Electrical Rigid Steel Conduit
 - C80.3-05.....Steel Electrical Metal Tubing
 - C80.6-05.....Electrical Intermediate Metal Conduit
- C. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 1-05.....Flexible Metal Conduit
 - 5-11.....Surface Metal Raceway and Fittings
 - 6-07.....Electrical Rigid Metal Conduit - Steel
 - 50-95.....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-07.....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
 - 1242-06.....Electrical Intermediate Metal Conduit - Steel
- E. National Electrical Manufacturers Association (NEMA):

- TC-2-13.....Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
- TC-3-13.....PVC Fittings for Use with Rigid PVC Conduit and Tubing
- FB1-12.....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)
- FB2.20-12.....Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable
- F. American Iron and Steel Institute (AISI):
- S100-2007.....North American Specification for the Design of Cold-Formed Steel Structural Members

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (0.5-inch) unless otherwise shown. Where permitted by the NEC, 13 mm (0.5-inch) flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
1. Size: In accordance with the NEC, but not less than 13 mm (0.5-inch).
 2. Rigid Steel Conduit (RMC): Shall conform to UL 6 and ANSI C80.1.
 3. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.
 4. Flexible Metal Conduit: Shall conform to UL 1.
 5. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
- 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.
2. Electrical Metallic Tubing Fittings:
- a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
 - b. Only steel 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.
3. Flexible Metal Conduit Fittings:
- a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 - b. Clamp-type, with insulated throat.
4. Liquid-tight Flexible Metal Conduit Fittings:
- a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.

- c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 5. 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.
- D. Conduit Supports:
 - 1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) diameter steel hanger rods.
 - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
 - 1. 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.

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 UL, NEC, NEMA, 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 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the same system is prohibited.
 - 2. Align and run conduit parallel or perpendicular to the building lines.
 - 3. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
 - 4. Tightening set screws with pliers is prohibited.
 - 5. 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.
- C. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the system is prohibited.
- D. Align and run conduit parallel or perpendicular to the building lines.
- E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- F. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.
- G. Surface Metal Raceways: 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 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.

3.6 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.

3.7 CONDUIT SUPPORTS

- A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an

additional 90 kg (200 lbs). Attach each conduit with U-bolts or other approved fasteners.

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

3.8 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush-mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.

- C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.
- D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.
- F. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.
- G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
- H. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."
- I. On all branch circuit junction box covers, identify the circuits with black marker.

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**SECTION 26 09 23
LIGHTING CONTROLS**

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.
- E. Section 26 51 00, INTERIOR LIGHTING: Luminaire ballast and drivers used in control of lighting systems.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - 1. Shop Drawings:
 - a. Submit the following information for each type of lighting controls.
 - b. Material and construction details.
 - c. Physical dimensions and description.
 - d. Wiring schematic and connection diagram.
 - e. Installation details.
 - 2. Manuals:
 - a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.

- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 3. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the Contractor that the lighting control systems have been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Green Seal (GS):
 - GC-12-03.....Occupancy Sensors
- C. National Electrical Manufacturer's Association (NEMA):
 - C136.10-10.....American National Standard for Roadway and Area Lighting Equipment—Locking-Type Photocontrol Devices and Mating Receptacles—Physical and Electrical Interchangeability and Testing
 - ICS-1-08.....Standard for Industrial Control and Systems General Requirements
 - ICS-2-05.....Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
 - ICS-6-11.....Standard for Industrial Controls and Systems Enclosures
- D. National Fire Protection Association (NFPA):
 - 70-14.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
 - 20.....Standard for General-Use Snap Switches
 - 773-95.....Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
 - 773A-06.....Nonindustrial Photoelectric Switches for Lighting Control
 - 98-04.....Enclosed and Dead-Front Switches

- 916-07.....Standard for Energy Management Equipment Systems
- 917-06.....Clock Operated Switches
- 924-06.....Emergency Lighting and Power Equipment (for use when controlling emergency circuits).

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

- A. Wall- or ceiling-mounting, solid-state units with a power supply and relay unit, suitable for the environmental conditions in which installed.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a 1 to 15 minute adjustable time delay for turning lights off.
 - 2. Sensor Output: Contacts rated to operate the connected relay. Sensor shall be powered from the relay unit.
 - 3. Relay Unit: Dry contacts rated for 20A ballast load at 120 volt and 277 volt, for 13A tungsten at 120 volt, and for 1 hp at 120 volt.
 - 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 - 6. Bypass Switch: Override the on function in case of sensor failure.
 - 7. Manual/automatic selector switch.
 - 8. Automatic Light-Level Sensor: Adjustable from 21.5 to 2152 lx (2 to 200 fc); keep lighting off when selected lighting level is present.
 - 9. Faceplate for Wall-Switch Replacement Type: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.
- B. Dual-technology Type: Ceiling mounting; combination PIR and ultrasonic detection methods, field-selectable.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 150 mm (6-inch) minimum movement of any portion of a human body that presents a target of not less than 232 sq. cm (36 sq. in), and detect a person of average size and weight moving not less than 305 mm (12 inches) in either a

horizontal or a vertical manner at an approximate speed of 305 mm/s (12 inches/s).

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

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. Aiming for wall-mounted and ceiling-mounted motion sensor switches shall be per manufacturer's recommendations.
- C. Set occupancy sensor "on" duration to 15 minutes.
- D. Locate photoelectric sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the available light level at the typical work plane for that area.
- E. Label time switches and contactors with a unique designation.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations.
- B. Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.
- C. Test for full range of dimming ballast and dimming controls capability. Observe for visually detectable flicker over full dimming range.
- D. Test occupancy sensors for proper operation. Observe for light control over entire area being covered.

3.3 FOLLOW-UP VERIFICATION

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

3.4 INSTRUCTION

- A. Furnish the services of a factory-trained technician for one 8-hour training period for instructing personnel in the maintenance and operation of the lighting control system on the dates requested by the COR.
- B. Contractor shall submit written instructions on training and maintenance as reviewed in training session.

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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. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
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 Fire Protection Association (NFPA):
 - 70-14.....National Electrical Code (NEC)
 - 99-15.....Health Care Facilities
- C. National Electrical Manufacturers Association (NEMA):
 - WD 1-10.....General Color Requirements for Wiring Devices
 - WD 6-12Wiring Devices - Dimensional Specifications
- D. Underwriter's Laboratories, Inc. (UL):
 - 5-11.....Surface Metal Raceways and Fittings
 - 20-10.....General-Use Snap Switches
 - 231-08.....Power Outlets
 - 467-13.....Grounding and Bonding Equipment
 - 498-12.....Attachment Plugs and Receptacles
 - 943-15.....Ground-Fault Circuit-Interrupters
 - 1449-14.....Surge Protective Devices
 - 1472-15.....Solid State Dimming Controls

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. General: All receptacles shall comply with NEMA, NFPA, UL, and as shown on the drawings.
 - 1. Mounting straps shall be nickel plated brass, brass, nickel plated steel or galvanize steel with break-off plaster ears, and shall

- include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four minimum) and side wiring from four captively held binding screws.
- B. Duplex Receptacles - Hospital-grade: shall be listed for hospital grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, NEMA 5-20R, with break-off feature for two-circuit operation.
1. Bodies shall be ivory in color.
 3. Duplex Receptacles on Emergency Circuit:
 - a. 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.

a. Bodies shall be brown nylon.

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.

2.4 WALL PLATES

A. Wall plates for switches and receptacles shall be type smooth nylon. Oversize plates are not acceptable.

B. Color shall be ivory unless otherwise specified.

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 red nylon with the word "EMERGENCY" engraved in 6 mm (1/4 inch) white letters

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. 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 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.
- J. Install horizontally mounted receptacles with the ground pin to the right.
- K. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.
- L. 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 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:
Low-voltage conductors.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS:
Requirements for personnel safety and to provide a low impedance path for possible ground faults.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
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-12.....International Building Code
- C. National Electrical Manufacturers Association (NEMA):
 - FU 1-07.....Low Voltage Cartridge Fuses
 - KS 1-06.....Enclosed and Miscellaneous Distribution
Equipment Switches (600 Volts Maximum)
- D. National Fire Protection Association (NFPA):
 - 70-11.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
 - 98-07.....Enclosed and Dead-Front Switches
 - 248-00.....Low Voltage Fuses
 - 489-09.....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.

2.5 CARTRIDGE FUSES

- A. Shall be in accordance with NEMA FU 1.
- B. Motor Branch Circuits: Class RK5, time delay.

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. 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 COTR.

---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.
- B. Section 02 41 00, DEMOLITION: Removal and disposal of lamps and ballasts.
- 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 to ground for possible ground fault currents.
- F. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
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 National Standards Institute (ANSI):
- C78.1-91.....Fluorescent Lamps - Rapid-Start Types -
 Dimensional and Electrical Characteristics
- C78.376-01.....Chromaticity of Fluorescent Lamps
- C. American Society for Testing and Materials (ASTM):
- C635-07.....Manufacture, Performance, and Testing of Metal
 Suspension Systems for Acoustical Tile and Lay-
 in Panel Ceilings
- D. Environmental Protection Agency (EPA):
- 40 CFR 261.....Identification and Listing of Hazardous Waste
- E. Federal Communications Commission (FCC):
- CFR Title 47, Part 15...Radio Frequency Devices
- CFR Title 47, Part 18...Industrial, Scientific, and Medical Equipment

F. Illuminating Engineering Society (IES):

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

LM-80-08.....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

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

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

H. International Code Council (ICC):

IBC-12.....International Building Code

I. National Fire Protection Association (NFPA):

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

101-12.....Life Safety Code

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

C82.1-04.....Lamp Ballasts - Line Frequency Fluorescent Lamp
Ballasts

C82.2-02.....Method of Measurement of Fluorescent Lamp
Ballasts

C82.4-02.....Lamp Ballasts - Ballasts for High-Intensity
Discharge and Low-Pressure Sodium (LPS) Lamps
(Multiple-Supply Type)

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

LL-9-09.....Dimming of T8 Fluorescent Lighting Systems

SSL-1-10.....Electronic Drivers for LED Devices, Arrays, or
Systems

K. Underwriters Laboratories, Inc. (UL):

496-08.....Lampholders

542-0599.....Fluorescent Lamp Starters

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

924-12.....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
2108-04.....Low-Voltage Lighting Systems
8750-09.....Light Emitting Diode (LED) Light Sources for
 Use in Lighting Products

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. 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.
- F. 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.

G. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

H. 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.

2.2 BALLASTS

A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V), electronic programmed-start 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.

2.3 FLUORESCENT EMERGENCY BALLAST

- A. Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture housing and compatible with ballast.
 1. Emergency Connection: Operate one fluorescent lamp continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 5. Integral Self-Test: Automatically initiates test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing LED.

2.4 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 sealed-beam MR-16 halogen, rated not less than 12 watts at the specified DC voltage.

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.

2.5 LAMPS

A. Linear and U-shaped T5 and T8 Fluorescent Lamps:

1. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature between 3500° and 4100°K, a Color Rendering Index (CRI) equal or greater than 80, average rated life equal to or greater than 24,000 hours when used with an instant start ballast and 30,000 hours when used with a programmed or rapid start ballast (based on 3 hour starts), and be suitable for use with dimming ballasts, unless otherwise indicated.
 - a. Other areas as shown on the drawings.
2. Lamps shall comply with EPA Toxicity Characteristic Leachate Procedure (TCLP) requirements.

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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, manufacturer's instructions, and as shown on the drawings or specified.
- B. Align, mount, and level the lighting fixtures uniformly.
- C. Lighting Fixture Supports:
 1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.
 2. Shall maintain the fixture positions after cleaning and relamping.
 3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
 4. Hardware for recessed fluorescent fixtures:
 - a. Where the suspended ceiling system is supported at the four corners of the fixture opening, hardware devices shall clamp the fixture to the ceiling system structural members, or plaster frame at not less than four points in such a manner as to resist spreading of the support members and safely lock the fixture into the ceiling system.
 - b. Where the suspended ceiling system is not supported at the four corners of the fixture opening, hardware devices shall independently support the fixture from the building structure at four points.
 5. Hardware for recessed lighting fixtures:
 - a. All fixture mounting devices connecting fixtures to the ceiling system or building structure shall have a capacity for a horizontal force of 100 percent of the fixture weight and a vertical force of 400 percent of the fixture weight.
 - b. Mounting devices shall clamp the fixture to the ceiling system structure (main grid runners or fixture framing cross runners) at four points in such a manner as to resist spreading of these supporting members. Each support point device shall utilize a

- screw or approved hardware to "lock" the fixture housing to the ceiling system, restraining the fixture from movement in any direction relative to the ceiling. The screw (size No. 10 minimum) or approved hardware shall pass through the ceiling member (T-bar, channel or spline), or it may extend over the inside of the flange of the channel (or spline) that faces away from the fixture, in a manner that prevents any fixture movement.
- c. In addition to the above, the following is required for fixtures exceeding 9 kg (20 pounds) in weight.
- 1) Where fixtures mounted in ASTM Standard C635 "Intermediate Duty" and "Heavy Duty" ceilings and weigh between 9 kg and 25 kg (20 pounds and 56 pounds), provide two 12 gauge safety hangers hung slack between diagonal corners of the fixture and the building structure.
 - 2) Where fixtures weigh over 25 kg (56 pounds), they shall be independently supported from the building structure by approved hangers. Two-way angular bracing of hangers shall be provided to prevent lateral motion.
- d. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.
6. 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.
7. 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.
- D. 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.
- E. 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.

- F. Bond lighting fixtures to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- G. At completion of project, replace all defective components of the lighting fixtures at no cost to the Government.
- H. 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 device(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.

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 27 05 11
REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes common requirements to communications installations and applies to all sections of Division 27 and Division 28.
- B. Provide completely functioning communications systems.
- C. Comply with VAAR 852.236.91 and FAR clause 52.236-21 in circumstance of a need for additional detail or conflict between drawings, specifications, reference standards or code.

1.2 REFERENCES

- A. Abbreviations and Acronyms
 - 1. Refer to <http://www.cfm.va.gov/til/sdetail.asp> for Division 00, ARCHITECTURAL ABBREVIATIONS.
 - 2. Additional Abbreviations and Acronyms:

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

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

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

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

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

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

VAMC	VA Medical Center (refer to CBOC, OPC, VACO)
VCCS	TIP's Vertical Cross Connection System (refer to CCS and HCCS)
VHF	Very High Frequency (Radio)
VISN	Veterans Integrated Services Network (refers to geographical region)
VSWR	Voltage Standing Wave 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. 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.
8. 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.
9. 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.
10. Electrostatic Interference (ESI) or Electrostatic Discharge Interference: Refer to EMI and RFI.
11. 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. Additional units are typically provided in facility's emergency room, designated nurses stations, director's office, Disaster Control Center, SCC, ECC.
12. 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.
13. Grounding Electrode Conductor: (GEC) Conductor connected to earth grounding electrode.
14. Grounding Electrode System: Electrodes through which an effective connection to earth is established, including supplementary, communications system grounding electrodes and GEC.
15. Grounding Equalizer or Backbone Bonding Conductor (BBC): Conductor that interconnects elements of telecommunications grounding infrastructure.
16. 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.
17. Microducts: All forms of air blown fiber pathways.
 18. Ohm: A unit of restive measurement.
 19. Received Signal Strength Indication (RSSI): A measurement of power present in a received RF signal.
 20. Service Provider Demarcation Point (SPDP): Not owned by LEC or service provider, but designated by Government as point within facility considered the DEMARC.
 21. Sound (SND): Changing air pressure to audible signals over given time span.
 22. System: Specific hardware, firmware, and software, functioning together as a unit, performing task for which it was designed.
 23. Telecommunications Bonding Backbone (TBB): Conductors of appropriate size (minimum 53.49 mm² [1/0 AWG]) stranded copper wire, that connect to Grounding Electrode System and route to telecommunications main grounding busbar (TMGB) and circulate to interconnect various TGBs and other locations shown on drawings.
 24. 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.
 25. 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 47	Chapter A, Paragraphs 6.1-6.23, Access to Telecommunications Service, Telecommunications Equipment and Customer Premises Equipment
Part 90	Rules and Regulations, Appendix C
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 Health and Human Services:

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy, Security and Breach Notification Rules

3. US Department of Justice:

2010 Americans with Disabilities Act Standards for Accessible Design (ADAAD).

4. 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 http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.htm <u>1)</u>
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
5. 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. VA's CEOSH, concurrence with warning identified in VA Directive 7700.
 - h. Wireless and Handheld Devices, "Guidelines and Compliance,"
 - i. 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/dts/otpc/nrtl/index.html>
- 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
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
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
797-2007	Electrical Metallic Tubing
1479-2003	Fire Tests of Through-Penetration Fire Stops
1480-2003	Speaker Standards for Fire Alarm, Emergency, Commercial and Professional use
1863-2013	Standard for Safety, communications Circuits Accessories
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
5. American Institute of Architects (AIA): 2006 Guidelines for Design & Construction of Health Care Facilities.
 6. 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
 7. American Society for Testing and Materials (ASTM):
 - B1 (2001) Standard Specification for Hard-Drawn Copper Wire
 - B8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 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
 8. 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-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-76900 (2010) AT&T Installation Testing Requirement
- ATT-TP-76911 (1999) AT&T LEC Technical Publication Notice
9. 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
10. Building Industry Consulting Service International(BICSI):
- 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
11. Electronic Components Assemblies and Materials Association,(ECA).
- ECA EIA/RS-270 (1973)Tools, Crimping, Solderless Wiring Devices - Recommended Procedures for User Certification
12. Facility Guidelines Institute: 2010 Guidelines for Design and Construction of Health Care Facilities.
13. 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-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
14. 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
- 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
15. 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

16. National Electrical Manufacturers Association (NEMA):

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

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

17. National Fire Protection Association (NFPA):

70E-2015 Standard for Electrical Safety in the Workplace

70-2014 National Electrical Code (NEC)

72-2013 National Fire Alarm Code

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

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

77-2014 Recommended Practice on Static Electricity

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

99-2015 Health Care Facilities Code

101-2015 Life Safety Code

241 Safeguarding construction, alternation and
Demolition Operations

255-2006 Standard Method of Test of Surface Burning
Characteristics of Building Materials

262 - 2011 Standard Method of Test for Flame Travel and
Smoke of Wires and Cables for Use in Air-
Handling Spaces

780-2014 Standard for the Installation of Lightning
Protection Systems

1221-2013 Standard for the Installation, Maintenance, and
Use of Emergency Services Communications
Systems

5000-2015 Building Construction and Safety Code

18. Society for Protective Coatings (SSPC):

SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning

19. Telecommunications Industry Association (TIA):

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/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-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)
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-854	A Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling (2001)
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.
 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 19, 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. Alarm initiating devices, alarm notification appliances, control units, fire safety control devices, annunciators, power supplies, and wiring: Section 28 31 00, FIRE DETECTION AND ALARM.

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Assign a single communications project manager to serve as point of contact for Government, contractor, and design professional.
- B. Be proactive in scheduling work.
 1. Use of premises is restricted at times directed by COR.
 2. Movement of materials: Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.
 3. Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 4. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work. 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 (0050P2H3) (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. Test Equipment List:
1. Supply test equipment of accuracy better than parameters to be tested.
 2. Submit test equipment list including make and model number:
 - a. ANSI/TIA-1152 Level IIIe twisted pair cabling test instrument.
 - b. Volt-Ohm meter.
 - c. Digital camera.
 - d. Bit Error Test Set (BERT).
 - e. Signal level meter.
 - f. Time domain reflectometer (TDR) with strip chart recorder (Data and Optical Measuring).
 - g. Spectrum analyzer.
 - h. Color video monitor with audio capability.
 - i. Video waveform monitor.
 - j. Video vector scope.
 - k. 100 MHz oscilloscope with video adapters.
 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.
- H. Submittal Drawings:
1. Access Panel Schedule on Submittal Drawings: Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment.
- I. Provide sustainable design submittals.
- J. 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.

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. Installation and maintenance instructions.
 - d. Safety precautions.
 - e. Diagrams and illustrations.
 - f. Test Results and testing methods.
 - g. Performance data.
 - h. 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.
 - i. Warranty documentation indicating end date and equipment protected under warranty.
 - j. 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. 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 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.

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, except as follows:
 - 1. Warranty material and equipment to be free from defects, workmanship, and remain so for a period of one year for Emergency Systems from date of final acceptance of system by Government; provide OEM's equipment warranty document to COR.
 - 2. Government maintenance personnel must have ability to contact OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time; contractor and OEM must provide this capability.

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 0050P2H3, 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.

2.3 WIRE LUBRICATING COMPOUND

- A. Provide non-hardening or forming adhesive coating cable lubricants suitable for cable jacket material and raceway.

2.4 FIREPROOFING TAPE

- A. Provide flexible, conformable fabric tape of organic composition and coated one side with flame-retardant elastomer.
- B. Tape must be self-extinguishing and cannot support combustion; arc-proof and fireproof.
- C. Tape cannot deteriorate when subjected to water, gases, salt water, sewage, or fungus; and tape must be resistant to sunlight and ultraviolet light.
- D. Application must withstand a 200-ampere arc for minimum 30 seconds.

- E. Securing Tape: Glass cloth electrical tape minimum 0.18 mm (7 mils) thick and 19 mm (3/4 inch) wide.

2.5 ACCESS PANELS

- A. Panels: 304 mm x 304 mm (12 inches by 12 inches), or size allowed by location to provide optimum access to equipment for maintenance and service.
- B. Provide access panels and doors as required to allow service of materials and equipment that require inspection, replacement, repair or service.
- C. Provide access panels where items installed require access and are concealed in floor, wall, furred space or above ceiling; ceilings consisting of lay-in or removable splined tiles do not require access panels.
- D. Provide access panels with same fire rating classification as surface penetrated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Penetrations and Sleeves:
 - 1. Lay out penetration and sleeve openings in advance, to permit provision in work.
 - 2. Set sleeves in forms before concrete is poured.
 - 3. Set sleeves prior to installation of structure for passage of pipes, conduit, ducts, etc.
 - 4. Provide sleeves and packing materials at penetrations of foundations, walls, slabs, partitions, and floors.
 - 5. Make sleeves that penetrate outside walls, basement slabs, footings, and beams waterproof.
 - 6. Fill slots, sleeves and other openings in floors or walls if not used.
 - a. Fill spaces in openings after installation of conduit or cable.
 - b. Provide fill for floor penetrations to prevent passage of water, smoke, fire, and fumes.
 - c. Provide fire resistant fill in 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.
- 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.

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. Cut, remove, and legally dispose of selected equipment, components, and materials, including removal of material, equipment, devices, and other items indicated to be removed and items made obsolete by new work.

- C. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
- D. Protect adjacent installations during cutting and patching operations.
- E. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- F. Patch finished surfaces and building components using new materials specified for original installation and experienced installers.

3.6 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 T568B pin assignments and cabling connections are in compliance with TIA standards.
6. Visually confirm minimum Category 6 cable marking at TCOs, CCSs locations, patch cords and origination locations.
7. Review conduit and path/wire way installation practice.
8. OEM and contractor to perform:
 - a. Baseband cable field inspection tests via attenuation measurements on factory reels and provide results along with OEM certification for factory reel tests.
9. Relocate failed cable reels to a secured location for inventory, as directed by COR, and then remove from project site within two working days; provide COR with written confirmation of defective cable reels removal from project site.
10. Provide results of interim inspections to COR.
11. If major or multiple deficiencies are discovered, additional interim inspections could be required until deficiencies are corrected, before permitting further system installation.
 - a. Additional inspections are scheduled at direction of COR.

- b. Re-inspection of deficiencies noted during interim inspections, must be part of system's Final Acceptance Proof of Performance Test.
 - c. The interim inspection cannot affect the system's completion date unless directed by COR.
- 12. 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.
 - 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 voice and data channel, at each of the following minimum points in system:
 - a. TER interconnections.
 - b. TR interconnections.
 - c. System interfaces in locations listed herein.
 - d. HE interconnections.
 - e. Others as required by AHJ (SMCS 0050P2H3).
 - 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 0050P2H3, (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 0050P2H3) 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 0050P2H3) 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 PROTECTION

- A. Protection of Fireproofing:
 1. Install clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed, if possible, prior to start of spray fireproofing work.
 2. Install conduits and other items that would interfere with proper application of fireproofing after completion of spray fire proofing work.
 3. Patch and repair fireproofing damaged due to cutting or course of work must be performed by installer of fireproofing and paid for by trade responsible for damage.
- B. Maintain equipment and systems until final acceptance.

- C. Ensure adequate protection of equipment and material during installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

- - - E N D - - -

SECTION 27 05 33
RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for communications cabling unless shown or specified otherwise.

1.2 RELATED WORK

- A. Sealing around penetrations to maintain integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- B. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.

1.3 SUBMITTALS

- A. In accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, submit the following:
1. Size and location of 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. 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.
 3. Flexible Galvanized Steel Conduit: Conform to UL 1.
 4. Liquid-tight Flexible Metal Conduit: Conform to UL 360.
- 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.
 - h. Set Screw Fittings: Not permitted for use with aluminum conduit.
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.
5. 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.
- 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. 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. Flush wall mounted 12.7 cm (5 inches) square x 7.3 cm (2-7/8 inches); deep pressed galvanized steel.
3. 2-Gang Tile Box:
 - a. Flush backbox type for installation in block walls.
 - b. Minimum 92 mm (3-5/8 inches) deep.

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		Conduit Not Required
Control, Communication and Signal Wiring		Complete Conduit Allowed in Non-Partitioned Cable Tray or Cable Ladders
Communications Structured Cabling	27 15 00	Conduit to Cable Tray Partitioned Cable Tray
Security Emergency Call, Duress Alarm, and Telecommunications		Conduit to Cable Tray, Partitioned Cable Tray
Grounding and Bonding for Electronic Safety and Security		Conduit Not Required Unless Required by Code
Physical Access Control System		Conduit to Cable Tray Partitioned Cable Tray

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 pull wire in all empty conduits; sleeves through floor are exceptions.
10. Complete each entire conduit run installation before pulling in cables.
11. Flattened, dented, or deformed conduit is not permitted.
12. Ensure conduit installation does not encroach into ceiling height head room, walkways, or doorways.
13. Cut conduit square with a hacksaw, ream, remove burrs, and draw tight.
14. Install conduit mechanically continuous.
15. Independently support conduit at 2.44 m (8 feet) on center; do not use other supports (i.e., suspended ceilings, suspended ceiling supporting members, luminaires, conduits, mechanical piping, or mechanical ducts).
16. Support conduit within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
17. Close ends of empty conduit with plugs or caps to prevent entry of debris, until cables are pulled in.
18. Attach conduits to cabinets, splice cases, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on inside of enclosure, made up wrench tight. Do not make conduit connections to box covers.
19. Unless otherwise indicated on drawings or specified herein, conceal conduits within finished walls, floors and ceilings.
20. Conduit Bends:

- a. Make bends with standard conduit bending machines; observe minimum bend radius for cable type and outside diameter.
 - b. Conduit hickey is permitted only for slight offsets, and for straightening stubbed conduits.
 - c. Bending of conduits with a pipe tee or vise is not permitted.
21. Layout and Homeruns - Deviations: Make only where necessary to avoid interferences and only after drawings showing proposed deviations have been submitted and approved by COR.
- D. Furred or Suspended Ceilings and in Walls:
- 1. Rigid steel, or rigid aluminum. Different type conduits mixed indiscriminately in same system is not permitted.
 - 2. Align and run conduit parallel or perpendicular to building lines.
 - 3. Tightening set screws with pliers is not permitted.

E. Exposed Work Installation:

1. Unless otherwise indicated on drawings, exposed conduit is only permitted in telecommunications rooms.
 - a. Provide rigid steel, IMC or rigid aluminum.
 - b. Different type of conduits mixed indiscriminately in system is not permitted.
2. Align and run conduit parallel or perpendicular to building lines.
3. Install horizontal runs close to ceiling or beams and secure with conduit straps.
4. Support horizontal or vertical runs at not over 2400 mm (96 inches) intervals.
5. Surface Metal Raceways: Use only where shown on drawings.
6. Painting:
 - a. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
 - b. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color.
 - c. Provide labels where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

F. 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.

G. 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.
- H. Box Installation:
1. Boxes for Concealed Conduits:
 - a. Flush mounted.
 - b. Provide raised covers for boxes to suit wall or ceiling, construction and finish.
 2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables during pulling.

3. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
4. Stencil or install phenolic nameplates on covers of boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
5. Outlet boxes mounted back-to-back in same wall are not permitted. A minimum 600 mm (24 inches) center-to-center lateral spacing must be maintained between boxes.

3.2 TESTING

- A. Examine fittings and locknuts for secureness.
- B. Test RMC, IMC and EMT systems for electrical continuity.
- C. Perform simple continuity test after cable installation.

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**SECTION 27 15 00
COMMUNICATIONS STRUCTURED CABLING**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies a complete and operating voice and digital structured cabling distribution system and associated equipment and hardware to be installed in VA Medical Center, here-in-after referred to as the "facility".

1.2 RELATED WORK

- A. Wiring devices: Section 26 27 26, WIRING DEVICES.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

- A. In addition to requirements of Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS provide:
1. 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 telecommunications outlets (TCO); copper distribution cables, connectors, and "patch" cables.
- 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 6 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 0050P2H3 (202-462-5310) for specific technical assistance and approvals.
 - E. Specific Subsystem Requirements: Provide products necessary for a complete and functional voice and data cabling system, including 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 cables on patch panels or punch blocks. Terminate unused or spare conductors. Do not leave unused or spare twisted pair wire 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, 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.

2.2 EQUIPMENT AND MATERIALS

- A. Cable Systems - Twisted Pair and Analog:
 1. General:
 - a. Provide cable conforming to accepted industry standards with regards to size, color code, and insulation.
 - b. Some areas can be considered "plenum". Comply with all codes pertaining to plenum environments. It is contractor's responsibility to review the VA's cable requirements with COR and OI&T Service prior to installation to confirm type of environment present at each location.
 - c. Provide proper test equipment to confirm that cable pairs meet each OEM's standard transmission requirements, and ensure cable carries data transmissions at required speeds, frequencies, and fully loaded bandwidth.
 2. Horizontal Cable: Installed from TCO jack to the TR patch panel.
 - a. Tested to ANSI/TIA-568-C.2 Category 6 requirements including NEXT, ELFEXT (Pair-to-Pair and Power Sum), Insertion Loss (attenuation), Return Loss, and Delay Skew.

- b. Minimum Transmission Parameters: 250 MHz.
- c. Provide four pair 0.326 mm² (22 AWG) cable
- d. Terminate all four pairs on same port at patch panel in TR.
- e. Terminate all four pairs on same jack, at work area

Telecommunication Outlets (TCO):

- 1) Jacks: Minimum three eight-pin RJ-45 ANSI/TIA-568-C.2 Category 6 Type jacks at TCO.
 - a) Top Port: RJ-45 jack compatible with RJ-11 plug for voice.
 - b) Bottom Two Ports: Unkeyed RJ-45 jacks for data.

B. Horizontal Cabling (HC):

- 1. Horizontal cable length to farthest system outlet to be maximum of 90 m (295 ft).
- 2. Splitting of pairs within a cable between different jacks is not permitted.

2.3 DISTRIBUTION EQUIPMENT AND SYSTEMS

A. Telecommunication Outlet:

- 1. TCO consists of minimum one voice (telephone) RJ45 jack and two data RJ45 jacks, 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.
- 3. Provide wall outlet with a stainless steel face plate and sufficient ports to fit voice (telephone) multi-pin jack, data multi-pin 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.

B. Outlet Connection Cables:

- 1. Voice (Telephone):
 - a. Provide a connection cable for each TCO voice (telephone) jack in system 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 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 6.
 - 3) Connector: RJ-45 male on each end.
 - 4) Color Coding: Required, data industry standard.
 - 5) Size: Minimum 22 AWG.

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 conduit or when specifically approved, flexible NEC Article 800 communications raceway. Confirm drawings show sufficient quantity and size of cable pathways. If flexible communications raceway is used, install in same manner as conduit.
 - 2. Bond to ground metallic cable sheaths, etc. (i.e. risers, underground, horizontal, etc.).
 - 3. Install temporary cable to not present a pedestrian safety hazard and be responsible for all work associated with removal. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and accepted by COR, IT Service, FMS and SMCS 0050P2H3 (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 either T568B or T568A pin assignments and cabling connections comply with TIA standards. Verify code with owner.
4. Visually confirm marking of cables, faceplates, patch panel connectors and patch cords.
5. Notify COR of the estimated date the contractor expects to be ready for interim inspection, at least 20 working days before requested inspection date, so interim inspection does not affect systems' completion date.
6. Provide results of interim inspection to COR. If major or multiple deficiencies are discovered, COR can require a second interim inspection before permitting contractor to continue with system installation.
7. Do not proceed with installation until COR determines if an additional inspection is required. In either case, re-inspection of deficiencies noted during interim inspections must be part of the proof of performance test.

B. Pretesting:

1. Pretest entire system upon completion of system installation.
2. Verify during system pretest, utilizing the accepted equipment, that system is fully operational and meets system performance requirements of this section.

3. Provide COR four copies of recorded system pretest measurements and the written certification that system is ready for formal acceptance test.

C. 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.

D. 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.

E. Performance Testing:

1. Perform Category 6 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.

- F. Total System Acceptance Test: Perform verification tests for UTP STP copper cabling systems 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.

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

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section of the specifications includes the furnishing, installation, and connection of fire alarm equipment to an existing 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, and wiring as shown on the drawings and specified.
- B. Fire alarm systems shall comply with requirements of the most recent VA FIRE PROTECTION DESIGN MANUAL and NFPA 72 unless variations to NFPA 72 are specifically identified within these contract documents. 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. Installers shall have a minimum of 2 years experience installing fire alarm systems.
- C. Alarm signals (by device), shall be distinctly transmitted to the existing fire alarm system control units located in building 1.

1.2 SCOPE

- A. Addressable fire alarm smoke detection shall be designed and installed in accordance with the specifications and drawings. Device locations shown on the drawings are for reference only. Actual locations shall be in accordance with NFPA 72 and this specification.
- B. Basic Performance:
 - 1. 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.
 - 2. Initiating device circuits (IDC), Signaling line circuits (SLC) shall be wired Class B in accordance with NFPA 72.
 - 3. Notification appliance circuits (NAC) shall be wired Style Y in accordance with NFPA 72.

1.3 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Requirements for procedures for submittals.

B. Section 07 84 00 - FIRESTOPPING. Requirements for fire proofing wall penetrations.

C. Section 21 13 13 - WET-PIPE SPRINKLER SYSTEMS. Requirements for sprinkler systems.

1.4 SUBMITTALS

A. General: Submit 5 copies in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Drawings:

1. Prepare drawings using AutoCAD software and include all contractors information. 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, individual circuits and raceway routing; 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 existing or removed devices on the floor plans. Show all interfaces for all fire safety functions.
3. Riser diagrams: Provide, for the new devices, 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, and all other fire safety interfaces. Show wiring Schedules on the riser diagram for all circuits.
4. 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. 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. Not used.
 - 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. Not used.
 - 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. Not used.
 - h. Not used.
 - i. Not used.
 - j. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
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. Not used.
 - 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 installer 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. Include in the certification the names and addresses of the proposed supervisor of installation.
2. Together with the shop drawing submittal, submit a certification that the components being furnished are compatible with the control unit.
3. Together with the shop drawing submittal, submit a certification 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 COR.

1.6 NOT USED

1.7 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by the basic designation only and the latest editions of these publications shall be applicable.
- B. National Fire Protection Association (NFPA):
 - NFPA 13Standard for the Installation of Sprinkler Systems, 2016 edition
 - NFPA 70.....National Electrical Code (NEC), 2014 edition
 - NFPA 72.....National Fire Alarm Code, 2016 edition
 - NFPA 101.....Life Safety Code, 2015 edition
- C. Underwriters Laboratories, Inc. (UL): Fire Protection Equipment Directory
- D. Factory Mutual Research Corp (FM): Approval Guide
- E. American National Standards Institute (ANSI):
 - S3.41.....Audible Emergency Evacuation Signal, 1990 edition, reaffirmed 2008
- F. International Code Council, International Building Code (IBC), 2015 edition

PART 2 - PRODUCTS**2.1 EQUIPMENT AND MATERIALS, GENERAL**

- A. All equipment and components shall be new and the manufacturer's current model. All equipment shall be tested and listed by Underwriters Laboratories, Inc. or Factory Mutual Research Corporation for use as part of a fire alarm system.

2.2 CONDUIT, BOXES, AND WIRE

- A. Conduit shall be in accordance with Division 26 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, Division 26, 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 16 AWG for notification device circuits.
- 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 high.

2.3 NOT USED**2.4 NOT USED****2.5 NOT USED****2.6 NOT USED****2.7 ALARM NOTIFICATION APPLIANCES**

- A. Speakers:
 - 1. Shall operate on either 25 VRMS or 70.7 VRMS with field selectable output taps from 0.5 to 2.0W and originally installed at the 1/2 watt tap. Speakers shall provide a minimum sound output of 80 dBA at 10 feet with the 1/2 watt tap.
 - 2. Frequency response shall be a minimum of 400 HZ to 4,000 HZ.
- C. Strobes:

1. Xenon flash tube type minimum candela rating per NFPA 72 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 permanent red letters. Lettering to read "Fire", be oriented on the wall or ceiling properly, and be visible from all viewing directions.
3. 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. Mount on removable adapter plates on conduit boxes.

2.8 ALARM INITIATING DEVICES

A. Smoke Detectors:

1. Smoke detectors shall be photoelectric type and UL listed for use with the existing fire alarm control unit.
2. Smoke detectors shall be addressable type complying with applicable UL Standards for system type detectors. Buildings with zoned fire alarm systems installed may be non-addressable zoned 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.
4. All spot 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.

2.9 NOT USED**2.10 ADDRESS REPORTING INTERFACE DEVICE**

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

2.11 SMOKE BARRIER DOOR CONTROL

- A. Electromagnetic Door Holders:
 - 1. New Door Holders shall be standard wall mounted electromagnetic type. In locations where doors do not come in contact with the wall when in the full open position, an extension post shall be added to the door bracket.
 - 2. Operation shall be by 24 volt DC supplied from a battery located at the fire alarm control unit. Door holders shall be coordinated as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring and fire alarm system for operation as specified. Existing system batteries shall be verified that capacity exists via calculations.
- B. Door holders shall be wired to allow releasing doors by smoke zone.
- C. Door holder control circuits shall be electrically supervised.

D. SMOKE DETECTORS SHALL NOT BE INCORPORATED AS AN INTEGRAL PART OF DOOR HOLDERS. 2.12 NOT USED**2.13 SPARE AND REPLACEMENT PARTS**

- A. Provide spare and replacement parts in accordance with NFPA 72.

2.14 NOT USED**PART 3 - EXECUTION****3.1 INSTALLATION:**

- A. Installation shall be in accordance with NFPA 70, 72, and 101 as shown on the drawings. Fire alarm wiring shall be installed in conduit. All conduit and wire shall be installed in accordance with Division 26 and NFPA 70, 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 exposed conduits shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas.
- D. Not used.
- E. Not used.
- F. All fire detection and alarm system devices shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Exact locations are to be approved by the COTR.
- G. Speakers may be ceiling mounted and fully recessed in areas with suspended ceilings, or wall mounted. 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 minimum 80 inches above the floor to a maximum of 96 inches, or 6 inches below ceiling, whichever is lower. Locate and mount to maintain a minimum 36 inches clearance from side obstructions.

3.2 TYPICAL OPERATION

- A. Activation of any smoke detector shall cause the following operations to occur:
 - 1. Operate the fire alarm system in building 1.
 - 2. Continuously flash all strobes in the building in alarm until reset at the local fire alarm control unit.
 - 3. Release the magnetic door holders in the smoke zone or 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.
- B. Smoke detectors in the primary new elevator shall, in addition to the above functions, return the new elevator to the secondary floor.
- C. Smoke detectors in the remaining new elevator lobbies shall, in addition to the above functions, return the new elevator to the primary floor.
- D. Operation of a smoke detector at a corridor door used for automatic closing shall also release only the magnetic door holders on that floor or in that smoke zone.
- E. Alarm verification shall not be used for smoke detectors installed for the purpose of early warning.

3.3 TESTS

- A. Provide the service of a NICET level III, competent, engineer or technician 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 fire alarm system extension 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. Open each new alarm initiating circuit to see if trouble signal actuates.
 - 4. Ground each new alarm initiation 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.

3.5 INSTRUCTION

- A. The contractor shall provide instruction and training to the VA as required by the COTR.

- - END - -

**SECTION 31 20 11
EARTHWORK (SHORT FORM)**

PART 1 - GENERAL

1.1:DESCRIPTION:

This section specifies the requirements for furnishing all equipment, materials, labor and techniques for earthwork including excavation, fill, backfill and site restoration utilizing fertilizer, seed and/or sod.

1.2 DEFINITIONS:

A. Unsuitable Materials:

1. Fills: Topsoil, frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic materials, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable.
2. Existing Subgrade (except footings): Same materials as above paragraph, that are not capable of direct support of slabs, pavement, and similar items, with the possible exception of improvement by compaction, proofrolling, or similar methods of improvement.
3. Existing Subgrade (footings only): Same as Paragraph 1, but no fill or backfill. If materials differ from reference borings and design requirements, excavate to acceptable strata subject to COR 's approval.

B. Earthwork: Earthwork operations required within the new construction area. It also includes earthwork required for auxiliary structures and buildings and sewer and other trenchwork throughout the job site.

C. Degree of Compaction: Degree of compaction is expressed as a percentage of maximum density obtained by the test procedure presented in ASTM D698 or D1557 Method A.

D. The term fill means fill or backfill as appropriate.

1.3 RELATED WORK:

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

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

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

1.4 CLASSIFICATION OF EXCAVATION:

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on the surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.
- B. Rock Excavation:
 - 1. Solid ledge rock (igneous, metamorphic, and sedimentary rock).
 - 2. Bedded or conglomerate deposits so cemented as to present characteristics of solid rock which cannot be excavated without blasting; or the use of a modern power excavator (shovel, backhoe, or similar power excavators) of no less than 0.75 m³ (1 cubic yard) capacity, properly used, having adequate power and in good running condition.
 - 3. Boulders or other detached stones each having a volume of 0.4 m³ (1/2 cubic yard) or more.

1.5 MEASUREMENT AND PAYMENT FOR EXCAVATION:

Measurement: The unit of measurement for excavation and borrow will be based on plan quantities.

1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION:

- A. Measurement: Cross section and measure the uncovered and separated materials, and compute quantities by the Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. Do not measure quantities beyond the following limits:
 - 1. 300 mm (12 inches) outside of the perimeter of formed footings.
 - 2. 600 mm (24 inches) outside the face of concrete work for which forms are required, except for footings.
 - 3. 150 mm (6 inches) below the bottom of pipe and not more than the pipe diameter plus 600 mm (24 inches) in width for pipe trenches.
 - 4. The outside dimensions of concrete work for which no forms are required (trenches, conduits, and similar items not requiring forms).

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 elevations.
- C. 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.
- D. Qualifications of the commercial testing laboratory or Contractor's Testing facility shall be submitted.

1.8 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Nursery and Landscape Association (ANLA):
2004.....American Standard for Nursery Stock
- C. American Association of State Highway and Transportation Officials (AASHTO):
T99-10.....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
- D. American Society for Testing and Materials (ASTM):
C33-03.....Concrete Aggregate
D698-e1.....Laboratory Compaction Characteristics of Soil Using Standard Effort
D1140-00.....Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
D1556-00.....Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D1557-09.....Laboratory Compaction Characteristics of Soil Using Modified Effort
D2167-94 (2001).....Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2487-06.....Standard Classification of Soil for Engineering Purposes (Unified Soil Classification System)
D6938-10.....Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

- E. Standard Specifications of State of Kansas Department of Transportation, latest revision.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Fills: Materials approved from on site and off site sources having a minimum dry density of 1760 kg/m³ (110 pcf), a maximum Plasticity Index of 6, and a maximum Liquid Limit of 30.
- B. 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 C33.
 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).
- C. Fertilizer: (5-10-5) delivered to site in unopened containers that clearly display the manufacturer's label, indicating the analysis of the contents.
- D. Seed: Grass mixture comparable to existing turf delivered to site in unopened containers that clearly display the manufacturer's label, indicating the analysis of the contents.
- E. Requirements For Offsite Soils: Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, 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. Material shall not be brought on site until tests have been approved by the COR.
- G. Buried Warning and Identification Tape: Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specific below for the intended utility with warning and identification imprinted in bold black letters

continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, Unaffected by moisture or soil. Warning tape color codes:

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

- H. 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.
- I. 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.
- J. 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: Clearing within the limits of earthwork operations as described or designated by the COR. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash and any other obstructions. Remove materials from the Medical Center.
- B. Grubbing: Remove stumps and roots 75 mm (3 inches) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inches) diameter, and nonperishable solid objects which will be a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.

- C. Stripping Topsoil: Unless otherwise indicated on the drawings, the limits of earthwork operations shall extend anywhere the existing grade is filled or cut or where construction operations have compacted or otherwise disturbed the existing grade or turf. Strip topsoil as defined herein, or as indicated in the geotechnical report, from within the limits of earthwork operations as specified above unless specifically indicated or specified elsewhere in the specifications or shown on the drawings. Topsoil shall be fertile, friable, natural topsoil of loamy character and characteristic of the locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by the COR. Eliminate foreign material, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials, larger than 0.014 m³ (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on the 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 the soil is wet so that the tilth of the soil will be destroyed.
1. 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 the Medical Center.
- E. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations. No burning of materials is permitted onsite.

3.2 EXCAVATION:

- A. Shoring, Sheet piling and Bracing: Shore, brace, or slope to its angle of repose banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities, in compliance with OSHA requirements.
1. Extend shoring and bracing to the bottom of the excavation. Shore excavations that are carried below the elevations of adjacent existing foundations.
2. If the bearing of any foundation is disturbed by excavating, improper shoring or removal of shoring, placing of backfill, and similar operations, provide a concrete fill support under disturbed foundations, as directed by COR, at no additional cost to the

- Government. Do not remove shoring until permanent work in excavation has been inspected and approved by COR.
- B. Excavation Drainage: Operate pumping equipment , and/or provide other materials, means and equipment as required, to keep excavations free of water and subgrades dry, firm, and undisturbed until approval of permanent work has been received from COR. Approval by the COR is also required before placement of the permanent work on all subgrades. When subgrade for foundations has been disturbed by water, remove the disturbed material to firm undisturbed material after the water is brought under control. Replace disturbed subgrade in trenches by mechanically tamped sand or gravel. When removed disturbed material is located where it is not possible to install and properly compact disturbed subgrade material with mechanically compacted sand or gravel, the COR should be contacted to consider the use of flowable fill. 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. 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. Blasting: Blasting shall not be permitted.
- D. 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 material to solid bottom.
 4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete, poured separately from the footings.

3. Do not tamp earth for backfilling in footing bottoms, except as specified.

E. 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. The length of open trench in advance of pipe laying shall not be greater than is authorized by the COR.
 - e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade
 - f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.
 - g. Bedding shall be of the type and thickness shown. 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 D 2487.
 - 3) Clean, coarse-grained sand classified in accordance with DOT or by ASTM D 2487 for bedding and backfill.
 - 4) Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as in accordance with the DOT or having a classification of in accordance with ASTM D 2487 for bedding and backfill as indicated. Maximum particle size shall not exceed 75 mm (3 inches).
2. Sanitary and storm sewer trenches:
- a. Trench width below a point 150 mm (6 inches) above top of the pipe shall be 600 mm (24 inches) for 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.
 - b. The bottom quadrant of the pipe shall be bedded 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 the pipe of 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
 - c. Place and compact as specified the 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 in accordance with the DOT or by ASTM D 487 for bedding and backfill as indicated.
 - 4) Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified in accordance with Section the DOT or having a classification accordance with ASTM D2487 for

bedding and backfill as indicated. Maximum particle size shall not exceed 75 mm (3 inches).

F. Site Earthwork: Excavation shall be accomplished as required by drawings and specifications. Remove subgrade materials that are determined by the Contracting Officer's Representative as unsuitable, and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the Contractor shall obtain samples of the material, under the direction of the COR, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. When unsuitable material is encountered and removed, the contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on meters (yardage) in cut section only.

G. Finished elevation of subgrade shall be as follows:

1. Pavement Areas - bottom of the pavement or base course as applicable.
2. Planting and Lawn Areas - 100 mm (4 inches) below the finished grade, unless otherwise specified or indicated on the drawings.

3.3 FILLING AND BACKFILLING:

- A. General: Do not fill or backfill until all debris, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from the excavation. Proof-roll exposed subgrades with a fully loaded dump truck. Use excavated materials or borrow for fill and backfill, as applicable. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, and pipes coming in contact with backfill have been installed, and inspected and approved by COR.
- B. Placing: Place material in horizontal layers not exceeding 200 mm (8 inches) in loose depth and then compacted. Do not place material on surfaces that are muddy, frozen, or contain frost.
- C. Compaction: Use approved equipment (hand or mechanical) well suited to the type of material being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without the prior approval of the COR. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each layer to not less than 95 percent of the maximum density determined in accordance with the following test method ASTM D1557 Method A . 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.

- E. 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 within the limits of the project site, selected by the Contractor. 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.
- F. Opening and Drainage of Excavation and Borrow Pits: The Contractor shall notify the COR sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.4 GRADING:

- A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
- B. Cut rough or sloping rock to level beds for foundations. In unfinished areas fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside the building away from the building walls for a minimum distance of 3048 mm (10 feet) at a minimum five percent (5%) slope.

- D. The finished grade shall be 150 mm (6 inches) below bottom line of windows or other building wall openings unless greater depth is shown.
- E. Place crushed stone or gravel fill under concrete slabs on grade tamped and leveled. The thickness of the fill shall be 150 mm (6 inches), unless otherwise indicated.
- F. Finish subgrade in a condition acceptable to the COR at least one day in advance of the paving operations. Maintain finished subgrade in a smooth and compacted condition until the succeeding operation has been accomplished. Scarify, compact, and grade the subgrade prior to further construction when approved compacted subgrade is disturbed by contractor's subsequent operations or adverse weather.
- G. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.5 LAWN AREAS:

- A. General: Harrow and till to a depth of 100 mm (4 inches), new or existing lawn areas to remain, which are disturbed during construction. Establish existing or design grades by dragging or similar operations. Do not carry out lawn areas earthwork out when the soil is wet so that the tilth of the soil will be destroyed. Plant bed must be approved by COR before seeding or sodding operation begins.
- B. Finished Grading: Begin finish grading after rough grading has had sufficient time for settlement. Scarify subgrade surface in lawn areas to a depth of 100 mm (4 inches). Apply topsoil so that after normal compaction, dragging and raking operations (to bring surface to indicated finish grades) there will be a minimum of 100 mm (4 inches) of topsoil over all lawn areas; make smooth, even surface and true grades, which will not allow water to stand at any point. Shape top and bottom of banks to form reverse curves in section; make junctions with undisturbed areas to conform to existing topography. Solid lines within grading limits indicate finished contours. Existing contours, indicated by broken lines are believed approximately correct but are not guaranteed.
- C. Fertilizing: Incorporate fertilizer into the soil to a depth of 100 mm (4 inches) at a rate of 12 kg/100 m² (25 pounds per 1000 square feet).
- D. Seeding: Seed at a rate of 2 kg/100 m² (4 pounds per 1000 square feet) and accomplished only during periods when uniform distribution may be assured. Lightly rake seed into bed immediately after seeding. Roll seeded area immediately with a roller not to exceed 225 kg/m (150 pounds per foot) of roller width.
- E. Watering: The COR is responsible for having adequate water available at the site. As sodding is completed in any one section, the entire sodded

area shall be thoroughly irrigated by the contractor, to a sufficient depth, that the underside of the new sod pad and soil, immediately below sod, is thoroughly wet. COR will be responsible for sod after installation and acceptance.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL:

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.
- B. Place excess excavated materials suitable for fill and/or backfill on site where directed.
- C. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.
- D. Segregate all excavated contaminated soil designated by the COR from all other excavated soils, and stockpile on site on two 0.15 mm (6 mil) polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Dispose of excavated contaminated material in accordance with State and Local requirements.

3.7 CLEAN-UP:

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

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GEOTECHNICAL REPORT

ROBERT J. DOLE V.A. MEDICAL CENTER

ELEVATOR SHAFT ADDITION

WICHITA, KANSAS

Prepared For:

WDM ARCHITECTURE

WICHITA, KANSAS

February 2016

Project No: 74-160165-000-1324

Professional Engineering Consultants, P.A.: Geotechnical Engineering Division
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APPENDIX - FIELD EXPLORATION AND LABORATORY TEST RESULTS



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INTRODUCTION

This report presents the results of a geotechnical study for the Robert J. Dole V.A. Medical Center – Elevator Shaft Addition. The study was conducted to develop geotechnical recommendations for project design and is intended for the exclusive use of the client for the referenced project.

The geotechnical study included a field exploration program to obtain information on the subsurface conditions and collect samples for laboratory testing. The samples obtained during the field exploration were visually observed and classified in the laboratory referencing American Society for Testing and Materials (ASTM) procedures. Representative samples were selected for laboratory testing to determine physical and engineering characteristics of the in-situ soils. Field exploration and laboratory test results were analyzed to develop geotechnical recommendations for the proposed construction. All field testing, laboratory testing, analysis, and report preparation was performed under the direction of a registered Professional Engineer.

The following sections present the results of the field exploration, laboratory tests, and our conclusions and recommendations for project design. The conclusions and recommendations are based on the project information available at the time of this report and the subsurface conditions encountered in the borings at the locations and times indicated. If project details including structure location, elevations, loads, cut and fill depths or other conditions change during design or if the subsurface conditions vary from those described in this report, the conclusions and recommendations may need to be re-evaluated and adjusted.

Site Location and Description

The proposed project is located in the courtyard of the Robert J. Dole V.A. Medical Center, located at 5500 East Kellogg Drive North, in Wichita, Kansas. The general project location is shown on Figure 1. Based on our visual observations at the time of our field exploration, the area of the proposed addition is located entirely within the courtyard of the main structure. The topography at the project site is relatively level.

PROPOSED CONSTRUCTION

The proposed project includes the construction of a reinforced brick and block elevator shaft structure extending to heights of approximately 50 to 55 feet above existing site grade. It is anticipated that the addition will be founded on either a shallow foundation system or deep foundation system consisting of auger cast in place (ACIP) piles, and that the footing or pile cap elevation will be approximately 15 to 18 feet below the existing site grade.

Although loading was not provided, we have estimated the column, wall, and floor loads are not to exceed 200 kips, 20 kips per linear foot (klf) and 150 pounds per square foot (psf), respectively.



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Grading plans were not provided at the time of this report. Based on the existing site conditions, we anticipate minimal site grading will be required to achieve design grades for the addition.

FIELD EXPLORATION

The field exploration was conducted on February 16, 2016. The Standard Penetration Test (SPT) boring was located in the field by the Professional Engineering Consultants, P.A. Field Services (PFS) Survey Division using the provided site plan and taped measurements from existing landmarks at the site. The boring location should be considered accurate only to the degree implied by the method of measurement used. The boring was drilled at the approximate location shown on the attached Boring Location Plan (Figure 2).

GENERAL

The boring location was determined in the field by the PFS drilling crew using the provided site plan and taped measurements from existing landmarks. The boring location should be considered accurate only to the degree implied by the method of measurement used. The approximate boring location is shown on the attached Boring Location Plan (Figure 2).

TEST BORINGS

The field exploration conducted on February 16, 2016 included one (1) boring to a depth of approximately 50.5 feet below the existing site grade.

The SPT Boring B-1 was drilled with a Mobile Drill B-53 truck mounted drill rig, using 6-inch outside diameter (O.D.) continuous flight auger. Subsurface conditions in the borehole were visually logged in the field by PFS personnel referencing ASTM D-2488 visual-manual procedures. A water level measurement was taken in the borehole shortly after completion of drilling.

Samples of the subsurface soils were primarily obtained using a 2-inch O.D. split-spoon sampler. The sampler was driven into the strata using a 140-pound safety hammer falling 30 inches. The number of blows required to advance the sampler three successive 6-inch increments is recorded. The total number of blows used to advance the sampler the second and third 6-inch increment is the penetration resistance "N" value. Standard Penetration Test borings were performed referencing ASTM D-1586.

LABORATORY TESTING

Soil samples obtained during the field exploration were observed and visually classified referencing ASTM D-2487 which is based on the Unified Soil Classification System. Selected samples were tested to evaluate engineering and physical properties. Tests performed included natural moisture content, Atterberg Limits, and dry unit weight. Tests were performed referencing current ASTM procedures unless otherwise noted. Laboratory test results are summarized on the attached Exploratory Boring Log report, Figure 4, and the Summary of Laboratory Results, Figure 6.



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SITE CONDITIONS

This section presents brief descriptions of the subsurface conditions encountered at the SPT boring location and general observations of the site. The attached Exploratory Boring Log report should be reviewed for more information on the subsurface conditions at the boring location. Sharp transitions between soil types are presented on the boring log. However, soil transitions may occur gradually and transition depths are approximate. The soil conditions noted on the boring log are based on visual observations and periodic sampling. Additional sampling, testing and Petrographic analysis may provide a different classification of the encountered soil.

GENERAL

The subsurface profile at the boring location predominantly consisted of approximately 3 inches of topsoil overlying fill materials extending to a depth of approximately 5.25 feet below existing site grade. The boring continued with native soils consisting of completely to highly weathered Shale clay soils with varying amounts of silt, gypsum, and calcareous materials extending to boring termination depth. Subsurface groundwater was observed in the borehole after completion of drilling operations at a depth of approximately 36.25 feet below existing site grade.

EXISTING FILL

Fill materials were encountered at the boring location extending from below the topsoil layer to a depth of approximately 5.25 feet below existing site grade. These fill soils primarily consisted of clay with varying amounts of brick rubble, concrete rubble, construction debris, and organic materials. These soils were characterized as moist with a medium stiff consistency. A SPT N value of 6 blows per foot of penetration was obtained in the encountered layer.

Due to previous grading and construction operations at the site, disturbed soils and/or fill materials are likely to be encountered at other areas of the site that were not explored during our fieldwork.

SOILS

The native subsurface profile encountered below the topsoil materials generally consisted of fat clay soils extending to the termination depths of the boring.

The clay soils and completely and highly weathered Shale soils were predominantly characterized as moist, moderate to high plasticity, with a medium stiff to hard consistency. For the samples tested, Liquid Limit values ranging from 47 to 77 and Plasticity Index values ranging from 19 to 52 were obtained. SPT N values ranged from 6 blows per foot of penetration to 50 blows per 0 inches of penetration.



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GROUNDWATER

Subsurface groundwater was observed in the borehole after completion of drilling operations at a depth of approximately 36.25 feet below existing ground surface. It should be noted that the groundwater level encountered during drilling operations may not necessarily indicate where groundwater will be encountered at the time of construction. Groundwater levels may fluctuate several feet depending on climatic conditions, time of year, surface runoff, and other factors beyond the scope of this report.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Our geotechnical engineering evaluation of the surface and subsurface conditions at the site, with respect to the planned construction, are based on (1) our site observations, (2) the field and laboratory test data obtained, and (3) our understanding of the project information and structural conditions as presented in this report.

If the project information is incorrect, or should the locations of the structures change, please contact the undersigned Engineer so that these recommendations can be reviewed. The discovery of any site or subsurface conditions during construction that deviate from the data obtained during this geotechnical exploration should also be reported to the undersigned Engineer for evaluation.

The recommendations presented in the subsequent sections of this report present design and construction techniques that are appropriate for the planned construction. We recommend that we be provided the opportunity to review the foundation plans and earthwork specifications to verify that our recommendations have been properly interpreted and implemented.

Based on the results of our exploration, we consider the subsurface conditions at the site adaptable for support of the proposed elevator shaft structure when constructed on a properly designed shallow or deep foundation placed on the very stiff native clay soils, or embedded into the highly weathered Shale clay. Provided the site preparation and earthwork construction recommendations outlined in this report are performed, the following parameters may be used for foundation design.

SITE GRADING

Ponded water can present significant problems during and after construction. Site grading plans should be designed to provide positive drainage away from all structures, slabs-on-grade, pavements and sidewalks. A minimum slope of 5 percent for the first 10 feet next to the structure and 2 percent thereafter is recommended for landscaped areas. Positive drainage should also be provided in all paved and sidewalk areas to the extent practicable within ADA requirements. All downspouts should be designed to discharge a minimum of 5 feet away from structures. Temporary drainage to a sump should be used to remove ponded water in excavations. Care should be taken to keep the moisture content of the clay soils constant during construction.



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SITE DEMOLITION

The addition construction area is currently developed near the existing Robert J. Dole V.A. Medical Center structure and other appurtenances that may require partial demolition and removal prior to construction. Prior to demolition and construction operations, the location of existing underground utility lines within the construction area should be established. Provisions should then be made to relocate interfering utilities to appropriate locations.

Based on the provided bottom of footing elevations, the encountered fill soils may be removed during normal excavation. However, over-excavation and replacement of existing fill and isolated softer soils may be necessary at this site due to previous construction. Although unlikely to be encountered at bottom of footing depth, the extent of over-excavation will not be known until construction. The demolition, removal, and over-excavation operations should be closely monitored to verify all debris is removed and all over-excavations are replaced with properly compacted, new engineered fill.

SUBGRADE PREPARATION

As noted above, partial demolition and removal operations will be necessary at this site if fill materials are encountered below bottom of footing depth. After demolition and removal operations and prior to placing new fill; all soft soil, existing fill, and deleterious materials should be removed.

Once demolition/removal, stripping, and over-excavation (as necessary) operations are complete, the exposed subgrade should be proof-rolled by the contractor using a heavily loaded scraper, dump truck, or front-end loader to verify all soft areas have been excavated and that the subgrade is suitable for fill placement. The proof-roll should be observed by a qualified Engineering Technician under the direction of a Professional Engineer. If excess drying or wetting of the exposed subgrade has occurred, the exposed subgrade should be scarified to a minimum depth of 8 inches; moisture conditioned and re-compacted to the requirements outlined below.

Due to site access conditions, in the event that the above equipment will not be feasible for use in the manner described above, we recommend extensive testing of the subgrade soils be performed using a Static Cone Penetrometer (SCP). Testing should be performed by a qualified technician under direct supervision from a registered Professional Engineer. Field testing should be performed at a minimum of one (1) location per five linear feet of continuous wall footing, and at one (1) location for every 25 square feet of isolated column footing.

Care should be exercised to avoid undermining any exposed footing and damaging any nearby structures while the over-excavation, proof-roll and compaction operations are underway. These operations should cease if deemed detrimental to adjacent structures, and the Geotechnical Engineer should be contacted immediately. It is recommended that the compaction equipment operate in static mode when adjacent structures are less than 50 feet from the edges of the construction area. We recommend monitoring and documentation of this compactive effort.

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Any loose, yielding, or pumping soils identified during compaction will require stabilization with rock, drying and additional compaction, or undercutting and replacement with engineered fill. Once the native soils have been compacted and approved by a geotechnical engineer or their representative, structural fill placement can commence.

ENGINEERED FILL

All new fill should consist of clean soils free of debris and deleterious materials. Imported general fill should consist of clean soils with a maximum plasticity index of 25, or select fill.

Select fill should consist of Low Volume Change (LVC) materials including limestone gravel, limestone screenings, crushed sandstone, or equivalent. Natural LVC materials consisting of sandy clay, clayey sand or similar soils with a minimum of 20 percent passing the No. 200 sieve and a plasticity index between 5 and 15 may also be used with prior approval from the designers. The lower plasticity index may be waived if the fill is placed in confined conditions (i.e. inside stem walls). The majority of the on-site clay may also be chemically stabilized to produce a select fill material. Typically, the addition of 3 to 4 percent of hydrated or pebble quick lime by dry unit weight is sufficient to stabilize clay soils similar to those encountered at this site. Actual application rates will need to be verified during construction.

Although the select fill options presented above provide for the necessary structural support, they may not necessarily provide a stable working surface for construction activities or inclement weather. The contractor should select the appropriate select fill materials for the anticipated construction traffic and to minimize weather delays, if necessary.

All engineered fill should be placed under controlled conditions with observation and testing by a licensed Professional Engineer or designated representative. The following minimum compaction requirements and moisture requirements based on the *Standard Proctor (ASTM D-698)* are recommended.

- | | |
|---|-----------------------------|
| • Footings, Pavement Stabilized Subbase | 98 % of Maximum Dry Density |
| • Structural Fill (Floor Slabs, Pavement) | 95 % of Maximum Dry Density |
| • Non-Structural Fill and Backfill | 90 % of Maximum Dry Density |

The following moisture ranges are recommended for various soil types:

- | | |
|---------------------------------|-----------------------------------|
| • Fat Clay, Lean Clay | Optimum Moisture Content to +4% |
| • Silts, Clayey Sand, LVC, Etc. | ± 3 % of Optimum Moisture Content |
| • Sands, Gravel | At Workable Moisture Content |



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New engineered fill should extend a minimum of 5 feet beyond any proposed building and structure footprints, and a minimum of 2 feet beyond the edges of all pavements. All fill should be placed in horizontal lifts with maximum compacted lift thickness of 6 inches (approximately 8 to 9 inches loose). Each lift should be evenly graded to provide a consistent lift thickness prior to placing additional lifts. Thinner lifts may aid compaction for energy sensitive soils (i.e. clay), or for light compaction equipment. Moisture sensitive soils (i.e. silt) may require stricter moisture control to achieve compaction. Potentially expansive clay soils should not be compacted more than 5 percent above the recommended minimum compaction requirements.

SHALLOW FOUNDATIONS

Based on the results of our exploration, we consider the subsurface conditions at the site adaptable for support of the proposed structures when constructed on a properly designed conventional shallow foundation system founded on the native clay soils.

Using the estimated maximum column and wall loads of approximately 200 kips, and 20 klf (respectively), the assumed final grade, and the existing site grades, the soils encountered at estimated bearing depth appear suitable to support the structure. A continuous spread footing foundation system used to support the interior and exterior walls should be designed for a maximum allowable net soil bearing capacity of approximately 3,000 pounds per square foot (psf). The bearing capacity recommendation is to limit settlement and provide a minimum theoretical factor of safety against shear failure of 3. Net bearing capacity is defined as the soil bearing capacity at the foundation bearing level in excess of the natural overburden pressure at that level.

The foundations should be designed based on the maximum load that could be imposed by all loading conditions. Using the loads given above, minimum footing widths of 6.0 feet for continuous spread footings, and 9.0 feet for isolated column footings are recommended to resist the estimated loads.

Provided that the previous recommendations are performed, long-term structural settlement for shallow spread footings designed and constructed as outlined above should be on the order of 1.0 inch or less. Differential settlements of up to 0.5 inches should be anticipated across the site. The estimated settlements are approximate and based on the recommended footing details and depths, and the provided loading (noted above). Additional settlement analysis may be warranted depending on final footing design.

The new construction will be attached to the existing structure. Shallow footings constructed near the existing structure should be placed at approximately the same elevation as the existing footings unless additional measures are taken to prevent undermining of the existing subgrade soils and to ensure adequate bearing pressure is maintained under the existing footings. Continuous strip footings should be founded a minimum of one footing width away from the existing footing to reduce overlap of stresses. The existing footings should be protected during construction.



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All footing excavations should be performed in a manner to avoid disturbing the soils below the bearing elevation. Hand excavation should be used to remove slough. Concrete should be placed for footings as soon as practicable after excavation to avoid drying or wetting of the exposed soils. If the bearing soils are disturbed, allowed to dry, or are wetted by rain or seepage water, remove the affected soil and extend the footings. Alternately, the over-excavated soil may be replaced with new engineered fill or gravel. All footing excavations should be observed by a qualified Professional Engineer or Engineering Technician. Over-excavation and replacement of some soft soils and/or existing fill may be required at this site.

DEEP FOUNDATIONS

Due to the proximity of the existing structures, the estimated loads, the encountered soils, and near surface groundwater levels, we recommend an auger cast-in-place (ACIP) pile deep foundation system. Auger cast-in-place piles will develop bearing capacities primarily through skin friction along the pile sides. For piles embedded a minimum of 3.0 feet into the highly weathered Shale clays encountered at and below a depth of approximately 35.0 feet below existing site grade, we recommend an average allowable skin friction value of 1.2 ksf (downward and uplift), an allowable end bearing of 18.0 ksf, and a minimum pile diameter of 16 inches be used for design.

The estimated allowable pile capacity values given above were developed based on our site investigation, the results of our laboratory analysis, and using the Allpile, version 7, software program and include a theoretical factor of safety of 3. These values recommended for design assume that the bottom of the ACIP pile will extend a minimum of 3.0 feet into the highly weathered Shale soils encountered at approximate depths of 35.0 feet below existing site grade.

Using the parameters given above, long term settlement for the ACIP foundation system is expected to be negligible (3/16 inch or less). Based on the proposed construction and the subsurface conditions encountered at the boring locations, significant down drag forces are not anticipated for this project. The design pile compressive capacity should not exceed the allowable capacity of the structural member as governed by appropriate codes.

Auger cast-in-place piles should have a minimum center to center pile spacing equal to 3 pile diameters to minimize the effects of overlapping stresses. If piles are spaced closer than 3 times the diameter, a suitable reduction value should be applied to the bearing capacity based on the actual spacing of the pile group. Once foundation designs are provided, group pile settlement values can be provided.

Installation of the piles should be performed in sequence ensuring lateral support of previously installed piles is maintained. Sufficient grout head should be maintained when raising the augers to prevent necking of the pile or creation of voids within the pile. The capacity of auger cast-in-place piles is greatly influenced by installation procedures. Auger cast-in-place pile installation should be observed by a qualified Professional Engineer or representative to monitor installation procedures. A minimum of one



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pile load test is recommended to verify the pile capacities prior to installation of production piles. At least one conventional static load test (per ASTM Standard D1143-81) should be performed at the site, to a load exceeding the computed ultimate by 50% or to a load producing displacement equal to 5% of the pile diameter, whichever comes first. The pile load test should be observed by a qualified Engineering Technician under the direction of a Professional Engineer.

It is also recommended that a testing plan be a requirement of the contract provided by the owner. The ACIP pile contractor should include a plan for constructing and performing the required tests to meet the requirements of the testing plan along with the Pile Installation Plan. The testing program should consist of pre-production static load tests, production static and/or rapid and/or dynamic load tests, and post-installation integrity tests in sufficient quantities to provide the data necessary to demonstrate that the installed piles meet the load and deflection criteria established in the project plans with an appropriate factor of safety.

FLOOR SLABS – ELEVATOR PIT FLOOR

The subsurface conditions at the pit level (approximately 15.0 to 18.0 feet below the existing site grade) consist primarily of moist, completely weathered Shale clay with a very stiff consistency.

Prior to placing select fill (LVC) or new engineered fill (if required), the subgrade should be prepared according to the Subgrade Preparation and Engineered Fill sections of this report. All utility lines entering the building should be sealed to prevent migration of surface and subsurface water and subsequent wetting of the subgrade soils. The utility lines should be sealed from the building foundation to a minimum of 3 feet outside the building foundation. The seal may consist of clay soils with a minimum plasticity index of 25 or lean concrete.

A minimum of 6 inches of clean granular fill consisting of (KDOT grading UD-1, clean gravel, or approved equivalent) is recommended below the basement floor. Boring results indicated wet soils near the assumed basement depth. Near surface groundwater was encountered at depths of approximately 36.25 feet below the existing ground surface. Based on the results of our fieldwork and depending on final design elevations, near surface groundwater may be present near the pit level. Wet soils and perched groundwater may also be experienced. Based on these conditions, the pit should be constructed with an adequate perimeter drain system and appropriate waterproofing should be used for the basement floor slab. The subgrade below the granular layer should be graded to allow water to drain to a sump pump and prevent ponded water from accumulating beneath the floor slab. An appropriate synthetic moisture barrier should also be used and installed in accordance with the manufacturer's recommendations. The exterior walls should also be constructed with an appropriate perimeter drain system and waterproof system installed per the manufacturer's recommendations. The perimeter drain system should be installed to provide positive outfall away from the structure, or should be directed to a sump pump.



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LATERAL EARTH PRESSURES

Below grade walls will be subject to lateral earth pressures. The magnitude of the lateral earth pressure is controlled by many factors including wall design, properties of the in-situ native and fill soils and backfill adjacent to the walls, drainage conditions, surcharge loads, and other factors. Significantly larger pressures will develop if backfill adjacent to the below grade or retaining walls becomes saturated. We generally recommend all below grade structures be designed and constructed using granular backfill and an appropriate drainage system. These measures are recommended to reduce the potential pressures on the below grade walls, the potential for saturation of the soils, and the possible detrimental effects due to shrink/swell of the clay soils. Significantly larger pressures will develop below the groundwater level. An active equivalent fluid pressure of 75 pounds per cubic foot (pcf) and an at-rest pressure equivalent fluid pressure of 90 pcf should be used for design of structures with a non-cohesive granular backfill that extends below the water level.

The estimated pressure coefficients and estimated equivalent fluid unit weights, based on the soils encountered during our fieldwork are shown in the following tables.

Granular Materials (Sand) (Moist Unit Weight = 115 pcf)		
	Estimated Coefficient	Estimated Equivalent Fluid Unit Weight
Active Pressure	0.30	35 pcf
At-Rest Pressure	0.47	54 pcf
Passive Pressure	3.25	374 pcf

LVC (Moist Unit Weight = 115 pcf)		
	Estimated Coefficient	Estimated Equivalent Fluid Unit Weight
Active Pressure	0.40	47 pcf
At-Rest Pressure	0.58	66 pcf
Passive Pressure	2.46	283 pcf

Fat Clay (Moist Unit Weight = 122 pcf)		
	Estimated Coefficient	Estimated Equivalent Fluid Unit Weight
Active Pressure	0.53	64 pcf
At-Rest Pressure	0.69	84 pcf
Passive Pressure	1.89	230 pcf



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The passive pressures and coefficient of friction are used to resist sliding and lateral forces. A coefficient of friction of 0.3 is recommended. The at-rest case should be used if the walls are rigid and little or no rotation is anticipated. Below grade walls should only be designed for the active case if walls are allowed to rotate sufficiently to fully mobilize active pressure.

The earth pressure parameters provided above do not include surcharge loads (i.e., structure loads, fill loads, forces from construction equipment). Appropriate safety factors and surcharge loads should be applied to these values. The parameters also do not account for hydrostatic pressures.

EXCAVATIONS

All excavations should be constructed and/or shored according to local, state, federal and OSHA requirements. Each excavation must be evaluated during construction by the responsible person to determine appropriate sloping, shoring and excavation techniques. Maximum OSHA recommended slopes for temporary excavations less than 20 feet deep with simple slopes include the following:

Stable Rock - vertical, Type A (stiff soils) - $3/4 H$ to $1 V$, Type B (medium stiff soils) - $1 H$ to $1 V$, Type C (soft soils/sands) - $1.5 H$ to $1 V$. These classifications are presented for general information only and preliminary design only. OSHA regulations should be reviewed for details regarding soil strengths, sloping/shoring requirements and other guidelines.

uplift pressures.

SEISMIC

The native soil profiles encountered at the site consist primarily of medium stiff to hard clay soils. Based on these conditions and our experience with similar projects in this area, the site should be characterized as Class D for seismic design according to the International Building Code (IBC) site classification definitions outlined in Table 1615.1.1. and in American Society of Civil Engineers (ASCE) 7.

QUALITY CONTROL TESTING

We recommend that PFS be retained to perform the construction materials testing and observations required for this project, to verify that our recommendations have been satisfied. Due to our familiarity with the project and the intent of our engineering design, we are the most qualified to efficiently address any problems that may arise during construction.

A representative number of field in-place density tests should be made in the upper 2 feet of compacted natural soils, in each lift of compacted backfill and fill, and in the upper 12 inches below the bearing levels in the footing excavations. The density tests are considered necessary to verify that satisfactory compaction operations have been performed. It is recommended that density testing be performed (1) at a minimum of 2 locations within the building area, and (2) at one location for every 5 linear feet of continuous wall footings.



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GENERAL NOTES AND LIMITATIONS

Clay soils with a moderate volume change potential are present at this site. These soils are stable at a constant moisture content, but can expand or consolidate with moisture variations. The volume change potential of soils can change erratically in both vertical and lateral extent. Moisture changes also occur erratically, resulting in conditions that cannot always be predicted.

The recommendations presented are based on experience with similar soils in this area. The builder and owner should be aware that there is a risk for construction on these soil types. Performance of the structure depends on following the design recommendations and maintenance after construction. This requires positive drainage away from the structures, and may require restricted planting and watering adjacent to the structures.

Geotechnical recommendations are based on periodic sampling in widely spaced, small diameter borings and subsurface conditions may vary from those encountered in the borings. Our scope of services was intended to evaluate the soil conditions within the zone of soil influenced by the foundation systems. Our scope of services does not address geologic conditions, such as sinkholes or soil conditions existing below the depth of the soil borings. Due to the variability, a Geotechnical Engineer should be retained for the construction monitoring to verify the subsurface conditions and make adjustments, if necessary.

The project site has areas that were previously developed. Over-excavation and replacement of existing fill and medium stiff clay soils may be required in these areas due to previous construction. Project plans and specifications should provide some contingency for over-excavation and replacement of existing fill due to previous construction.

The conclusions and recommendations presented are based on the data obtained from the borings at the locations indicated. No other warranties or guarantees are intended. The nature and extent of subsurface conditions may vary across the site. If subsurface conditions are encountered other than described in this report, the recommendations presented may need to be re-evaluated and adjusted.

PEC FIELD SERVICES: GEOTECHNICAL ENGINEERING DIVISION

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Prepared by:

Nicholas K. Steele, E.I.
Geotechnical Division Project Manager

Reviewed By:



Herbert Kent Magleby, P.E.
Senior Geotechnical Engineer

attachments

***Robert J. Dole V.A. Medical Center
Elevator Addition
Wichita, Kansas
Project Number: 74-160165-000-1324***

SITE LOCATION MAP	Figure 1
BORING LOCATION PLAN	Figure 2
SUMMARY OF EXPLORATORY BORINGS	Figure 3
EXPLORATORY BORING LOG	Figure 4
KEY TO SYMBOLS	Figure 5
SUMMARY OF LABORATORY TEST RESULTS	Figure 6
LIQUID AND PLASTIC LIMITS TEST REPORT	Figure 7
SOIL CLASSIFICATION CHART	Figure 8
GENERAL GEOTECHNICAL NOTES	Figure 9

SITE LOCATION MAP

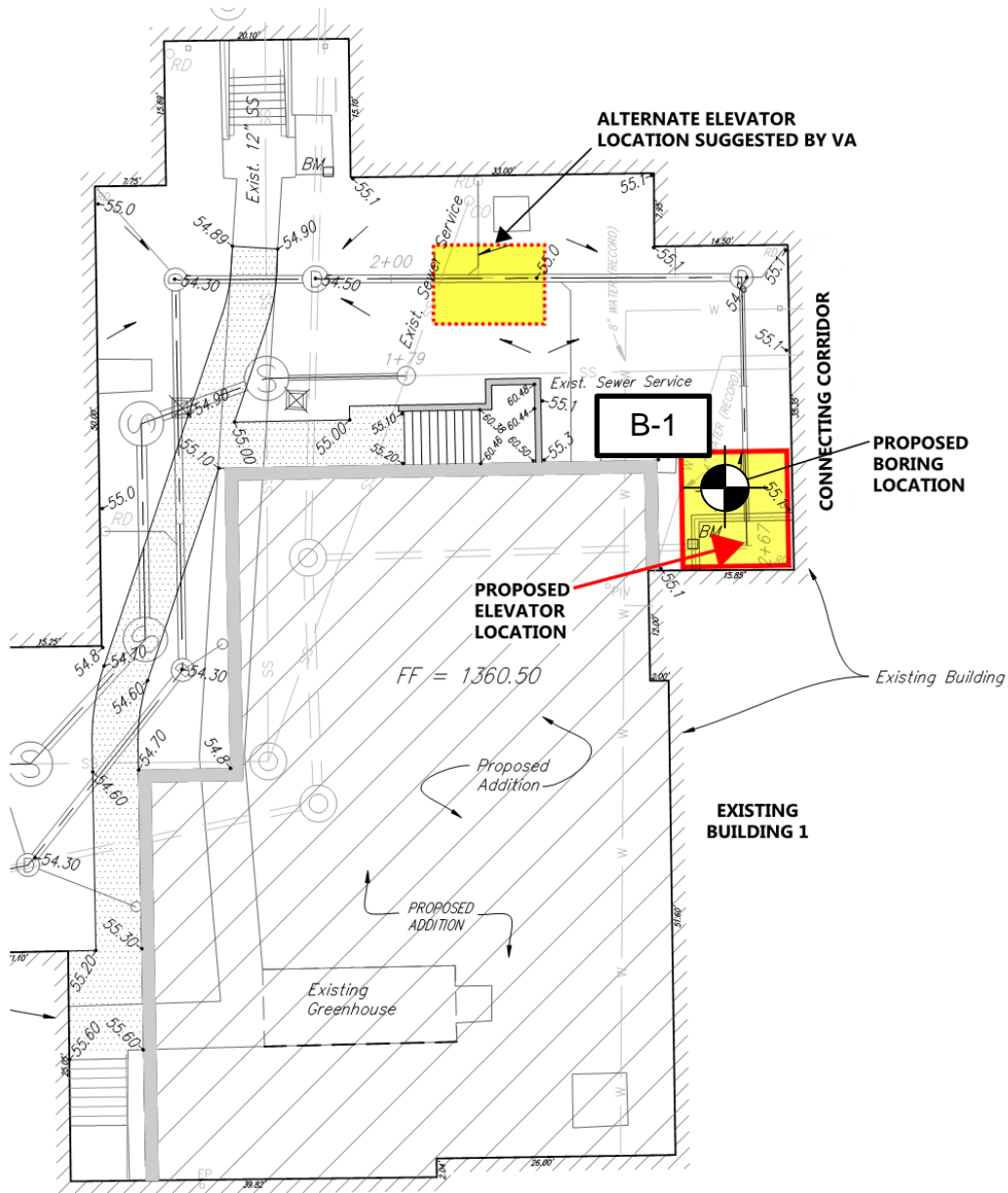
Robert J. Dole V.A. Medical Center Elevator Addition
Wichita, Kansas
Project Number: 74-160165-000-1324



Figure 1

BORING LOCATION PLAN

Robert J. Dole V.A. Medical Center Elevator Addition
Wichita, Kansas
Project Number: 74-160165-000-1324



WICHITA VA - COURTYARD NORTH OF BLDG 1

No Scale
[Scale bar]



Standard Penetration Test Boring
Approximate Location

Plan provided by client for Boring
location illustration only.

Not for Construction.

Figure 2



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SUBSURFACE DIAGRAM

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PROJECT NUMBER 74-160165-000-1324

PROJECT LOCATION Wichita, Kansas

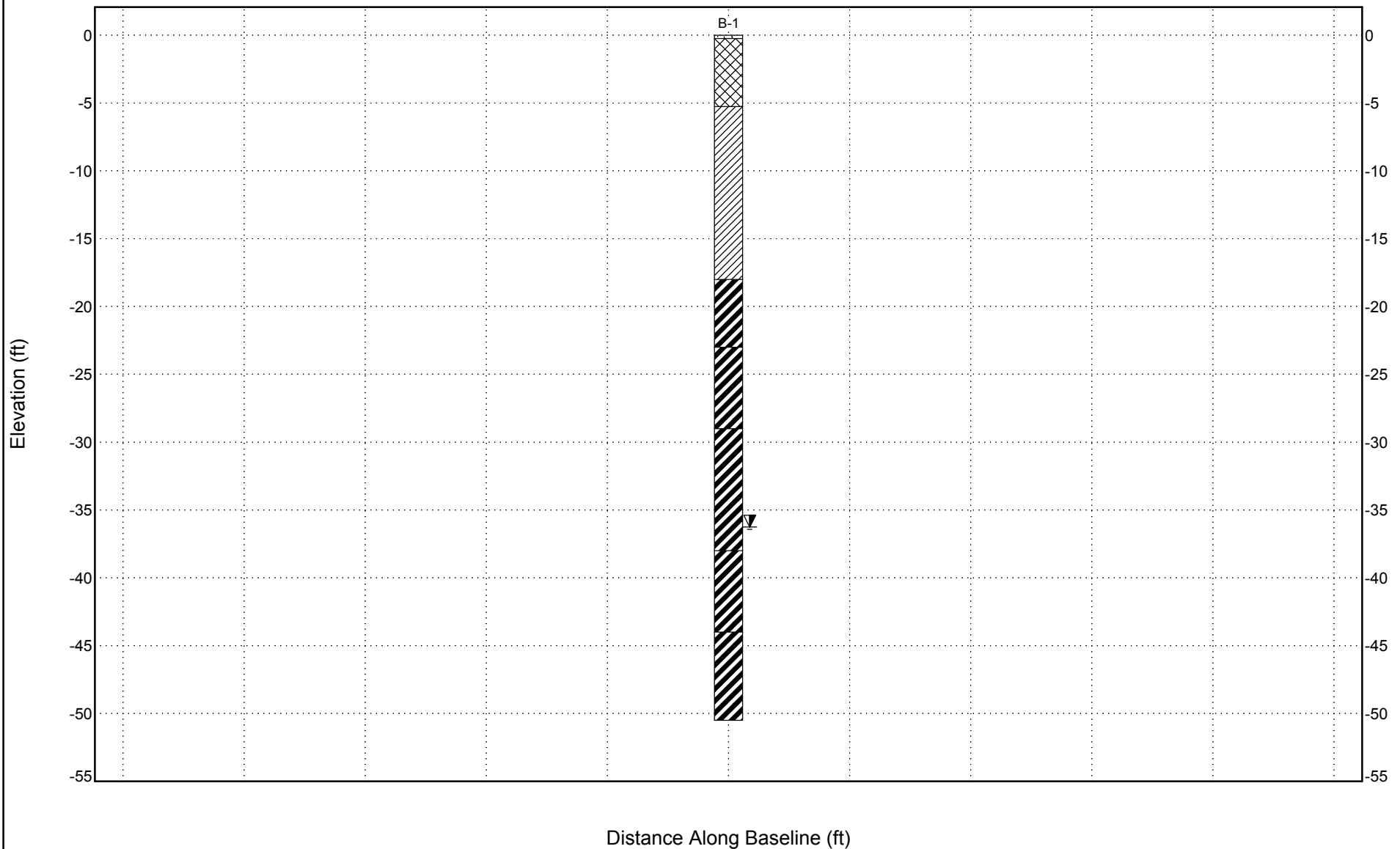


Figure 3



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BORING NUMBER B-1

PAGE 1 OF 3

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PROJECT NUMBER 74-160165-000-1324

PROJECT LOCATION Wichita, Kansas

DATE STARTED 2/16/16

COMPLETED 2/16/16

GROUND ELEVATION 0 ft

HOLE SIZE 6 inches

DRILLING CONTRACTOR PEC

GROUND WATER LEVELS:

DRILLING METHOD Flight Auger

AT TIME OF DRILLING ---

LOGGED BY N. Steele

CHECKED BY H. Magleby

AT END OF DRILLING ---

NOTES - none -

▼ AFTER DRILLING 36.25 ft / Elev -36.25 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		TOPSOIL, dark brown, many organic materials, trace fine grained sand, moist, medium stiff	SPT B1-1		3-3-3 (6)							
5		FILL (60 inches), Fat Clay, brown and dark brown mixed, yellowish brown and reddish brown seams, some brick and concrete rubble, trace construction debris, trace organic materials, moist, medium stiff										
		LEAN CLAY, completely weathered Shale, olive with yellowish brown and reddish brown seams, blocky texture, trace iron stains and nodules, some silt seams, trace calcareous seams and nodules, moist, medium stiff to very stiff	SPT B1-2		3-3-3 (6)							
10			SPT B1-3		7-10-17 (27)							
15			SPT B1-4		7-11-13 (24)		96	27	47	28	19	
20		CLAY, completely weathered Shale, olive with yellowish brown and reddish brown seams, blocky texture, trace iron stains and nodules, some silt seams, trace calcareous seams and nodules, moist, medium stiff to very stiff	SPT B1-5		11-13-15 (28)		96	28	60	27	33	

(Continued Next Page)

Figure 4



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BORING NUMBER B-1

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PROJECT NUMBER 74-160165-000-1324

PROJECT LOCATION Wichita, Kansas

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
20		CLAY, completely weathered Shale, olive with yellowish brown and reddish brown seams, blocky texture, trace iron stains and nodules, some silt seams, trace calcareous seams and nodules, moist, medium stiff to very stiff (<i>continued</i>)	SPT B1-6		11-12-21 (33)		95	23	77	25	52	
25		CLAY, highly weathered Shale, olive with yellowish brown and gray seams, Shale lenses, gypsum nodules and seams, moist, hard	SPT B1-7		8-17-15 (32)		91	33	63	35	28	
30		CLAY, highly weathered Shale, dark gray with olive and yellowish brown seams, Shale seams, gypsum seams and nodules, moist, hard	SPT B1-8		50/4"		109	20				
35			SPT B1-9		50/0"							
40		CLAY, highly weathered Shale, dark gray and gray mottled, reddish brown seams, gypsum lenses, silt seams, moist, hard	SPT B1-10		50/1"							

(Continued Next Page)

Figure 4



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BORING NUMBER B-1

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PROJECT NUMBER 74-160165-000-1324

PROJECT LOCATION Wichita, Kansas

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
45		CLAY, highly weathered Shale, dark gray and gray mottled, reddish brown seams, gypsum lenses, silt seams, moist, hard (continued)	SPT B1-11		50/0"							
		CLAY, highly weathered Shale, dark gray and gray mottled, gypsum lenses and seams, moist, hard										
50			SPT B1-12		36-50/0"							
Bottom of borehole at 50.5 feet.												

Figure 4



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KEY TO SYMBOLS

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PROJECT NUMBER 74-160165-000-1324

PROJECT LOCATION Wichita, Kansas

LITHOLOGIC SYMBOLS

(Unified Soil Classification System)



CH: USCS High Plasticity Clay



CL: USCS Low Plasticity Clay



FILL: Fill (made ground)



TOPSOIL: Topsoil

SAMPLER SYMBOLS



Standard Penetration Test

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
▽ Water Level at Time
Drilling, or as Shown
▼ Water Level at End of
Drilling, or as Shown
▽ Water Level After 24
Hours, or as Shown

Figure 5



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FIELD SERVICES

SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

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PROJECT NUMBER 74-160165-000-1324

PROJECT LOCATION Wichita, Kansas

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	15.0	47	28	19				27.2	95.9	97	0.757
B-1	17.5	60	27	33				27.6	95.9	99	0.757
B-1	20.0	77	25	52				22.9	95.4	81	0.766
B-1	25.0	63	35	28				33.3	90.7	105	0.859
B-1	30.0							19.9	109.1	98	0.545

Figure 6



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ATTERBERG LIMITS' RESULTS

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PROJECT NUMBER 74-160165-000-1324

PROJECT LOCATION Wichita, Kansas

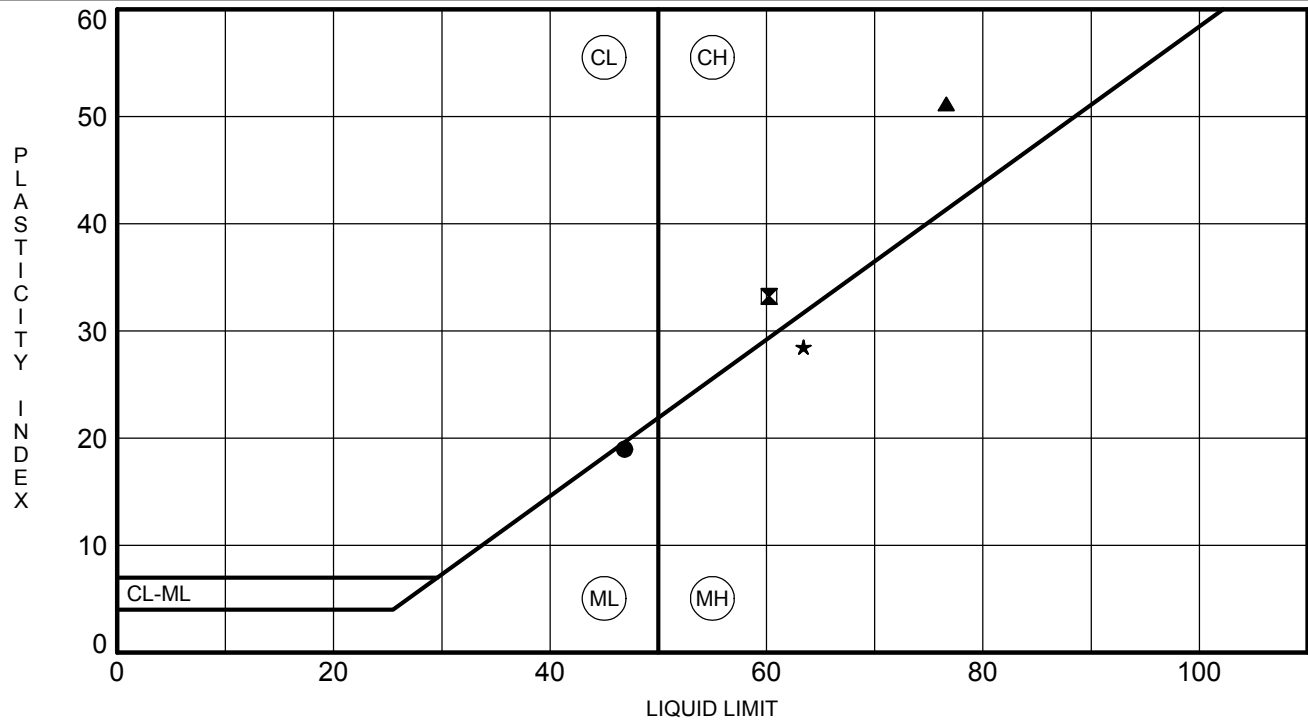
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Figure 7

SOIL CLASSIFICATION CHART

REFERENCE: ASTM D 2487

(Based on Unified Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name ^B
Coarse-Grained Soils More than 50 % retained on No. 200 sieve.	Gravels More than 50 % coarse fraction retained on No. 4 sieve.	Clean Gravels Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well graded gravel ^{C, F}
			$Cu < 4$ and/or $1 > Cc > 3$ ^E	GP	Poorly graded gravel ^{C, F}
		Gravels with fines More than 12% fines ^C	Fines Classify as ML or MH	GM	Silty gravel ^{F, G, H}
			Fines Classify as CL or CH	GC	Clayey gravel ^{F, G, H}
	Sands 50 % or more passes No. 4 sieve.	Clean Sands Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well graded sand ^{D, I}
			$Cu < 6$ and/or $1 > Cc > 3$ ^E	SP	Poorly graded sand ^{D, I}
		Sands with Fines More than 12% fines ^D	Fines Classify as ML and MH	SM	Silty sand ^{G, H, I}
			Fines Classify as CL and CH	SC	Clayey sand ^{G, H, I}
Fine Grained Soils 50 % or more passes No. 200 sieve.	Silts and Clays Liquid Limit less than 50.	Inorganic	$PI > 7$ and plots on or above "A" line ^J	CL	Lean clay ^{K, L, M}
			$PI < 4$ and plots on or below "A" line ^J	ML	Silt ^{K, L, M}
		Organic	$\frac{\text{Liquid Limit} - \text{oven dried}}{\text{Liquid Limit} - \text{not dried}} \leq 0.75$	OL	Organic clay ^{K, L, M, N}
					Organic silt ^{K, L, M}
	Silts and Clays Liquid Limit of 50 or more.	Inorganic	PI plots on or above "A" Line	CH	Fat clay ^{K, L, M}
			PI plots below "A" Line	MH	Elastic silt ^{K, L, M}
		Organic	$\frac{\text{Liquid Limit} - \text{oven dried}}{\text{Liquid Limit} - \text{not dried}} \leq 0.75$	OH	Organic clay ^{K, L, M, P}
					Organic silt ^{K, L, M, Q}
Highly organic soils	Primarily organic matter, dark in color, and organic odor			Pt	Peat

^A Based on the material passing the 3-in. (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols:

GW-GM Well graded gravel with silt.

GW-GC Well graded gravel with clay.

GP-GM Poorly graded gravel with silt.

GP-GC Poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols:

SW-SM Well graded sand with silt.

SW-SC Well graded sand with clay.

SP-SM Poorly graded sand with silt.

SP-SC Poorly graded sand with clay.

^E $C_u = D_{60}/D_{10}$; $C_c = (D_{30})^2 / (D_{10} \times D_{60})$.

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in hatched area, soil is a CL-ML silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel" to group name.

^L If soil contains $\geq 30\%$ plus No. 200, predominately sand, add "sandy" to group name.

^M If soil contains $\geq 30\%$ plus No. 4, predominately gravel, add "gravelly" to group name.

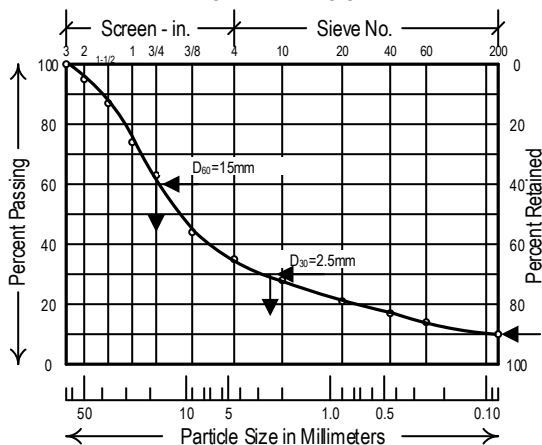
^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.

SIEVE ANALYSIS



PLASTICITY CHART

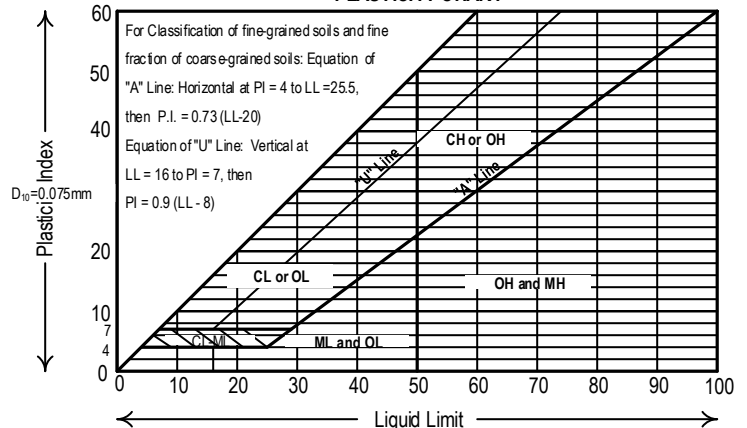


Figure 8

GENERAL GEOTECHNICAL NOTES

SOIL CLASSIFICATION TERMINOLOGY

Soil classification is based on ASTM D-2487 "Soil Classification for Engineering Purposes" which is based on the Unified Soil Classification System. Fine grained soils have less than 50 percent of their particles retained on the No. 200 sieve. These soils are classified as silts if they are non-plastic to slightly plastic and as clays if they classify as plastic. Coarse grained soils have more than 50 percent of their particles retained on the No. 200 sieve and are classified as sands, gravels, cobbles and boulders depending on the grain size. Minor and major constituents may be added as modifiers depending on the proportions of the soil types. Additionally, fine grained soils are described based on their consistency and coarse grained soils are delineated by their relative density. Examples: Fat clay with sand (CH) and Silty sand (SM).

WATER LEVEL MEASUREMENTS

Water level measurements presented on the test boring logs are for the times indicated. These measurements may not necessarily represent the actual groundwater levels at the site. Fine grained soils of low permeability may require measurements for extended periods to accurately reflect free water levels. Coarse grained soils will generally reflect true groundwater levels after short periods. Groundwater levels and seepage water can vary depending on time of year, climatic conditions and other factors beyond the scope of normal geotechnical explorations. Typical water level abbreviations follows:

WD - Water level during drilling	WA - Water level after drilling
W24 - Water level 24 hours after drilling	W48 - Water level 48 hours after drilling
CW - Depth to wet cave of boring	CD - Depth to dry cave of boring

SAMPLING AND DRILLING ABBREVIATIONS

Drilling and sampling procedures are typically performed in accordance with ASTM standards unless otherwise noted. Typical sampling and drilling abbreviations follows:

P - Standard Penetration sampler (1-3/8 in. ID split-spoon)	SB - Sawtooth bit barrel sampler
S - 3 in. diameter thin walled Shelby Tube	CF4 - 4 in. diameter continuous flight auger
D - Denison Barrel Sampler	CF6 - 6 in. diameter continuous flight auger
B - Bulk/grab sample	HS - 7-1/4 in. diameter hollow stem auger
	NX - Diamond bit coring

DENSITY OF COARSE GRAINED SOILS

CONSISTENCY OF FINE GRAINED SOILS

Relative Density (D_R)	Percent D_R	Approximate N - Value (blows/foot)	Consistency	Unconfined Compressive Strength (Q_u) psf	Approximate N - Value (blows/foot)
Very Loose	less than 15	0 to 4	Very Soft	Less than 500	0 to 2
Loose	15 to 35	4 to 10	Soft	500 to 1000	2 to 4
Medium Dense	35 to 65	10 to 30	Medium Stiff	1000 to 2000	4 to 8
Dense	65 to 85	30 to 50	Stiff	2000 to 4000	8 to 16
Very Dense	85 to 100	over 50	Very Stiff	4000 to 8000	16 to 30
			Hard	Over 8000	Over 30

BEDROCK HARDNESS DESCRIPTIONS

GRAIN SIZE DESCRIPTIONS

Hardness	Approximate N - Value (blows/foot)	Constituent Description	Particle Size
Weathered (Soft)	Less than 20	Silt or Clay Sand Gravel Cobbles Boulders	Passing No. 200 Sieve (0.075 mm)
Firm	20 to 30		No. 200 to No. 4 Sieve (0.075 to 4.75 mm)
Medium Hard	30 to 50		No. 4 to 3 inch Sieve (4.75 to 75 mm)
Hard	50 to 80		3 to 12 inch Sieve (75 to 300 mm)
Very Hard	Over 80		Over 12 inch Sieve (300 mm)
PROPORTIONING OF CONSTITUENTS			
Constituent Description	Percent		
Trace	Less than 5		
With	5 to 12		
Modifier	More than 12		

Figure 9

**SECTION 33 46 13
FOUNDATION DRAINAGE**

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies materials and procedures for construction of foundation drainage systems, including installation, backfill, and cleanout extensions, to a point of connection to storm sewer.

1.2 RELATED WORK

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTHWORK.
- B. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

1.3 DEFINITIONS

Subdrainage: Foundation drainage system that collects and removes subsurface or seepage water from building foundation from building to discharge.

1.4 ABBREVIATIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.6 COORDINATION

- A. Coordinate connection to storm sewer main, if approved, with the Public Agency responsible for the storm sewer system.
- B. Coordinate exterior utility lines and connections to foundation building drain.

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 Agency having jurisdiction over the connection to public storm sewer lines or the requirements for discharge of subsurface drainage.

1.8 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred in the text by basic designation only.

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

A48-03.....Gray Iron Castings

C14-07.....Nonreinforced Concrete Sewer, Storm Drain, and
Culvert Pipe

C33/C33M-11.....Concrete Aggregates

C443-10.....Joints for Concrete Pipe and Manholes, Using
Rubber Gaskets

C444-03(2009).....Perforated Concrete Pipe

C578-10a.....Rigid, Cellular Polystyrene Thermal Insulation

C1173-08.....Flexible Transition Couplings for Underground
Piping Systems

D448-08.....Sizes of Aggregate for Road and Bridge
Construction

D1621-10.....Standard Test Method for Compressive Properties
of Rigid Cellular Plastics

D2235-04(2011).....Solvent Cement for Acrylonitrile-Butadiene-
Styrene (ABS) Plastic Pipe and Fittings

D2321-11.....Underground Installation of Thermoplastic Pipe
for Sewers and Other Gravity-Flow Applications

D2751-05.....Acrylonitrile-Butadiene-Styrene (ABS) Sewer
Pipe and Fittings

D3034-08.....	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3350-10a.....	Polyethylene Plastic Pipe and Fittings Material
D4491-99a(2009).....	Test Methods for Water Permeability of Geotextiles by Permittivity
D4716-08.....	Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D5926-09.....	Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
D6707-06 (2011).....	Circular-Knit Geotextile for Use in Subsurface Drainage Applications
F405-05.....	Corrugated Polyethylene (PE) Pipe and Fittings
F477-10.....	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F667-06.....	Larger Diameter Corrugated Polyethylene Pipe and Fittings
F2648-10.....	2 to 60 Inch Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications

1.9 WARRANTY

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will furnish all manufacturer's and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

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

- B. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

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

2.3 PERFORATED-WALL PIPES AND FITTINGS FOR VAULTS OR MANHOLES

SPEC WRITER NOTE: Pipe materials in this Article have perforated walls and are joined with tight joints.

A. Perforated PE Pipe and Fittings:

1. Pipe shall be ASTM F405; corrugated, for coupled joints.
2. Couplings: Manufacturer's standard.

B. Perforated PVC Sewer Pipe and Fittings shall be ASTM D3034.

C. Perforated Concrete Pipe and Fittings: ASTM C444, Type 1, and applicable requirements in ASTM C14, Class 2, socket-and-spigot ends for gasketed joints.

1. Gaskets: ASTM C443, rubber.

2.4 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C1173 for joining underground non-pressure piping.

Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.

1. Sleeve Materials:

- a. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

2. Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant metal tension band and tightening mechanism on each end.

2.5 SOIL MATERIALS

A. Drainage Material

1. Bedding shall be crushed stone, 3/4 inch (20 mm) to No. 4 per ASTM D448, at a minimum or as per geotechnical recommendations.
2. Fill to 1 foot (300 mm) above pipe shall be Crushed stone, 3/4 inch (20 mm) to No. 4 per ASTM D448, at a minimum or as per geotechnical recommendations.

B. Concrete Sand shall be ASTM C33.

2.6 GEOTEXTILE FILTER FABRICS

A. Geotextile fabric shall conform to ASTM 6707. Elongation will be greater than 50 percent and the flow rate shall range from 110 to 330 gpm/sq. ft. (4480 to 13440 L/min. per sq. m).

1. Structure Type shall be woven, monofilament or multifilament.
2. Style(s) shall be Flat and sock.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS

- A. Underground Subdrainage Piping shall be:
 1. Perforated PE pipe and fittings, couplings, and coupled joints.
 2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

3.3 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape and install drainage piping.
- E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- F. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

- H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Install vertical drainage panels as follows:
1. Coordinate placement with other drainage materials.
 2. Lay perforated drainage pipe at base of footing. Do not install aggregate.
 3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
 4. Wrap bottom of panel around drainage pipe.
 5. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
 6. If additional panels are required on same row, cut away 4 inches (100 mm) of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
 7. If additional rows of panels are required, overlap lower panel with 4 inches (100 mm) of fabric.
 8. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
 9. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
- J. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.
- K. Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and

couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
 2. Lay perforated pipe with perforations down.
 3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install PE piping according to ASTM D2321.

3.5 PIPE JOINT CONSTRUCTION

- A. Join PE pipe or perforated PE pipe, and fittings with couplings for soil-tight joints according to ASTM D2321.
- B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.6 CONNECTIONS

- A. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.
- B. Where required, connect low elevations of foundation to stormwater sump pumps.

3.7 IDENTIFICATION

- A. Install PE warning tape or detectable warning tape over ferrous piping.
- B. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.8 FIELD QUALITY CONTROL

Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.9 CLEANING

Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping

and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

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