

**TECHNICAL SPECIFICATIONS**  
Volume 2 of 2

Department of Veterans Affairs  
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**WADE PARK**  
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**ENHANCE/CONSOLIDATE MENTAL HEALTH SERVICES**  
Project No. 541-16-104

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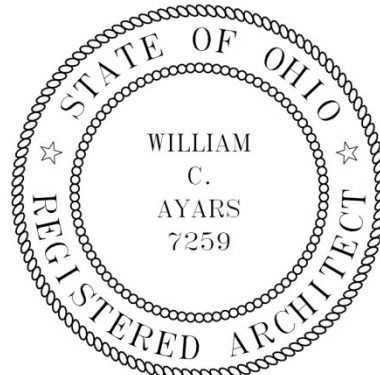
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**BID ISSUE**

**ISSUE DATE: June 17, 2016**



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Expiration Date 12/31/2017

**DEPARTMENT OF VETERANS AFFAIRS  
SPECIFICATIONS**

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Bid Issue  
June 17, 2016

VAMC WADE PARK  
Enhance/Consolidate Mental Health Services  
Project No. 541-16-104

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**SECTION 21 05 11  
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. The requirements of this Section apply to all sections of Division 21.

B. Definitions:

1. Exposed: Piping and equipment exposed to view in finished rooms.
2. Option or optional: Contractor's choice of an alternate material or method.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 07 84 00, FIRESTOPPING.
- D. Section 07 92 00, JOINT SEALANTS.
- E. Section 09 91 00, PAINTING.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.3 QUALITY ASSURANCE**

A. 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. See other specification sections for any exceptions.
2. Equipment Service: Products shall be supported by a service organization which maintains a complete inventory of repair parts and is located reasonably close to the site.
3. 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.
4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
5. 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.
6. Asbestos products or equipment or materials containing asbestos shall not be used.

B. 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.

- C. Supports for sprinkler piping shall be in conformance with NFPA 13.
- D. Supports for standpipe shall be in conformance with NFPA 14.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
  - 1. Equipment and materials identification.
  - 2. Fire-stopping materials.
  - 3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  - 4. Wall, floor, and ceiling plates.
- C. Coordination Drawings: Provide detailed layout drawings of all piping systems. In addition provide details of the following.
  - 1. Mechanical equipment rooms.
  - 2. Interstitial space.
  - 3. Hangers, inserts, supports, and bracing.
  - 4. Pipe sleeves.
  - 5. Equipment penetrations of floors, walls, ceilings, or roofs.
- D. Maintenance Data and Operating Instructions:
  - 1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  - 2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - A36/A36M-2001.....Carbon Structural Steel
  - A575-96.....Steel Bars, Carbon, Merchant Quality, M-Grades R  
(2002)



E84-2003.....Standard Test Method for Burning Characteristics  
of Building Materials

E119-2000.....Standard Test Method for Fire Tests of Building  
Construction and Materials

C. National Fire Protection Association (NFPA):

90A-96.....Installation of Air Conditioning and Ventilating  
Systems

101-2012.....Life Safety Code

**PART 2 - PRODUCTS**

**2.1 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.
- C. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- D. 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.

**2.2 FIRESTOPPING**

Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping.

**2.3 GALVANIZED REPAIR COMPOUND**

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

#### 2.4 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 this requirement must receive prior approval of COR.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms. 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.

## **2.5 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: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- D. 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.

## **2.6 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. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Coordinate location of piping, sleeves, inserts, hangers, and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced.

2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly exposed materials and equipment.
- C. Install gages, valves, and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position 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.
- D. Work in Existing Building:
1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
  2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
  3. 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 COR. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the COR for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After the COR's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
- E. Switchgear 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.
- F. 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 STARTUP AND TEMPORARY OPERATION**

Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

**3.3 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and 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 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.

**3.4 INSTRUCTIONS TO VA PERSONNEL**

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

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**SECTION 21 08 00  
COMMISSIONING OF FIRE SUPPRESSION SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 21.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIRMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

**1.2 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**1.3 SUMMARY**

- A. This Section includes requirements for commissioning the Fire Suppression systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

**1.4 DEFINITIONS**

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

**1.5 COMMISSIONED SYSTEMS**

- A. Commissioning of a system or systems specified in Division 21 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and

of Division 21, is required in cooperation with the VA and the Commissioning Agent.

- B. The Fire Suppression systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements.

#### **1.6 SUBMITTALS**

- A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

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

#### **PART 3 - EXECUTION**

##### **3.1 CONSTRUCTION INSPECTIONS**

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

##### **3.2 PRE-FUNCTIONAL CHECKLISTS**

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent

determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

### **3.3 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 21 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### **3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING**

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



**3.5 TRAINING OF VA PERSONNEL**

- A. Training of the VA operation and maintenance personnel is required in cooperation with the COR and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be scheduled in coordination with the VA COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 21 Sections for additional Contractor training requirements.

----- END -----

**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 a hydraulically calculated automatic wet-pipe system complete and ready for operation, for all portions of basement and fourth floor identified on the drawings.
- C. Modification of the existing sprinkler system as indicated on the drawings and as further required by these specifications.

**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 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING.
- E. 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. Do not restrict design area reductions permitted for using quick response sprinklers throughout by the required use of standard response sprinklers in the areas identified in this section.
  - 2. Sprinkler Protection: Sprinkler hazard classifications shall be in accordance with NFPA 13. The hazard classification examples of uses and conditions identified in the Annex of NFPA 13 shall be mandatory for areas not listed below. Request clarification from the Government for any hazard classification not identified. To determining spacing and sizing, apply the following coverage classifications:

- a. Light Hazard Occupancies: Patient care, treatment, and customary access areas.
  - b. Ordinary Hazard Group 1 Occupancies: Laboratories, Mechanical Equipment Rooms, Transformer Rooms, Electrical Switchgear Rooms, Electric Closets, and Repair Shops.
  - c. Ordinary Hazard Group 2 Occupancies: Storage rooms, trash rooms, clean and soiled linen rooms, pharmacy and associated storage, laundry, kitchens, kitchen storage areas, retail stores, retail store storage rooms, storage areas, building management storage, boiler plants, energy centers, warehouse spaces, file storage areas for the entire area of the space up to 140 square meters (1500 square feet) and Supply Processing and Distribution (SPD).
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 perform a water supply hydrant test or if available, may use the annual fire pump test data that is no older than 12 months as the water supply information. This water flow test shall record and document the following:
- a. Location \_\_\_\_\_
  - b. Elevation Static Test Gauge \_\_\_\_\_ m  
( \_\_\_\_\_ ft)
  - c. Elevation Residual Test Gauge \_\_\_\_\_ m  
( \_\_\_\_\_ ft)
  - d. Static pressure: \_\_\_\_\_ kPa ( \_\_\_\_\_ psi)
  - e. Residual pressure: \_\_\_\_\_ kPa ( \_\_\_\_\_ psi)
  - f. Flow: \_\_\_\_\_ L/s ( \_\_\_\_\_ gpm)
  - g. Date: \_\_\_\_\_ Time \_\_\_\_\_
5. Zoning:
- a. For each sprinkler zone provide a control valve, flow switch, and a test and drain assembly with pressure gauge. For buildings greater than two stories, provide a check valve at each control valve.
  - b. Sprinkler zones shall conform to the smoke barrier zones shown on the drawings.

#### 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 bind submittals in notebooks or binders and provide an index referencing the appropriate specification section. In addition to the hard copies, provide submittal items in Paragraphs 1.4(A)1 through 1.4(A)5 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 fire sprinkler and 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 1:100 (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. Valve Charts: Provide a valve chart that identifies the location of each control valve. Coordinate nomenclature and identification of control valves with COR. Where existing nomenclature does not exist, the chart shall include no less than the following: Tag ID No., Valve Size, Service (control valve, main drain, aux. drain, inspectors test valve, etc.), and Location.
6. 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 step-by-step procedures required for system startup, operation, shutdown, and routine maintenance and testing. The manuals shall 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, simplified wiring and controls diagrams, troubleshooting guide, 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 Ohio fire sprinkler 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):**
  - 13-13.....Installation of Sprinkler Systems
  - 25-14.....Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
  - 101-15.....Life Safety Code
  - 170-15.....Fire Safety Symbols
- 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 private underground water mains shall be in accordance with NFPA 13.
  - 1. Pipe and fittings from inside face of building 300 mm (12 in.) above finished floor to a distance of approximately 1500 mm (5 ft.) outside building: Ductile Iron, flanged fittings and 316 stainless steel bolting.
- B. 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 50 mm (2 inches) and smaller shall be black steel Schedule 40 with threaded end connections.
  - 3. Piping sizes 65 mm (2 ½ inches) and larger shall be black steel Schedule 10 with grooved connections. Grooves in Schedule 10 piping shall be rolled grooved only.
  - 4. Use nonferrous piping in MRI Scanning Rooms.
  - 5. Plastic piping shall not be permitted.
  - 6. 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 VALVES**

- A. General:
  - 1. Valves shall be in accordance with NFPA 13.
  - 2. Do not use quarter turn ball valves for 50 mm (2 inch) or larger drain valves.
- B. Control Valve: The control valves shall be a listed indicating type. Control valves shall be UL Listed or FM Approved for fire protection installations. System control valve shall be rated for normal system pressure but in no case less than 175 PSI.
- C. Check Valve: Shall be of the swing type with a flanged cast iron body and flanged inspection plate.
- D. Automatic Ball Drips: Cast brass 20 mm (3/4 inch) in-line automatic ball drip with both ends threaded with iron pipe threads.

### **2.3 SPRINKLERS**

- A. All sprinklers shall be FM approved quick response except "institutional" type sprinklers shall be permitted to be UL Listed quick response. "Institutional" type sprinklers in Mental Health and Behavior Units shall be UL listed or FM approved quick response type. Maximum break away strength shall be certified by the manufacturer to be no more than 39 kPa (85 pounds).
- B. Temperature Ratings: In accordance with NFPA 13 except that sprinklers in elevator shafts and elevator machine rooms shall be no less than intermediate temperature rated and sprinklers in generator rooms shall be no less than high temperature rated.
- C. Provide sprinkler guards in accordance with NFPA 13 and when the elevation of the sprinkler head is less than 7 feet 6 inches above finished floor. The sprinkler guard shall be UL listed or FM approved for use with the corresponding sprinkler.

### **2.4 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 adjacent to the riser.
- 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.

### **2.5 SPRINKLER SYSTEM SIGNAGE**

Rigid plastic, steel or aluminum signs with white lettering on a red background with holes for easy attachment. Sprinkler system signage shall be attached to the valve or piping with chain.

### **2.6 SWITCHES:**

- A. OS&Y Valve Supervisory Switches shall be in a weatherproof die cast/red baked enamel, oil resistant, aluminum housing with tamper resistant screws, 13 mm (1/2 inch) conduit entrance and necessary facilities for



attachment to the valves. Provide two SPDT switches rated at 2.5 amps at 24 VDC.

- B. Water flow Alarm Switches: Mechanical, non-coded, non-accumulative retard and adjustable from 0 to 60 seconds minimum. Set flow switches at an initial setting between 20 and 30 seconds. Activation of the flow switch shall cause an alarm on the fire alarm system control unit.
- C. Alarm Pressure Switches: Activation by any flow of water equal to or in excess of the discharge from one sprinkler. The alarm pressure switch shall be UL Listed or Factory Mutual Approved for the application in which it is used. Activation of the alarm pressure switch shall cause an alarm on the fire alarm system control unit.
- D. Valve Supervisory Switches for Ball and Butterfly Valves: May be integral with the valve.

## **2.7 GAUGES**

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

## **2.8 PIPE HANGERS, SUPPORTS AND RESTRAINT OF SYSTEM PIPING**

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

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

Provide chrome plated steel escutcheon plates.

## **2.10 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, brass chain, or nylon twist tie.

## **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. Concealed piping in spaces that have finished

ceilings. Where ceiling mounted equipment exists, such as in operating and radiology rooms, install sprinklers so as not to obstruct the movement or operation of the equipment. Sidewall heads may need to be utilized. In stairways, locate piping as near to the ceiling as possible to prevent tampering by unauthorized personnel and to provide a minimum headroom clearance of 2250 mm (seven feet six inches). 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. 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. Supervisory Switches: Provide supervisory switches for sprinkler control valves.
- F. Waterflow Alarm Switches: Install waterflow alarm switches and valves in stairwells or other easily accessible locations.
- G. Inspector's Test Connection: Install and supply in accordance with NFPA 13, locate in a secured area, and discharge to the exterior of the building.
- H. Affix cutout disks, which are created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections to the respective waterflow switch or pipe connection near to the pipe from where they were cut.
- I. Provide escutcheon plates for exposed piping passing through walls, floors or ceilings.
- J. Clearances: For systems requiring seismic protection, piping that passes through floors or walls shall have penetrations sized 50 mm (2 inches) nominally larger than the penetrating pipe for pipe sizes 25 mm (1 inch) to 90 mm (3 ½ inches) and 100 mm (4 inches) nominally larger for penetrating pipe sizes 100 mm (4 inches) and larger.

- K. 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.
- L. Provide pressure gauges at each water flow alarm switch location and at each main drain connection.
- M. For each fire department connection, provide the symbolic sign given in NFPA 170 and locate 2400 to 3000 mm (8 to 10 feet) above each connection location. Size the sign to 450 by 450 mm (18 by 18 inches) with the symbol being at least 350 by 350 mm (14 by 14 inches).
- N. Firestopping shall be provided for all penetrations of fire resistance rated construction. Firestopping shall comply with Section 07 84 00, FIRESTOPPING.
- O. Painting of Pipe: In finished areas where walls and ceilings have been painted, paint primed surfaces with two coats of paint to match adjacent surfaces, except paint valves and operating accessories with two coats of gloss red enamel. 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.
- P. 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 control valve, drain valve, sprinkler cabinet, and inspector's test.
    - b. Provide valve tags for each operable valve. Coordinate nomenclature and identification of operable valves with COR. Where existing nomenclature does not exist, the Tag Identification shall include no less than the following: (FP-B-F/SZ-#) Fire Protection, Building Number, Floor Number/Smoke Zone (if applicable), and Valve Number. (E.g., FP-500-1E-001) Fire Protection, Building 500, First Floor East, Number 001.)

2. Instruction/Information Signs:

- a. Provide signage for each control valve to indicate valve function and to indicate what system is being controlled.
- b. Provide signage indicating the number and location of low point drains.

3. Hydraulic Placards:

- a. Provide signage indicating hydraulic design information. The placard shall include location of the design area, discharge densities, required flow and residual pressure at the base of riser, occupancy classification, hose stream allowance, flow test information, and installing contractor. Locate hydraulic placard information signs at each alarm check valve.

Q. 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.

R. Interruption of Service: There shall be no interruption of the existing sprinkler protection, water, electric, or fire alarm services without prior permission of the Contracting Officer. 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, including the fire department connections, as specified in NFPA 13, in the presence of the Contracting Officers Representative (COR) or his designated representative. Test and flush underground water line prior to performing these hydrostatic tests.

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

**3.3 INSTRUCTIONS**

Furnish the services of a competent instructor for not less than two hours for instructing personnel in the operation and maintenance of the system, on the dates requested by the COR.

- - - E N D - - -

**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. AISI: American Iron and Steel Institute
  - 3. AWG: American Wire Gauge
  - 4. BACnet: Building Automation and Control Network
  - 5. BSG: Borosilicate Glass Pipe
  - 6. CDA: Copper Development Association
  - 7. CO: Carbon Monoxide
  - 8. COR: Contracting Officer's Representative
  - 9. CPVC: Chlorinated Polyvinyl Chloride
  - 10. CR: Chloroprene
  - 11. CWP: Cold Working Pressure
  - 12. db(A): Decibels (A weighted)
  - 13. DDC: Direct Digital Control
  - 14. DISS: Diameter Index Safety System
  - 15. DWV: Drainage, Waste and Vent
  - 16. ECC: Engineering Control Center
  - 17. EPDM: Ethylene Propylene Diene Monomer
  - 18. EPT: Ethylene Propylene Terpolymer
  - 19. ETO: Ethylene Oxide
  - 20. FAR: Federal Acquisition Regulations
  - 21. FD: Floor Drain
  - 22. FG: Fiberglass
  - 23. FNPT: Female National Pipe Thread
  - 24. FPM: Fluoroelastomer Polymer
  - 25. HDPE: High Density Polyethylene
  - 26. HOA: Hands-Off-Automatic
  - 27. HP: Horsepower
  - 28. ID: Inside Diameter
  - 29. MAWP: Maximum Allowable Working Pressure

- 30. NPTF: National Pipe Thread Female
- 31. NPS: Nominal Pipe Size
- 32. NPT: National Pipe Thread
- 33. OD: Outside Diameter
- 34. OSD: Open Sight Drain
- 35. OS&Y: Outside Stem and Yoke
- 36. PP: Polypropylene
- 37. PTFE: Polytetrafluoroethylene
- 38. PVC: Polyvinyl Chloride
- 39. PVDF: Polyvinylidene Fluoride
- 40. RTRP: Reinforced Thermosetting Resin Pipe
- 41. SPS: Sterile Processing Services
- 42. SUS: Saybolt Universal Second
- 43. SWP: Steam Working Pressure
- 44. TFE: Tetrafluoroethylene
- 45. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 46. THWN: Thermoplastic Heat & Water Resistant Nylon Coated Wire
- 47. USDA: U.S. Department of Agriculture
- 48. VAC: Voltage in Alternating Current
- 49. WOG: Water, Oil, Gas

## 1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- D. Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 03 30 53, SHORT FORM CAST-IN-PLACE CONCRETE.
- G. Section 07 84 00, FIRESTOPPING.
- H. Section 07 92 00, JOINT SEALANTS.
- I. Section 09 91 00, PAINTING.
- J. Section 22 07 11, PLUMBING INSULATION.
- K. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- M. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- N. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- O. Section 26 29 11, MOTOR CONTROLLERS.

**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



- 70-2011.....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. Installing Contractor shall provide lists of previous installations for selected items of equipment. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.
- G. 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. Coordination Drawings: Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8 inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, controls, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment or piping layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.
1. Mechanical equipment rooms.
  2. Interstitial space.
  3. Hangers, inserts, supports, and bracing.
  4. Pipe sleeves.
  5. Equipment penetrations of floors, walls, ceilings, or roofs.
- J. 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.

2. Include listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

#### **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.
  9. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- 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. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved by VA.
4. Installer Qualifications: Installer shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity. Provide tradesmen skilled in the appropriate trade.
5. 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. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC). All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

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

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

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
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.

- 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 on Auto-Cad version 2012 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

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

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372.
- B. In-line devices such as water meters, building valves, check valves, stops, valves, fittings, tanks and backflow preventers shall comply with NSF 61 and NSF 372.
- C. End point devices such as drinking fountains, lavatory faucets, kitchen and bar faucets, ice makers supply stops, and end-point control valves used to dispense drinking water must meet requirements of NSF 61 and NSF 372.

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

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
  - 1. All components of an assembled unit need not be products of same manufacturer.

2. Constituent parts that are alike shall be products of a single manufacturer.
  3. Components shall be compatible with each other and with the total assembly for intended service.
  4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly at no additional cost or time to the Government.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, shall be the same make and model.

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

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

### **2.4 SAFETY GUARDS**

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

### **2.5 LIFTING ATTACHMENTS**

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



## 2.6 ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING

- A. All material and equipment furnished and installation methods used shall conform to the requirements of Section 26 29 11, MOTOR CONTROLLERS; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. All electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.
- B. Special Requirements:
1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 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. Other wiring at boilers and water heaters, and to control panels, shall be NFPA 70 designation THWN.
    - c. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.
  4. Motor sizes shall be selected so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
  5. Motors utilized with variable frequency drives shall be rated "inverter-ready" per NEMA Standard, MG1.
- C. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency or Premium Efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient". Motors not specified as "high efficiency or premium

efficiency" shall comply with the requirements of the Energy Policy and Conservation Act.

- D. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal pumps may be split phase or permanent split capacitor (PSC).
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. A time delay (20 seconds minimum) relay shall be provided for switching from high to low speed.
- F. Rating: Rating shall be continuous duty at 100 percent capacity in an ambient temperature of 40° C (104° F); minimum horsepower as shown on drawings; maximum horsepower in normal operation shall not exceed nameplate rating without service factor.
- G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

## **2.7 VARIABLE SPEED MOTOR CONTROLLERS**

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

## **2.8 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Coordinate equipment and valve identification with facility maintenance staff. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. 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. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 7 mm (3/16 inch) high riveted or bolted to the equipment.
- D. 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.
- E. 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.

## **2.9 FIRESTOPPING**

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

## **2.10 GALVANIZED REPAIR COMPOUND**

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

## 2.11 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC). Submittals based on the International Building Code (IBC) requirements, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in the state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the COR in all cases. See the above specifications for lateral force design requirements.
- B. Type Numbers Specified: For materials, design, manufacture, selection, application, and installation refer to MSS SP-58.
- C. For Attachment to Concrete Construction:
1. Concrete insert: Type 18, MSS SP-58.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
  3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- D. For Attachment to Steel Construction: MSS SP-58.
1. Welded attachment: Type 22.
  2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- E. Attachment to Metal Pan or Deck: As required for materials specified in Section 05 31 00, STEEL DECKING.
- F. For Attachment to Wood Construction: Wood screws or lag bolts.
- G. Hanger Rods: Hot-rolled steel, ASTM A36/A36M or ASTM A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 40 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 43 mm by 43 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 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.

I. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 11, PLUMBING INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.

1. General Types (MSS SP-58):

- a. Standard clevis hanger: Type 1; provide locknut.
- b. Riser clamps: Type 8.
- c. Wall brackets: Types 31, 32 or 33.
- d. Roller supports: Type 41, 43, 44 and 46.
- e. Saddle support: Type 36, 37 or 38.
- f. Turnbuckle: Types 13 or 15.
- g. U-bolt clamp: Type 24.
- h. Copper Tube:

- 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, copper-coated, plastic coated or taped with isolation tape to prevent electrolysis.
- 2) For vertical runs use epoxy painted, copper-coated or plastic coated riser clamps.
- 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
- 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.

i. Spring hangers are required on all plumbing system pumps one horsepower and greater.

2. Plumbing Piping (Other Than General Types):

- a. Horizontal piping: Type 1, 5, 7, 9, and 10.
- b. Chrome plated piping: Chrome plated supports.
- c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.

- d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.
- J. Pre-insulated Calcium Silicate Shields:
1. Provide 360 degree water resistant high density 965 kPa (140 psig) compressive strength calcium silicate shields encased in galvanized metal.
  2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  3. Shield thickness shall match the pipe insulation.
  4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting cold water shall have insulation that extends a minimum of 25 mm (1 inch) past the sheet metal.
    - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS SP-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.

#### **2.12 PIPE PENETRATIONS**

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all firestopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
  1. For sleeves: Extend sleeve 50 mm (2 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.
- K. Pipe passing through roof shall be installed through a 4.9 kg per square meter copper flashing with an integral skirt or flange. Skirt or flange shall extend not less than 200 mm (8 inches) from the pipe and set in a solid coating of bituminous cement. Extend flashing a minimum of 250 mm (10 inches) up the pipe. Pipe passing through a waterproofing membrane shall be provided with a clamping flange. The annular space between the sleeve and pipe shall be sealed watertight.

### **2.13 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the COR, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

- C. Tool Containers: metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- D. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application. Bio-based materials shall be utilized when possible.

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

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

#### **2.15 ASBESTOS**

- A. Materials containing asbestos are 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. Interconnection of Pneumatic Instrumentation and Controls: Generally, pneumatic interconnections are not shown but must be provided.
- H. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- I. 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.

- J. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psig) minimum, specified in Section 03 30 53, MISCELLANEOUS CAST-IN-PLACE CONCRETE, shall be used for all pad or floor mounted equipment.
- K. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- L. Interconnection of Electrical Instrumentation and Controls: 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.
- M. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and Section 23 09 23, DIRECT DIGITAL CONTROL SYSTEM FOR HVAC.
- N. Work in Existing Building:
  - 1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
  - 2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will cause the least interfere with normal operation of the facility.
- O. Work in Animal Research Areas: Seal all pipe penetrations with silicone sealant to prevent entrance of insects.
- P. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.
- Q. 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.
- R. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance,

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

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

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

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- 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 shall apply.
- C. Temporary facilities and piping shall be completely removed back to the nearest active distribution branch or main pipe line and any openings in structures sealed. Dead legs are not allowed in potable water systems. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

### **3.3 RIGGING**

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

rigging purposes and support of equipment on structures shall be Contractor's full responsibility.

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

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

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the COR.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work shall be provided.
- D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC) and these specifications.
- E. Overhead Supports:
  - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
  - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
  - 3. Tubing and capillary systems shall be supported in channel troughs.
- F. Floor Supports:
  - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.

2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.

### **3.5 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of 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.

### **3.6 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 per Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All valves including gate, globe, ball, butterfly and check, all pressure 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.

### **3.7 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.

- B. In addition, the following special conditions apply:
1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
  2. The following Material and Equipment shall NOT be painted:
    - a. Motors, controllers, control switches, and safety switches.
    - b. Control and interlock devices.
    - c. Regulators.
    - d. Pressure reducing valves.
    - e. Control valves and thermostatic elements.
    - f. Lubrication devices and grease fittings.
    - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
    - h. Valve stems and rotating shafts.
    - i. Pressure 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.

### **3.8 IDENTIFICATION SIGNS**

- A. Laminated plastic signs, with engraved lettering not less than 7 mm (3/16 inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, and performance data shall be placed on factory built equipment.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

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

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

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

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

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

- A. All new and temporary equipment and all elements of each assembly shall be included.



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

### **3.12 COMMISSIONING**

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

### **3.13 DEMONSTRATION AND TRAINING**

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

- - - E N D - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- C. Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.
- D. 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. American Society of Mechanical Engineers (ASME):
  - B40.100-2013.....Pressure Gauges and Gauge Attachments
  - B40.200-2008.....Thermometers, Direct Reading and Remote Reading
- C. American Water Works Association (AWWA):
  - C700-2009.....Standard for Cold Water Meters, Displacement Type, Bronze Main Case
  - C701-2012.....Cold Water Meters-Turbine Type, for Customer Service
  - C702-2010.....Cold Water Meters - Compound Type
  - C706-2010.....Direct-Reading, Remote-Registration Systems for Cold-Water Meters
- D. Institute of Electrical and Electronics Engineers (IEEE):
  - C2-2012.....National Electrical Safety Code (NESC)
- E. International Code Council (ICC):
  - IPC-2012.....International Plumbing Code

- F. National Fire Protection Association (NFPA):  
70-2011.....National Electrical Code (NEC)
- G. NSF International (NSF):  
61-2012.....Drinking Water System Components - Health  
Effects  
372-2011.....Drinking Water System Components - Lead Content

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 19, METERS AND GAGES FOR PLUMBING PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Water Meter.
  - 2. Pressure Gages.
  - 3. Thermometers.
  - 4. Product certificates for each type of meter and gage.
  - 5. BACnet communication protocol.
- D. Operations and Maintenance manual shall include:
  - 1. System Description.
  - 2. Major assembly block diagrams.
  - 3. Troubleshooting and preventive maintenance guidelines.
  - 4. Spare parts information.
- E. Shop Drawings shall include the following: One line, wiring and terminal diagrams including terminals identified, protocol or communication modules, and Ethernet connections.

**1.5 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit copies of complete operation and maintenance data updated to include submittal review comments, substitutions and construction

revisions shall be inserted into a three ring binder per the requirements of Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. 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. 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 PRESSURE GAGES FOR WATER AND SEWAGE USAGE**

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

### **2.2 THERMOMETERS**

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

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

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

**3.2 FIELD QUALITY CONTROL**

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

**3.3 TRAINING**

- A. A training course shall be provided to the medical center on meter configuration and maintenance. Training manuals shall be supplied for all attendees with four additional copies supplied. The training course shall cover meter configuration, troubleshooting, and diagnostic procedures.

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

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

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):  
A112.14.1-2003.....Backwater Valves
- C. American Society of Sanitary Engineering (ASSE):  
1001-2008.....Performance Requirements for Atmospheric Type  
Vacuum Breakers  
1003-2009.....Performance Requirements for Water Pressure  
Reducing Valves for Domestic Water Distribution  
Systems  
1011-2004.....Performance Requirements for Hose Connection  
Vacuum Breakers  
1013-2011.....Performance Requirements for Reduced Pressure  
Principle Backflow Preventers and Reduced  
Pressure Principle Fire Protection Backflow  
Preventers

- 1015-2011.....Performance Requirements for Double Check  
Backflow Prevention Assemblies and Double Check  
Fire Protection Backflow Prevention Assemblies
- 1017-2009.....Performance Requirements for Temperature  
Actuated Mixing Valves for Hot Water  
Distribution Systems
- 1020-2004.....Performance Requirements for Pressure Vacuum  
Breaker Assembly
- 1035-2008.....Performance Requirements for Laboratory Faucet  
Backflow Preventers
- 1069-2005.....Performance Requirements for Automatic  
Temperature Control Mixing Valves
- 1070-2004.....Performance Requirements for Water Temperature  
Limiting Devices
- 1071-2012.....Performance Requirements for Temperature  
Actuated Mixing Valves for Plumbed Emergency  
Equipment
- D. American Society for Testing and Materials (ASTM):
  - A126-2004(R2009).....Standard Specification for Gray Iron Castings  
for Valves, Flanges, and Pipe Fittings
  - A276-2013a.....Standard Specification for Stainless Steel Bars  
and Shapes
  - A536-1984(R2009).....Standard Specification for Ductile Iron  
Castings
  - B62-2009.....Standard Specification for Composition Bronze  
or Ounce Metal Castings
  - B584-2013.....Standard Specification for Copper Alloy Sand  
Castings for General Applications
- E. International Code Council (ICC):
  - IPC-2012.....International Plumbing Code
- F. Manufacturers Standardization Society of the Valve and Fittings  
Industry, Inc. (MSS):
  - SP-25-2008.....Standard Marking Systems for Valves, Fittings,  
Flanges and Unions
  - SP-67-2011.....Butterfly Valves
  - SP-70-2011.....Gray Iron Gate Valves, Flanged and Threaded  
Ends

- SP-71-2011.....Gray Iron Swing Check Valves, Flanged and Threaded Ends
- SP-80-2013.....Bronze Gate, Globe, Angle, and Check Valves
- SP-85-2011.....Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
- SP-110-2010.....Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- G. National Environmental Balancing Bureau (NEBB):  
7th Edition 2005                   Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- H. NSF International (NSF):  
61-2012.....Drinking Water System Components - Health Effects  
372-2011.....Drinking Water System Components - Lead Content
- I. University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USC FCCCHR):  
9th Edition.....Manual of Cross-Connection Control

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Ball Valves.
  - 2. Gate Valves.
  - 3. Butterfly Valves.
  - 4. Balancing Valves.
  - 5. Check Valves.
  - 6. Globe Valves.
  - 7. Water Pressure Reducing Valves and Connections.
  - 8. Backflow Preventers.



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

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

- A. Valves shall be prepared for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set angle, gate, and globe valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Valves shall be prepared for storage as follows:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature.
- C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

## **PART 2 - PRODUCTS**

### **2.1 VALVES, GENERAL**

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

### **2.2 SHUT-OFF VALVES**

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

3. 100 mm DN100 (4 inches) and larger:
  - a. Class 125, OS&Y, Cast Iron Gate Valve. The gate valve shall meet MSS SP-70 type I standard. The gate valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall meet ASTM A126, grey iron with bolted bonnet, flanged ends, bronze trim, and positive-seal resilient solid wedge disc. The gate valve shall be gear operated for sizes under 200 mm or DN200 (8 inches) and crank operated for sizes 200 mm or DN200 (8 inches) and above.
  - b. Single flange, ductile iron butterfly valves: The single flanged butterfly valve shall meet the MSS SP-67 standard. The butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The butterfly valve shall be lug type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange. The body material shall comply with ASTM A536 ductile iron. The seat shall be EPDM with stainless steel disc and stem.
  - c. Grooved end, ductile iron butterfly valves. The grooved butterfly valve shall meet the MSS SP-67 standard. The grooved butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall be epoxy coated ductile iron conforming to ASTM A536 with two piece stainless steel stem, EPDM encapsulated ductile iron disc, and EPDM seal. The butterfly valve shall be gear operated.

### 2.3 BALANCING VALVES

- A. Hot Water Re-circulating, 75 mm or DN75 (3 inches) and smaller manual balancing valve shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read out ports shall be fitting with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (1/4 inch NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to set point without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.
- B. Larger than 75 mm or DN75 (3 inches): Manual balancing valves shall be of heavy duty cast iron flanged construction with 861 kPa (125 psig)

flange connections. The flanged manual balancing valves shall have either a brass ball with glass and carbon filled TFE seal rings or fitted with a bronze seat, replaceable bronze disc with EPDM seal insert and stainless steel stem. The design pressure shall be 1200 kPa (175 psig) at 121 degrees C (250 degrees F).

#### **2.4 CHECK VALVES**

- A. 75 mm or DN75 (3 inches) and smaller shall be Class 125, bronze swing check valves with non-metallic disc suitable for type of service. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B62, solder joints, and PTFE or TFE disc.
- B. 100 mm or DN100 (4 inches) and larger:
  - 1. Check valves shall be Class 125, iron swing check valve with lever and weight closure control. The check valve shall meet MSS SP-71 Type I standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a clear or full waterway body design with gray iron body material conforming to ASTM A126, bolted bonnet, flanged ends, bronze trim.
  - 2. All check valves on the discharge side of submersible sump pumps shall have factory installed exterior level and weight with sufficient weight to prevent the check valve from hammering against the seat when the sump pump stops.

#### **2.5 GLOBE VALVES**

- A. 75 mm or DN75 (3 inches) or smaller: Class 150, bronze globe valve with non-metallic disc. The globe valve shall meet MSS SP-80, Type 2 standard. The globe valve shall have a CWP rating of 2070 kPa (300 psig). The valve material shall be bronze with integral seal and union ring bonnet conforming to ASTM B62 with solder ends, copper-silicon bronze stem, PTFE or TFE disc, and malleable iron hand wheel.
- B. Larger than 75 mm or DN75 (3 inches): Similar to above, except with cast iron body and bronze trim, Class 125, iron globe valve. The globe valve shall meet MSS SP-85, Type 1 standard. The globe valve shall have a CWP rating of 1380 kPa (200 psig). The valve material shall be gray

iron with bolted bonnet conforming to ASTM A126 with flanged ends, bronze trim, and malleable iron handwheel.

## **2.6 WATER PRESSURE REDUCING VALVE AND CONNECTIONS**

- A. 75 mm or DN75 (3 inches) or smaller: The pressure reducing valve shall consist of a bronze body and bell housing, a separate access cover for the plunger, and a bolt to adjust the downstream pressure. The pressure reducing valve shall meet ASSE 1003. The bronze bell housing and access cap shall be threaded to the body and shall not require the use of ferrous screws. The assembly shall be of the balanced piston design and shall reduce pressure in both flow and no flow conditions. The assembly shall be accessible for maintenance without having to remove the body from the line.
- B. 100 mm or DN100 (4 inches) and larger: The pressure reducing valve shall consist of a flanged cast iron body and rated to 1380 kPa (200 psig). The valve shall have a large elastomer diaphragm for sensitive response. The pressure reducing valve shall meet ASSE 1003.
- C. The regulator shall have a tap for pressure gauge.
- D. The regulator shall have a temperature rating of 100 degrees C (212 degrees F) for hot water or hot water return service. Pressure regulators shall have accurate pressure regulation to 6.9 kPa (+/- 1 psig).
- E. Setting: Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the drawings.
- F. Connections Valves and Strainers: Shut off valves shall be installed on each side of reducing valve and a bypass line equal in size to the regulator inlet pipe shall be installed with a normally closed globe valve. A strainer shall be installed on inlet side of, and same size as pressure reducing valve. A pressure gage shall be installed on the inlet and outlet of the valve.

## **2.7 BACKFLOW PREVENTERS**

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCC).

- B. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y positive-seal resilient gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be the thermoplastic type suited for water service. The stem shall be stainless steel conforming to ASTM A276. The seat disc shall be the elastomer type suited for water service. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet. Reduced pressure backflow preventers shall be installed in the following applications.
1. Water make up to heating systems and similar equipment consuming water.
  2. Medical equipment.
  3. Process equipment.
- C. The pipe applied or integral atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be cast bronze. The seat disc shall be the elastomer type suited for water service. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable. Atmospheric vacuum breakers shall be installed in the following applications.
1. Hose bibs and sinks with threaded outlets.
  2. Showers.
  3. Service sinks (integral with faucet only).
  4. Laundry tubs (integral with faucet only).
- D. The hose connection vacuum breaker shall be ASSE listed 1011. The main body shall be cast brass with stainless steel working parts. The diaphragm and disc shall be the elastomer type suited for water service. The device shall permit the attachment of portable hoses to hose thread outlets. Hose connection vacuum breakers shall be installed in the following locations requiring non-continuous pressure:
1. Hose bibbs and wall hydrants.
- E. The pressure vacuum breaker shall be ASSE listed 1020. The main body shall be brass. The disc and O-ring seal shall be the elastomer type.

The valve seat and disc float shall be the thermoplastic type. Tee handle or lever handle shut-off ball valves. Test cocks for testing and draining where freezing conditions occur. All materials shall be suitable for water service. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable.

- F. The laboratory faucet vacuum breaker shall be ASSE listed 1035. The main body shall be cast brass. Dual check valves with stainless steel working parts. The diaphragm and disc shall be the elastomer type suited for water service. The device shall permit the attachment of portable hoses to laboratory faucets for non-continuous pressure applications.

## **2.8 CHAINWHEELS**

- A. Valve chain wheel assembly with sprocket rim brackets and chain shall be constructed according to the following:
  - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
  - 2. Attachment: For connection to ball or butterfly valve stem.
  - 3. Sprocket rim with chain guides: Ductile or cast iron of type and size required for valve with zinc coating.
  - 4. Chain: Hot dipped galvanized steel of size required to fit sprocket rim.

## **2.9 THERMOSTATIC MIXING VALVES**

- A. Thermostatic Mixing Valves shall comply with the following general performance requirements:
  - 1. Shall meet ASSE requirements for water temperature control.
  - 2. The body shall be cast bronze or brass with corrosion resistant internal parts preventing scale and biofilm build-up. Provide chrome-plated finish in exposed areas.
  - 3. No special tool shall be required for temperature adjustment, maintenance, replacing parts and disinfecting operations.
  - 4. Valve shall be able to be placed in various positions without making temperature adjustment or reading difficult.

5. Valve finish shall be chrome plated in exposed areas.
  6. Valve shall allow easy temperature adjustments to allow hot water circulation. Internal parts shall be able to withstand disinfecting operations of chemical and thermal treatment of water temperatures up to 82°C (180°F) for 30 minutes or 50 mg/L (50 ppm) chlorine residual concentration for 24 hours.
  7. Parts shall be easily removed or replaced without dismantling the valves, for easy scale removal and disinfecting of parts.
  8. Valve shall have a manual adjustable temperature control with locking mechanism to prevent tampering by end user. Outlet temperature shall be visible to ensure outlet temperature does not exceed specified limits, particularly after thermal eradication procedures.
  9. Provide mixing valves with integral checkvalves with screens and stop valves.
- B. Automatic Water Temperature Control Mixing Valves:
1. Application: Gang plumbing fixtures point-of-use when no other mixing at fixtures occurs.
  2. Standard: ASSE 1069.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Thermostatically controlled water mixing valve set at 43 degrees C (110 degrees F).
  5. Connections: Threaded union or soldered inlets and outlet.
  6. Thermometers shall be provided to indicate mixed water temperature.
  7. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.5 gpm maximum.
- C. Water Temperature Limiting Devices:
1. Application: Single plumbing fixture point-of-use such as sinks or lavatories.
  2. Standard: ASSE 1070.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Thermostatically controlled water mixing valve set at 43 degrees C (110 degrees F).
  5. Connections: Threaded union, compression or soldered inlets and outlet.
  6. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.2 gpm maximum.



D. Temperature Activated Mixing Valves:

1. Application: Emergency eye/face/drench shower equipment.
2. Standard: ASSE 1071.
3. Pressure Rating: 861 kPa (125 psig).
4. Type: Thermostatically controlled water mixing valve set at 24-30 degrees C (75-85 degrees F).
5. Connections: Soldered or threaded union inlets and outlet.
6. Cabinet: Factory-fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.
7. Thermometers shall be provided to indicate mixed water temperature.
8. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.5 gpm maximum.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

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

**3.2 INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.

- C. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- D. Valves shall be installed in a position to allow full stem movement.
- E. Install chain wheels on operators for 4 inches and larger and more than 3.6 m (12 feet) above floor. Chains shall be extended to 1524 mm (60 inches) above finished floor.
- F. Check valves shall be installed for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level and on top of valve.
- G. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment or system.
  - 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
- H. Install pressure gages on outlet of backflow preventers.
- I. Do not install bypass piping around backflow preventers.
- J. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets.
  - 1. Install thermometers if specified.
  - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- K. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

### **3.3 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Calibrated balancing valves.
  - 2. Master, thermostatic, water mixing valves.
  - 3. Manifold, thermostatic, water-mixing-valve assemblies.

- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

### **3.4 ADJUSTING**

- A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Valves shall be replaced if persistent leaking occurs.
- B. Set field-adjustable flow set points of balancing valves and record data. Ensure recorded data represents actual measured or observed conditions. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.
- D. Testing and adjusting of balancing valves shall be performed by an independent NEBB Accredited Test and Balance Contractor. A final settings and flow report shall be submitted to the VA Contracting Officer's Representative (COR).

### **3.5 COMMISSIONING**

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

### **3.6 DEMONSTRATION AND TRAINING**

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

- - E N D - - -

**SECTION 22 07 11  
PLUMBING INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for:
1. Plumbing piping and equipment.
  2. Re-insulation of plumbing piping and equipment after asbestos abatement.
- 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 or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
  4. Concealed: Piping above ceilings and in chases and pipe spaces.
  5. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather. Shafts, chases, crawl spaces and pipe basements are not considered finished areas.
  6. FSK: Foil-scrim-kraft facing.
  7. Hot: Plumbing equipment or piping handling media above 41 degrees C (105 degrees F).
  8. Density: kg/m<sup>3</sup> - kilograms per cubic meter (Pcf - pounds per cubic foot).
  9. Thermal conductance: Heat flow rate through materials.
    - a. Flat surface: Watts per square meter (BTU per hour per square foot).
    - b. Pipe or Cylinder: Watts per square meter (BTU per hour per linear foot).
  10. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
  11. 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.
12. R: Pump recirculation.
  13. CW: Cold water.
  14. SW: Soft water.
  15. HW: Hot water.
  16. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

### 1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- B. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General mechanical requirements and items, which are common to more than one section of Division 22.
- C. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.
- D. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS. Requirements for commissioning, systems readiness checklists, and training.

### 1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- B. Criteria:
  1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:
    - 4.3.3.1 Pipe insulation and coverings, vapor retarder facings, adhesives, fasteners, tapes, unless otherwise provided for in 4.3.3.1.12 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.)
    - 4.3.3.3 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).

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

4.3.10.2.6.7 Smoke detectors shall not be required to meet the provisions of this section.

2. Test methods: ASTM E84, UL 723, or NFPA 255.
  3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
  4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
    - a. Insulation materials: Specify each type used and state surface burning characteristics.
    - b. Insulation facings and jackets: Each type used.

- 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)-91.....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):
  - A167-04 .....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
- C1126-10.....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



E136-09 b.....Standard Test Methods for Behavior of Materials  
in a Vertical Tube Furnace at 750 degrees C  
(1380 F)

E. National Fire Protection Association (NFPA):

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 08/03

G. Manufacturer's Standardization Society of the Valve and Fitting  
Industry (MSS):

SP58-2002.....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/m<sup>3</sup> (3 pcf), k =  
0.037 (.26) at 24 degrees C (75 degrees F), external insulation for  
temperatures up to 204 degrees C (400 degrees F).

B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density 32 kg/m<sup>3</sup> (2  
pcf), k = 0.04 (0.27) at 24 degrees C (75 degrees F), for use at  
temperatures up to 204 degrees C (400 degrees F)

C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation),  
Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at  
temperatures up to 230 degrees C (450 degrees F)with an all service  
vapor retarder jacket with polyvinyl chloride premolded fitting  
covering.

**2.2 MINERAL WOOL OR REFRACTORY FIBER**

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

**2.3 RIGID CELLULAR PHENOLIC FOAM**

A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1, k =  
0.021(0.15) at 10 degrees C (50 degrees F), for use at temperatures up  
to 121 degrees C (250 degrees F) with vapor retarder and all service

vapor retarder jacket with polyvinyl chloride premolded fitting covering.

- B. Equipment Insulation, ASTM C 1126, type II, grade 1, k = 0.021 (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket.

**2.4 CELLULAR GLASS CLOSED-CELL**

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

**2.5 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.

**2.6 CALCIUM SILICATE**

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- C. Equipment Insulation: ASTM C533, Type I and Type II
- D. Characteristics:

| <b>Insulation Characteristics</b>  |                 |                  |
|--|-----------------|------------------|
| <b>ITEMS</b>   | <b>TYPE I</b>   | <b>TYPE II</b>   |
| Temperature, maximum degrees C (degrees F)   | 649 (1200)      | 927 (1700)       |
| Density (dry), Kg/m <sup>3</sup> (lb/ ft <sup>3</sup> )  | 232 (14.5)      | 288 (18)         |
| Thermal conductivity:<br>Min W/ m K (Btu in/h ft <sup>2</sup> degrees F)@<br>mean temperature of 93 degrees C<br>(200 degrees F) | 0.059<br>(0.41) | 0.078<br>(0.540) |

|                                  |   |   |
|----------------------------------|---|---|
| Surface burning characteristics: |   |   |
| Flame spread Index, Maximum      | 0 | 0 |
| Smoke Density index, Maximum     | 0 | 0 |

**2.7 INSULATION FACINGS AND JACKETS**

- A. Vapor Retarder, higher strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on pipe insulation jackets. Facings and jackets shall be 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 75mm (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. 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.
- E. 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.

**2.8 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 insulation of the same thickness as adjacent insulation.

| <b>Nominal Pipe Size and Accessories Material (Insert Blocks)</b> |                           |
|---|---------------------------|
| Nominal Pipe Size mm (inches)                                     | Insert Blocks mm (inches) |
| Up through 125 (5)  | 150 (6) long              |

| Nominal Pipe Size and Accessories Material (Insert Blocks) |                           |
|--|---------------------------|
| Nominal Pipe Size mm (inches)                              | Insert Blocks mm (inches) |
| 150 (6)  | 150 (6) long              |

B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation.

### 2.9 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.

### 2.10 MECHANICAL FASTENERS

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching galvanized steel
- 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 (1/2 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

### 2.11 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.

#### **2.12 FIRESTOPPING MATERIAL**

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

#### **2.13 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 piping joints and connections shall be completed and the work approved by the COR for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.
- 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. Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

- D. Install vapor stops at all insulation terminations on either side of valves and equipment and particularly in straight lengths of pipe insulation.
- E. Construct insulation on parts of equipment that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- F. 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. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. Plumbing work not to be insulated:
  - 1. Piping and valves of fire protection system.
  - 2. Chromium plated brass piping.
  - 3. Water piping in contact with earth.
  - 4. Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).
- I. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- J. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights.  
Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- K. Firestop Pipe 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 penetrations requiring fire stop insulation including, but not limited to the following:
    - a. Pipe risers through floors
    - b. Pipe chase walls and floors
    - c. Smoke partitions
    - d. Fire partitions
- L. Provide metal jackets over insulation as follows:
- a. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
  - b. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

### **3.2 INSULATION INSTALLATION**

#### **A. Mineral Fiber Board:**

1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
2. Plain board:
  - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
  - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.

- c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
- B. Molded Mineral Fiber Pipe and Tubing Covering:
1. Fit insulation to pipe, 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.
- C. Rigid Cellular Phenolic Foam:
1. Rigid closed cell phenolic insulation may be provided for piping 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. Condensation control insulation: Minimum 25 mm (1.0 inch) thick for all pipe sizes.
    - a. Plumbing piping as follows:
      - 1) Body of roof and overflow drains horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.
      - 2) Waste piping from electric water coolers and icemakers to drainage system.
      - 3) Waste piping located above basement floor from ice making from equipment(including trap) to main vertical waste pipe.
      - 4) Reagent grade water piping.
      - 5) Cold water piping.
- D. 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.
- E. 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 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
    - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the

slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. 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.

### 3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and related sections for contractor responsibilities for system commissioning.

### 3.4 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 |
| 38-60 degrees C (100-140 degrees F)<br>(Domestic Hot Water Supply and Return) | Mineral Fiber (Above ground piping only)   | 38 (1.5)                               | 38 (1.5)         | 50 (2.0)         | 50 (2.0)          |
| 38-60 degrees C (100-140 degrees F)<br>(Domestic Hot Water                    | Rigid Cellular Phenolic Foam (Above ground | 38 (1.5)                               | 38 (1.5)         | 50 (2.0)         | 50 (2.0)          |

|   |   |             |          |          |          |
|---|---|-------------|----------|----------|----------|
| Supply and Return)  | piping only)  |             |          |          |          |
| 38-60 degrees C<br>(100-140 degrees F)<br>(Domestic Hot Water<br>Supply and Return) | Flexible<br>Elastomeric<br>Cellular<br>Thermal (Above<br>ground piping<br>only) | 38<br>(1.5) | 38 (1.5) | ----     | ----     |
|   |   |             |          |          |          |
| 4-16 degrees C<br>(40-60 degrees F)   | Rigid Cellular<br>Phenolic Foam<br>(Above ground<br>piping only)                | 25<br>(1.0) | 25(1.0)  | 25 (1.0) | 25 (1.0) |
| (4-16 degrees C<br>(40-60 degrees F)  | Flexible<br>Elastomeric<br>Cellular<br>Thermal (Above<br>ground piping<br>only) | 25<br>(1.0) | 25(1.0)  | 25 (1.0) | 25 (1.0) |

- - - E N D - - -

**SECTION 22 08 00  
COMMISSIONING OF PLUMBING SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 22.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

**1.2 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**1.3 SUMMARY**

- A. This Section includes requirements for commissioning plumbing systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

**1.4 DEFINITIONS**

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

**1.5 COMMISSIONED SYSTEMS**

- A. Commissioning of a system or systems specified in Division 22 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and

of Division 22, is required in cooperation with the VA and the Commissioning Agent.

- B. The Plumbing systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements.

#### **1.6 SUBMITTALS**

- A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

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

#### **PART 3 - EXECUTION**

##### **3.1 CONSTRUCTION INSPECTIONS**

- A. Commissioning of the Building Plumbing Systems will require inspection of individual elements of the Plumbing construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning Plan to schedule inspections as required to support the commissioning process.

##### **3.2 PRE-FUNCTIONAL CHECKLISTS**

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent

determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

### **3.3 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 22 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### **3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:**

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

**3.5 TRAINING OF VA PERSONNEL**

- A. Training of the VA operation and maintenance personnel is required in cooperation with the COR and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be scheduled in coordination with the COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 22 Sections for additional Contractor training requirements.

----- END -----

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Penetrations in rated enclosures: Section 07 84 00, FIRESTOPPING.
- B. Waterproof penetrations: Section 07 92 00, JOINT SEALANTS.
- C. Preparation and finish painting and identification of piping systems: Section 09 91 00, PAINTING.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. Pipe Insulation: Section 22 07 11, PLUMBING INSULATION.

**1.3 SUBMITTALS**

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



date of completion, in accordance with the requirements of Section 22  
08 00, COMMISSIONING OF PLUMBING SYSTEMS.

**1.4 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. B. American Society of Mechanical Engineers (ASME):
  - A13.1-2007 (R2013).....Scheme for Identification of Piping Systems
  - B16.3-2011.....Malleable Iron Threaded Fittings: Classes 150 and 300
  - B16.9-2012.....Factory-Made Wrought Buttwelding Fittings
  - B16.11-2011.....Forged Fittings, Socket-Welding and Threaded
  - B16.12-2009 (R2014).....Cast Iron Threaded Drainage Fittings
  - B16.15-2013 .....Cast Copper Alloy Threaded Fittings: Classes 125 and 250
  - B16.18-2012.....Cast Copper Alloy Solder Joint Pressure Fittings
  - B16.22-2013.....Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
  - B16.24-2011.....Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
  - B16.51-2013.....Copper and Copper Alloy Press-Connect Fittings
  - ASME Boiler and Pressure Vessel Code -
  - BPVC Section IX-2015....Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):
  - 1010-2004.....Performance Requirements for Water Hammer Arresters
- D. American Society for Testing and Materials (ASTM):
  - A47/A47M-1999 (R2014)...Standard Specification for Ferritic Malleable Iron Castings
  - A53/A53M-2012.....Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  - A183-2014.....Standard Specification for Carbon Steel Track Bolts and Nuts

- A269/A269M-2014e1.....Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- A312/A312M-2015.....Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- A403/A403M-2014.....Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
- A536-1984 (R2014).....Standard Specification for Ductile Iron Castings
- A733-2013.....Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
- B32-2008 (R2014).....Standard Specification for Solder Metal
- B43-2014.....Standard Specification for Seamless Red Brass Pipe, Standard Sizes
- B61-2008 (R2013).....Standard Specification for Steam or Valve Bronze Castings
- B62-2009.....Standard Specification for Composition Bronze or Ounce Metal Castings
- B75/B75M-2011.....Standard Specification for Seamless Copper Tube
- B88-2014.....Standard Specification for Seamless Copper Water Tube
- B584-2014.....Standard Specification for Copper Alloy Sand Castings for General Applications
- B687-1999 (R2011).....Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
- C919-2012.....Standard Practice for Use of Sealants in Acoustical Applications
- D1785-2012.....Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- D2000-2012.....Standard Classification System for Rubber Products in Automotive Applications
- D2564-2012.....Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems

- D2657-2007.....Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
- D2855-1996 (R2010).....Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
- D4101-2014.....Standard Specification for Polypropylene Injection and Extrusion Materials
- E1120-2008.....Standard Specification for Liquid Chlorine
- E1229-2008.....Standard Specification for Calcium Hypochlorite
- F2389-2010.....Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
- F2620-2013.....Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
- F2769-2014.....Standard Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems
- E. American Water Works Association (AWWA):
  - C110-2012.....Ductile-Iron and Gray-Iron Fittings
  - C151-2009.....Ductile Iron Pipe, Centrifugally Cast
  - C153-2011.....Ductile-Iron Compact Fittings
  - C203-2008.....Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
  - C213-2007.....Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
  - C651-2014.....Disinfecting Water Mains
- F. American Welding Society (AWS):
  - A5.8M/A5.8-2011-AMD1....Specification for Filler Metals for Brazing and Braze Welding
- G. International Code Council (ICC):
  - IPC-2012.....International Plumbing Code
- H. Manufacturers Specification Society (MSS):
  - SP-58-2009.....Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
  - SP-72-2010a.....Ball Valves with Flanged or Butt-Welding Ends for General Service

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

I. NSF International (NSF):

14-2015.....Plastics Piping System Components and Related  
Materials

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

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

J. Plumbing and Drainage Institute (PDI):

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

K. Department of Veterans Affairs:

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

**1.5 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 in electronic version on compact disc or DVD and inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 13 or later provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certificate if applicable that all results of tests were within limits specified. If a certificate is not available, all documentation shall be on the Certifier's letterhead.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372. Endpoint devices used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9.
- B. Plastic pipe and fittings, shall not be used on this project.

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

- A. Pipe: Copper tube, ASTM B88, Type K or L, drawn.
- B. Fittings for Copper Tube:
1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 & SP 110, Solder or braze joints. Use 95/5 tin and antimony for all soldered joints.
  2. Grooved fittings, 2 to 6 inch (50 to 150 mm) wrought copper ASTM B75 C12200, 5 to 6 inch (125 to 150 mm) bronze casting ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
- C. Adapters: Provide adapters for joining screwed pipe to copper tubing.
- D. Solder: ASTM B32 Composition Sb5 HA or HB. Provide non-corrosive flux.
- E. Brazing alloy: AWS A5.8, Classification BCuP.

### **2.3 EXPOSED WATER PIPING**

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, casework, cabinets, and

equipment when not concealed by apron including those furnished by the Government or specified in other sections.

1. Pipe: Fed. Spec. WW-P-351, standard weight.
2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
3. Nipples: ASTM B 687, Chromium-plated.
4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

#### **2.4 TRAP PRIMER WATER PIPING:**

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

#### **2.5 WATERPROOFING**

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
- B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

#### **2.6 STRAINERS**

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Smaller than 80 mm (3 inches), brass or bronze.

#### **2.7 DIELECTRIC FITTINGS**

- A. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

#### **2.8 STERILIZATION CHEMICALS**

- A. Liquid Chlorine: ASTM E1120.

B. Hypochlorite: ASTM E1229, or Fed. Spec. AA-1427C, grade B.

**2.9 WATER HAMMER ARRESTER:**

A. Closed copper tube chamber with permanently sealed 413 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010. Access shall be provided where devices are concealed within partitions or above ceilings. Size and install in accordance with PDI-WH 201 requirements.

Provide water hammer arrestors at:

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

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. A. General: Comply with the International Plumbing Code and the following:

1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.
3. All pipe runs shall be laid out to avoid interference with other work/trades.
4. Install union and shut-off valve on pressure piping at connections to equipment.
5. Pipe Hangers, Supports and Accessories:
  - a. All piping shall be supported per the IPC, H-18-8 Seismic Design Handbook, MSS SP-58, and SMACNA as required.
  - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc

chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.

c. Floor, Wall and Ceiling Plates, Supports, Hangers:

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



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

6. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
  7. Penetrations:
    - a. Firestopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke, and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between raceways and openings with the firestopping materials.
    - b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
    - c. Acoustical sealant: Where pipes pass through sound rated walls, seal around the pipe penetration with an acoustical sealant that is compliant with ASTM C919.
  8. Mechanical press-connect fitting connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Ensure the tube is completely inserted to the fitting stop (appropriate depth) and squared with the fitting prior to applying the pressing jaws onto the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer. Minimum distance between fittings shall be in accordance with the manufacturer's requirements. When the pressing cycle is complete, visually inspect the joint to ensure the tube has remained fully inserted, as evidenced by the visible insertion mark.
- B. Domestic Water piping shall conform to the following:
1. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.

2. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

### **3.2 TESTS**

- A. General: Test system either in its entirety or in sections. Submit testing plan to COR 10 working days prior to test date.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 1035 kPa (150 psig) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested. Pressure gauge shall have 1 psig increments.
- C. Re-agent Grade Water Systems: Fill system with water and maintain hydrostatic pressure of 1380 kPa (200 psig) gage during inspection and prove tight.
- D. All Other Piping Tests: Test new installed piping under 1-1/2 times actual operating conditions and prove tight.
- E. The test pressure shall hold for the minimum time duration required by the applicable plumbing code or authority having jurisdiction.

### **3.3 STERILIZATION**

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
- B. Remove all laminar flow devices and/or screens and completely flush all fixtures at full volume for a minimum 10 minutes.
- C. Install isolation valves and injection tees on the hot, cold, and hot water recirculation lines so all fixtures installed in the scope of the project can be disinfected (shock chlorinated). Insure isolation valves are installed to prohibit disinfection chemicals from entering back into the medical center domestic water lines.
- D. Disinfection shall be at a level of at least 200 ppm free chlorine for a minimum of 2 hours and a maximum of 24 hours. All fixtures shall have 200 ppm at the tap.

- E. After disinfection, all fixtures must be flushed and tested to insure safe potable water levels are available. No more than 3 ppm free chlorine.
- F. Sterilization procedures, schedules, and testing shall be coordinated with the project commissioning agent.

**3.4 COMMISSIONING**

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

- - - E N D - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

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

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  - A13.1-2007.....Scheme for the Identification of Piping Systems
  - A112.36.2M-1991(R 2012).Cleanouts
  - A112.6.3-2001 (R2007)...Standard for Floor and Trench Drains
  - B1.20.1-2013.....Pipe Threads, General Purpose (Inch)
  - B16.1-2010.....Gray Iron Pipe Flanges and Flanged Fittings

- B16.4-2011.....Standard for Grey Iron Threaded Fittings  
Classes 125 and 250
- B16.15-2013.....Cast Copper Alloy Threaded Fittings, Classes  
125 and 250
- B16.18-2012.....Cast Copper Alloy Solder Joint Pressure  
Fittings
- B16.21-2011.....Nonmetallic Flat Gaskets for Pipe Flanges
- B16.22-2013.....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings
- B16.23-2011.....Cast Copper Alloy Solder Joint Drainage  
Fittings: DWV
- B16.24-2001 (R2006).....Cast Copper Alloy Pipe Flanges and Flanged  
Fittings
- B16.29-2012.....Wrought Copper and Wrought Copper Alloy Solder-  
Joint Drainage Fittings: DWV
- B16.39-2009.....Malleable Iron Threaded Pipe Unions Classes  
150, 250, and 300
- B18.2.1-2012.....Square, Hex, Heavy Hex, and Askew Head Bolts  
and Hex, Heavy Hex, Hex Flange, Lobed Head, and  
Lag Screws (Inch Series)
- C. American Society of Sanitary Engineers (ASSE):
  - 1001-2008.....Performance Requirements for Atmospheric Type  
Vacuum Breakers
  - 1018-2001.....Performance Requirements for Trap Seal Primer  
Valves - Potable Water Supplied
  - 1044-2001.....Performance Requirements for Trap Seal Primer  
Devices - Drainage Types and Electronic Design  
Types
  - 1079-2012.....Performance Requirements for Dielectric Pipe  
Unions
- D. American Society for Testing and Materials (ASTM):
  - A53/A53M-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

- A888-2013a.....Standard Specification for Hubless Cast Iron  
Soil Pipe and Fittings for Sanitary and Storm  
Drain, Waste, and Vent Piping Applications
- B32-2008.....Standard Specification for Solder Metal
- B43-2009.....Standard Specification for Seamless Red Brass  
Pipe, Standard Sizes
- B75-2011.....Standard Specification for Seamless Copper Tube
- B88-2009.....Standard Specification for Seamless Copper  
Water Tube
- B306-2013.....Standard Specification for Copper Drainage Tube  
(DWV)
- B584-2013.....Standard Specification for Copper Alloy Sand  
Castings for General Applications
- B687-1999 (R 2011).....Standard Specification for Brass, Copper, and  
Chromium-Plated Pipe Nipples
- B813-2010.....Standard Specification for Liquid and Paste  
Fluxes for Soldering of Copper and Copper Alloy  
Tube
- B828-2002 (R 2010).....Standard Practice for Making Capillary Joints  
by Soldering of Copper and Copper Alloy Tube  
and Fittings
- C564-2012.....Standard Specification for Rubber Gaskets for  
Cast Iron Soil Pipe and Fittings
- D1785-2012.....Standard Specification for Poly(Vinyl Chloride)  
(PVC) Plastic Pipe, Schedules 40, 80, and 120
- D2321-2011.....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
- D2665-2012.....Standard Specification for Poly(Vinyl Chloride)  
(PVC) Plastic Drain, Waste, and Vent Pipe and  
Fittings
- D2855-1996 (R 2010).....Standard Practice for Making Solvent-Cemented  
Joints with Poly(Vinyl Chloride) (PVC) Pipe and  
Fittings

- D5926-2011.....Standard Specification for Poly(Vinyl Chloride)  
(PVC) Gaskets for Drain, Waste, and Vent (DWV),  
Sewer, Sanitary, and Storm Plumbing Systems
- F402-2005 (R 2012).....Standard Practice for Safe Handling of Solvent  
Cements, Primers, and Cleaners Used for Joining  
Thermoplastic Pipe and Fittings
- F477-2010.....Standard Specification for Elastomeric Seals  
(Gaskets) for Joining Plastic Pipe
- F1545-1997 (R 2009).....Standard Specification for Plastic-Lined  
Ferrous Metal Pipe, Fittings, and Flanges
- E. Cast Iron Soil Pipe Institute (CISPI):
  - 2006.....Cast Iron Soil Pipe and Fittings Handbook
  - 301-2012.....Standard Specification for Hubless Cast Iron  
Soil Pipe and Fittings for Sanitary and Storm  
Drain, Waste, and Vent Piping Applications
  - 310-2012.....Specification for Coupling for Use in  
Connection with Hubless Cast Iron Soil Pipe and  
Fittings for Sanitary and Storm Drain, Waste,  
and Vent Piping Applications
- F. Copper Development Association, Inc. (CDA):
  - A4015.....Copper Tube Handbook
- G. International Code Council (ICC):
  - IPC-2012.....International Plumbing Code
- H. Manufacturers Standardization Society (MSS):
  - SP-123-2013.....Non-Ferrous Threaded and Solder-Joint Unions  
for Use With Copper Water Tube
- I. National Fire Protection Association (NFPA):
  - 70-2011.....National Electrical Code (NEC)
- J. Plumbing and Drainage Institute (PDI):
  - WH-201 (R 2010).....Water Hammer Arrestors Standard
- K. Underwriters' Laboratories, Inc. (UL):
  - 508-99 (R2013).....Standard For Industrial Control Equipment

**1.4 SUBMITTALS**

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

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 13 00, FACILITY SANITARY AND VENT PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Piping.
  - 2. Floor Drains.
  - 3. Cleanouts.
  - 4. Trap Seal Protection.
  - 5. Penetration Sleeves.
  - 6. Pipe Fittings.
  - 7. Traps.
  - 8. Exposed Piping and Fittings.
- D. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

#### **1.5 QUALITY ASSURANCE**

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

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

- A. 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 on Auto-Cad version 2012 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.
- B. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test



results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

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

- A. Cast iron waste, drain, and vent pipe and fittings
  - 1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:
    - a. pipe buried in or in contact with earth
    - b. sanitary pipe extensions to a distance of approximately 1500 mm (5 feet) outside of the building.
    - c. interior waste and vent piping above grade.
  - 2. Material, (Pipe and Fittings): ASTM A74, C1SP1-301, Service Class.
  - 3. Joints: Provide any one of the following types to suit pipe furnished.
    - a. Lead and oakum and caulked by hand.
    - b. Double seal, compression-type molded neoprene gasket. Gaskets shall suit class of pipe being jointed.
    - c. Mechanical: Heavy-duty coupling band. Sealing clamps shall be torqued to a minimum of 80 in-lbs and have bands of 305 stainless steel with 3/8" hex head/shoulder screws.
    - d. Adapters: Where service weight pipe is connected to extra heavy pipe and extra heavy fittings of chair carriers, provide adapters or similar system to make tight, leak proof joints.
- B. Copper Tube, (DWV): May be used for piping above ground, except for urinal drains.
  - 1. Tube: ASTM B306.
  - 2. Fittings:
    - a. Solder type.
    - b. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper conforming to ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) bronze casting conforming to ASTM B584, CDA 844(81-3-7-9). Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housings, with EPDM

gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.

3. Joints: ASTM B32, 50/50, special alloy, lead free. Solder using non-corrosive flux.

## **2.2 EXPOSED WASTE PIPING**

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed waste piping connecting fixtures, casework, cabinets, and equipment when not concealed by apron including those furnished by the Government or specified in other sections.
  1. Pipe: Fed. Spec. WW-P-351, standard weight.
  2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
  3. Nipples: ASTM B 687, Chromium-plated.
  4. Unions: Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- B. Unfinished Rooms and Mechanical Rooms: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

## **2.3 SPECIALTY PIPE FITTINGS**

- A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
  1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
  2. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.

- C. Dielectric flange insulating kits shall be of non conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

#### **2.4 CLEANOUTS**

- A. Same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Provide a minimum clearance of 600 mm (24 inches) for the rodding.
- B. In Floors: Floor cleanouts shall have cast iron body and frame with square adjustable scoriated secured nickel bronze top. Unit shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts. Cleanouts shall consist of "Y" fittings and 3 mm (1/8 inch) bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, provide carpet cleanout markers. Provide two way cleanouts where indicated on drawings.
- C. Provide cleanouts at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. Extend the cleanouts to the wall access cover. Cleanout shall consist of sanitary tees. Furnish nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed roughing work, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required by the NPHCC National Standard Plumbing Code.

- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

## **2.5 FLOOR DRAINS**

- A. General Data: floor drain shall comply with ASME A112.6.3. A caulking flange, inside gasket, or hubless connection shall be provided for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe. The drain connection shall be bottom outlet. A membrane clamp and extensions shall be provided, if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening will not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe. For drains not installed in connection with a waterproof membrane, a .45 kg (16-ounce) soft copper flashing membrane, 600 mm (24 inches) square or another approved waterproof membrane shall be provided.
- B. Type C (FD-C) floor drain shall comply with ANSI A112.6.3. The type C floor drain shall have a cast iron body, double drainage pattern, clamping device, light duty square or round nickel bronze adjustable strainer and grate with vandal proof screws. The grate shall be square, 150 mm (6 inches) minimum. For drains used in showers coordinate strainer size to match drain opening in shower base.

## **2.6 TRAPS**

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

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

- A. Trap Primer (TP-1): The trap seal primer valve shall be hydraulic, supply type with a pressure rating of 5.98 kPa (125 psig) and conforming to standard ASSE 1018.
1. The inlet and outlet connections shall be 15 mm or DN15 (NPS ½ inch)
  2. The trap seal primer valve shall be fully automatic with an all brass or bronze body.
  3. The trap seal primer valve shall be activated by a drop in building water pressure, no adjustment required.
  4. The trap seal primer valve shall include a manifold when serving two, three, or four traps.
  5. The manifold shall be omitted when serving only one trap.

## **2.8 PENETRATION SLEEVES**

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

## **PART 3 - EXECUTION**

### **3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings where possible.
- F. The piping shall be installed to permit valve servicing or operation.

- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried soil and waste drainage and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to Copper Development Association's (CDA) "Copper Tube Handbook".
- M. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

### **3.2 JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.

- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
  2. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.
- F. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

### **3.3 SPECIALTY PIPE FITTINGS**

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

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

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be 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. 40 mm or DN40 to 50 mm or DN50 (NPS 1-1/2 inch to NPS 2 inch): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
  2. 80 mm or DN 80 (NPS 3 inch): 1500 mm (60 inches) with 13 mm (½ inch) rod.
  3. 100 mm or DN100 to 125 mm or DN125 (NPS 4 to NPS 5): 1500 mm (60 inches) with 16 mm (5/8 inch) rod.
  4. 150 mm or DN150 to 200 mm or DN200 (NPS 6 inch to NPS 8 inch): 1500 mm (60 inches) with 19 mm (¾ inch) rod.
  5. 250 mm or DN250 to 300 mm or DN 300 (NPS 10 inch to NPS 12 inch): 1500 mm (60 inch) with 22 mm (7/8 inch) rod.
- E. The maximum spacing for plastic pipe 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 4.57 m (15 feet).
- G. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:
1. Solid or split unplated cast iron.
  2. All plates shall be provided with set screws.
  3. Height adjustable clevis type pipe hangers.
  4. Adjustable floor rests and base flanges shall be steel.
  5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  7. Riser clamps shall be malleable iron or steel.
  8. Rollers shall be cast iron.
  9. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- 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 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 provided 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 shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- K. Piping shall conform to the following:
  - 1. Waste and Vent Drain to main stacks:

| Pipe Size                              | Minimum Pitch |
|--|---------------|
| 80 mm or DN 80 (3 inches) and smaller  | 2%            |
| 100 mm or DN 100 (4 inches) and larger | 1%            |

- 2. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

**3.5 TESTS**

- A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.
- B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
  - 1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least

- upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. For an air test, an air pressure of 35 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the air test.
  3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.
  3. Final Tests: Either one of the following tests may be used.
    - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce (2 ounces) of peppermint into each line or stack.

### 3.6 COMMISSIONING

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

- - - E N D - - -

**SECTION 22 14 00  
FACILITY STORM DRAINAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section describes the requirements for storm drainage systems, including piping and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- B. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- D. Section 22 07 11, PLUMBING INSULATION: Pipe Insulation.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Piping.
  - 2. Cleanouts.
  - 3. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.

**1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI).
- C. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - A13.1-07.....Scheme for Identification of Piping Systems
  - B16.3-06.....Malleable Iron Threaded Fittings, Classes 150 and 300. B16.9-07 Factory-Made Wrought Steel Butt welding Fittings
  - B16.11-05.....Forged Steel Fittings, Socket-Welding and Threaded B16.12-98 (R 2006) Cast Iron Threaded Drainage Fittings

- B16.15-06).....Cast Bronze Threaded Fittings, Class 125 and  
250
- B16.18-01 (R 2005).....Cast Copper Alloy Solder-Joint Pressure  
Fittings
- B16.22-01 (R 2005).....Wrought Copper and Copper Alloy Solder Joint  
Pressure Fittings
- D. American Society for Testing and Materials (ASTM):
  - A47-99 (R 2004).....Standard Specification for Steel Sheet,  
Aluminum Coated, by the Hot-Dip Process
  - A53-07.....Standard Specification for Pipe, Steel, Black  
And Hot-Dipped, Zinc-coated Welded and Seamless
  - A74-06.....Standard Specification for Cast Iron Soil Pipe  
and Fittings
  - A183-03).....Standard Specification for Carbon Steel Track  
Bolts and Nuts
  - A312-03.....Standard Specification for Seamless and Welded  
Austenitic Stainless Steel Pipe
  - A536-84(R 2004).....Standard Specification for Ductile Iron  
Castings
  - A733-03.....Standard Specification for Welded and Seamless  
Carbon Steel and Austenitic Stainless Steel  
Pipe Nipples
  - B32-04.....Standard Specification for Solder Metal
  - B61-08.....Standard Specification for Steam or Bronze  
Castings
  - B62-02.....Standard Specification for Composition Bronze  
or Ounce Metal Castings
  - B75-02.....Standard Specification for Seamless Copper Tube
  - B88-03.....Standard Specification for Seamless Copper  
Water Tube
  - B306-02.....Standard Specification for Copper Drainage Tube  
(DWV)
  - B584-08.....Standard Specification for Copper Alloy Sand  
Castings for General Applications
  - B687-99.....Standard Specification for Brass, Copper, and  
Chromium-Plated Pipe Nipples

- C564-06a.....Standard Specification for Rubber Gaskets for  
Cast Iron Soil Pipe and Fittings
- D2000-08.....Standard Classification System for Rubber  
Products in Automotive Applications
- D4101-07.....Standard Specification for Propylene Plastic  
Injection and Extrusion Materials
- D2447-03.....Standard Specification for Polyethylene (PE)  
Plastic Pipe, Schedule 40 and 80, Based on  
Outside Diameter
- D2564-04e1.....Standard Specification for Solvent Cements for  
Poly (Vinyl Chloride) (PVC) Plastic Pipe and  
Fittings
- D2665-07.....Standard Specification for Poly (Vinyl  
Chloride) (PVC) Plastic Drain, Waste, and Vent  
Pipe and Fittings
- E. American Welding Society (AWS):
  - A5.8-04.....Specification for Filler Metals for Brazing and  
Braze Welding
- F. International Code Council (ICC):
  - IPC-06.....International Plumbing Code
- G. Cast Iron Soil Pipe Institute (CISPI):
  - 301-05.....Hubless Cast Iron Soil and Fittings for  
Sanitary and Storm Drain, Waste, and Vent  
Piping Applications
  - 310-04.....Couplings for Use in Connection with Hubless  
Cast Iron Soil and Fittings for Sanitary and  
Storm Drain, Waste, and Vent Piping  
Applications
- H. Manufacturers Standardization Society of the Valve and Fittings  
Industry, Inc. (MSS):
  - SP-72-99.....Standard for Ball Valves with Flanged or Butt  
Welding For General Purpose
  - SP-110-96.....Ball Valve Threaded, Socket Welding, Solder  
Joint, Grooved and Flared Ends

## **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. Interior storm piping above grade.
  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 Standard 301, ASTM A-888, or ASTM A-74.
  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 Standard C-564 or be installed with leak and oakum.

### **2.2 SPECIALTY PIPE FITTINGS**

- A. Transition pipe couplings shall join piping with small differences in outside diameters or be of different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear erring and corrosion resistant metal tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.
- C. Dielectric flange insulating kits shall be of non conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.

- D. The dielectric nipples shall be electroplated steel nipple comply with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

### 2.3 CLEANOUTS

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. A minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged storm sewer line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts where shall be provided where indicated on the drawings and at each building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty.
- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel bronze square frame and stainless steel cover with minimum opening of 150 mm by 150 mm (6 inch by 6 inch) shall be provided at each wall cleanout.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

#### **2.4 WATERPROOFING**

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

### **PART 3 - EXECUTION**

#### **3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the International code 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 shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings to allow for ceiling panel removal.
- F. Unless otherwise stated on the documents, minimum horizontal slope shall be one inch for every 1.22 m (4 feet) 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  $\frac{1}{8}$  bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.



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

### **3.2 JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
  - 2. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.

### **3.3 SPECIALTY PIPE FITTINGS**

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.

B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

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

A. All piping shall be supported according to the International plumbing code, 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 13 mm (1/2 inch) rod.
3. NPS 4 to NPS 5 (DN 100 to DN 125): 1500 mm (60 inches) with 16 mm (5/8 inch) rod.
4. NPS 6 to NPS 8 (DN 150 to DN 200): 1500 mm (60 inches) with 19 mm (3/4 inch) rod.
5. NPS 10 to NPS 12 (DN 250 to DN 300): 1500 mm (60 inches) with 22 mm (7/8 inch) rod.

E. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).

F. 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 (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gage steel. The shield shall be sized for the insulation.
- G. 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 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- H. Cast escutcheon with set screw shall be installed at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- I. Penetrations:
1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
  2. Water proofing: At floor penetrations, Clearances around the pipe shall be completely sealed and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- J. Piping shall conform to the following:
1. Storm Water Drain and Vent Drain to main stacks:

| Pipe Size                               | Minimum Pitch |
|---|---------------|
| 80 mm (3 inches) and smaller            | 2%            |
| 100 mm (4 inches) (4 inches) and larger | 1%            |

### 3.5 TESTS

- A. Storm sewer system shall be tested either in its entirety or in sections.

- B. Storm Water Drain tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
1. If entire system is tested with water, tightly close all openings in pipes except the highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
  2. For an air test, an air pressure of 35 kPa (5 psi) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the test.
  3. Final Tests: Either one of the following tests may be used.
    - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce .06 liters (2 ounces) of peppermint into each line or stack.

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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.

**1.2 RELATED WORK**

- A. Sealing between fixtures and other finish surfaces: Section 07 92 00, JOINT SEALANTS.
- B. Flush panel access doors: Section 08 31 13, ACCESS DOORS AND FRAMES.
- C. Through bolts: Section 10 21 13, TOILET COMPARTMENTS.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.  
Requirements for commissioning, systems readiness checklist, and training.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit plumbing fixture information in an assembled brochure, showing cuts and full detailed description of each fixture.

**1.4 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):  
The American Society of Mechanical Engineers (ASME):  
A112.6.1M-02(R2008).....Floor Affixed Supports for Off-the-Floor  
Plumbing Fixtures for Public Use  
A112.19.1M-08 .....Enameled Cast Iron Plumbing Fixtures  
A112.19.2M-03.....Vitreous China Plumbing Fixtures  
A112.19.3-2001(R2008)...Stainless Steel Plumbing Fixtures (Designed for  
Residential Use)

- C. American Society for Testing and Materials (ASTM):
  - A276-2010 .....Stainless and Heat-Resisting Steel Bars and Shapes
  - WW-P-541-E/GEN .....Plumbing Fixtures with Amendment 1
- D. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM AMP 500-505  
Metal Finishes Manual (1988)
- E. American Society of Sanitary Engineers (ASSE):  
1016-05.....Performance Requirements for Individual  
Thermostatic, Pressure Balancing and Combination  
Pressure Balancing and Thermostatic Control  
Valves for Individual Fixture Fittings
- F. NSF International (NSF)
  - NSF/ANSI 14 (2013).....Plastics Piping System Components and Related Materials
  - NSF/ANSI 61 (2012).....Drinking Water System Components - Health Effects
  - NSF/ANSI 372 (2011).....Drinking Water System Components - Lead Content
- G. American with Disabilities Act (A.D.A) Section 4-19.4 Exposed Pipes and Surfaces
- H. Environmental Protection Agency EPA PL 93-523 1974; A 1999) Safe Drinking Water Act.
- I. International Building Code, ICC IPC 2012.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372. Endpoint devices used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended.

**2.2 STAINLESS STEEL**

- A. Corrosion-resistant Steel (CRS):
  - 1. Plate, Sheet and Strip: CRS flat products shall conform to chemical composition requirements of any 300 series steel specified in ASTM A276.

2. Finish: Exposed surfaces shall have standard polish (ground and polished) equal to NAAMM finish Number 4.

B. Die-cast zinc alloy products are prohibited.

### **2.3 STOPS**

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

B. Furnish keys for lock shield stops to COR.

C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.

D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe, i.e. red brass pipe nipple, chrome plated where exposed.

E. Psychiatric Area: Provide stainless steel drain guard for all lavatories not installed in casework.

### **2.4 ESCUTCHEONS**

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

### **2.5 LAMINAR FLOW CONTROL DEVICE**

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

B. Flow Control Restrictor:

1. Capable of restricting flow from 95 ml/s to 110 ml/s (1.5 gpm to 1.7 gpm) for lavatories; 125 ml/s to 140 ml/s (2.0 gpm to 2.2 gpm) for sinks P-505 through P-520, P-524 and P-528; and 170 ml/s to 190 ml/s (2.75 gpm to 3.0 gpm) for dietary food preparation and rinse sinks or as specified.

2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 170 kPa and 550 kPa (25 psi and 80 psi).

3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-cleaning action, and is capable of easy manual cleaning.

## **2.6 CARRIERS**

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

## **2.7 WATER CLOSETS**

- A. (P-103 & P-103A) Water Closet (Wall Hung, ASME/ANSI A112.19.2M, Figure 9) office and industrial, elongated bowl, siphon jet 6 L (1.6 gallons) per flush, wall outlet. Top of rim shall be between 406 mm and 432 mm (16 inches and 17 inches) above finished floor. Handicapped water closet shall have rim set 457 mm (18 inches) above finished floor.
  1. Seat: Institutional/Industrial, extra heavy duty, chemical resistant, solid plastic, open front less cover for elongated bowls, integrally molded bumpers, concealed check hinge with stainless steel post. Seat shall be posture contoured body design. Color shall be white.
  2. Fittings and Accessories: Gaskets-neoprene; bolts with chromium plated caps nuts and washers.
  3. Flush valve: Large chloramines resistant diaphragm, semi-red brass valve body, exposed chrome plated, battery powered active infra-red sensor for automatic operation with courtesy flush button for manual operation, water saver design 6 L (1.6 gallons) per flush with maximum 10 percent variance 25 mm (1 inch) screwdriver back check angle stop with vandal resistant cap, adjustable tailpiece, a high back pressure vacuum breaker, spud coupling for 38 mm (1 1/2 inches) top spud, wall and spud flanges, and sweat solder adapter with cover tube and set screw wall flange. Valve body, cover, tailpiece and control stop shall be in conformance with ASTM alloy classification



for semi-red brass. Seat bumpers shall be integral part of flush valve. Set centerline of inlet 292 mm (11 1/2 inches) above rim.

## 2.8 URINALS

- A. (P-202) Urinal (Wheelchair, Wall Hung, ANSI A112.19.2M, Figure 30) bowl with integral flush distribution, wall to front of flare 356 mm (14 inches). Wall hung with integral trap, siphon jet flushing action 4 L (1.0 gallon per flush) with 51 mm (2 inches) back outlet and 19 mm (3/4 inch) top inlet spud.
1. Support urinal with chair carrier and install with rim 381 mm (15 inches) above finished floor.
  2. Flushing Device: Large chloramines resistant diaphragm, semi-red brass body, exposed flush valve, electronic sensor operated, non-hold-open, water saver design, 19 mm (3/4 inch) capped screwdriver angle stop valve. Set centerline of inlet 292 mm (11 1/2 inches) above urinal. Valve body, cover, tailpiece and control stop shall be in conformance with ASTM alloy classification for semi-red brass.

## 2.9 LAVATORIES

- A. Dimensions for lavatories are specified, Length by width (distance from wall) and depth.
- B. Brass components in contact with water shall contain no more than 3 percent lead content by dry weight.
- C. (P-417) Lavatory (Counter Mounted ASME/ANSI A112.19.2M, Figure 25) vitreous china, self-rimming, approximately 483 mm (19 inches) in diameter with punching for faucet on 102 mm (4 inches) centers. Mount unit in countertop. Support countertop with ASME/ANSI A112.19.1M, Type 1, chair carrier with exposed arms.
1. Faucet: Solid cast brass construction, chrome plated, gooseneck spout with outlet 102 mm to 127 mm (4 inches to 5 inches) above rim. Electronic sensor operated, 102 mm (4 inches) center set mounting, wiring box, 120/24 volt solenoid, remote mounted, back check valves, solid brass hot-cold water mixer adjusted from top deck with barrier free design control handle and inline filter. Provide laminar flow control device. Breaking the light beam shall activate the water flow. Flow shall stop when user moves away from light beam. Provide steel access door with key operated cylinder lock. See Section 08 31 13, ACCESS DOORS AND FRAMES. All connecting wiring between transformer, solenoid valve and sensor shall be cut to length with no excess hanging or wrapped up wiring allowed.

2. Drain: Cast or wrought brass with flat grid strainer, offset tailpiece, chrome plated.
3. Stops: Angle type. See paragraph 2.2. Stops
4. Trap: Cast copper alloy, 38 mm by 32 mm (1 1/2 inches by 1 1/4 inches) P-trap, adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extension to wall. Set trap parallel to the wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish.
5. Provide cover for drain, stops and trap per A.D.A 4-19.4.

#### **2.10 SINKS AND LAUNDRY TUBS**

- A. Dimensions for sinks and laundry tubs are specified, length by width (distance from wall) and depth.
- B. (P-516) Sink (CRS, Single Compartment, Wall Hung) 14 gage CRS, approximately 762 mm by 508 mm (30 inches by 20 inches) by 203 mm (8 inches) deep with 305 mm (12 inch) splash back. Provide rolled rim on front and ends. Corners and edges shall be well rounded. Support sink with 10 gage CRS brackets on ASME/ANSI A112.6.1M, Type I, chair carrier and secure fixture with minimum 10 mm (3/8 inch) all-thread bracket studs and nuts. Set rim of sink 914 mm (36 inches) above finished floor.
  1. Faucet: Solid brass construction, combination faucet with replaceable monel seat, removable replacement unit containing all parts subject to wear, and swinging elevated spout, integral stops, mounted as close as possible to top of splash back. Wrist blade handles on faucet shall be cast, formed or drop forged copper alloy or CRS. Exposed metal parts, including exposed part under valve when in open position, shall have a smooth bright finish. Provide laminar flow control device.
  2. Drain: Drain plug with strainer, stainless steel.
  3. Trap: Cast copper alloy, 38 mm (1 1/2 inches) P-trap. Adjustable with connected elbow and nipple to wall and escutcheon.
  4. Provide cover for drain, stops and trap per A.D.A 4-19.4.
- C. (P-528) Sink (CRS, Single Compartment, Counter Top ASME/ANSI A112.19.2M, Kitchen Sinks, Figure 5) undermount, approximately 457 mm by 533 mm (18 inches by 21 inches) with single compartment inside dimensions approximately 406 mm by 483 mm by 191 mm (16 inches by 19 inches by 10 1/2 inches) deep. Shall be minimum of 1.3 mm thick (18 gauge) CRS. Corners and edges shall be well rounded:
  1. Faucet: Solid brass construction, deck mounted combination faucet with monel or ceramic seats, removable replacement unit containing

all parts subject to ware, swivel gooseneck spout with approximately 203 mm (8 inches) reach with spout outlet 152 mm (6 inches) above deck and 102 mm (4 inches) wrist blades with hose spray. Faucet shall be polished chrome plated.

2. Drain: Drain plug with cup strainer, stainless steel.
3. Trap: Cast copper alloy 38 mm (1 1/2 inches) P-trap with cleanout plug. Provide wall connection and escutcheon.
4. Provide cover for drain, stops and trap per A.D.A 4-19.4.

#### **2.11 DISPENSER, DRINKING WATER**

- A. Standard rating conditions: 10 degrees C (50 degrees F) water with 27 degrees C (80 degrees F) inlet water temperature and 32 degrees C (90 degrees F) ambient air temperature.
- B. (P-609) Electric Water Cooler: Mechanically cooled, self contained, wheel chair, bubbler style fully exposed dual height stainless steel fountain, recessed in wall refrigeration system, stainless steel grille, stainless steel support arm, wall mounting box, energy efficient cooling system consisting of a hermetically sealed reciprocating type compressor, 115v, 60 Hz, single phase, fan cooled condenser, permanently lubricated fan motor. Set highest bubbler 1016 mm (40 inches) above finished floor.

#### **2.12 SHOWER BATH FIXTURE**

- A. (P702) 36" x 36" Transfer Shower Unit with wall mounted, concealed supplies, type T/P combination valve:
  1. Shower base and wall surround unit shall be constructed from molded reinforced fiberglass with a 15% minimum fiberglass content. Unit shall be in full compliance with ADA requirements.
  2. Unit shall have an anti-skid floor treatment to meet performance requirements of ASTM F-462.
  3. The unit shall include molded soap dishes and stainless steel curtain rod.
  3. Hand held shower set: Wall mounted, shower head connected to shower arm. All external trim shall be chrome plated metal. Chrome plated metal head, adjustable ball joint, self-cleaning with automatic flow control device to limit discharge to not more than 2 gpm. Body, internal parts of shower head and flow control fittings shall be copper alloy or CRS.
  4. Valves: Washerless ceramic disc valve cartridge with volume and temperature control. Cast brass valve body. Hot limit safety stop.

Pressure balancing cartridge maintains constant output temperature in response to changes in relative hot and cold supply pressures.

Chrome plated metal lever with adjustment for rough-in variations, type operating handle and chrome plated brass or CRS face plate.

Provide external screwdriver check stops, and temperature limit stops. Set stops for a maximum temperature of 40 degrees C (105 degrees F). All exposed fasteners shall be vandal resistant.

B. (P702A) 36" x 36" Handicap Transfer Shower Unit with wall mounted, concealed supplies, type T/P combination valve:

1. Similar to P-702 but the unit shall include a fold up transfer seat with stainless steel support and stainless steel grab bars secured with stainless steel bolts to rear mounting plates.

### **2.13 EMERGENCY FIXTURES**

A. (P-708) Emergency Eye and Face Wash (Wall Mounted): CRS, wall mounted, foot pedal control. Mount eye and face wash spray heads 1067 mm (42 inches) above finished floor. Pedal shall be wall mounted, entirely clear of floor, and be hinged to permit turning up. Receptor shall be complete with drain plug with perforated strainer, P-trap and waste connection to wall with escutcheon. Provide with adjustable thermostatic mixing valve in recessed cabinet.

## **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.
- B. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls and related finish surfaces. Exposed heads of bolts and nuts in finished rooms shall be hexagonal, polished chrome plated brass with rounded tops.
- C. Through Bolts: For free standing marble and metal stud partitions refer to Section 10 21 13, TOILET COMPARTMENTS.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 6 mm (1/4 inch) diameter bolts, and to extend at least 76 mm (3 inches) into masonry and be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.

- F. Power Set Fasteners: May be used for concrete walls, shall be 6 mm (1/4 inch) threaded studs, and shall extend at least 32 mm (1 1/4 inches) into wall.
- G. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- H. Where water closet waste pipe has to be offset due to beam interference, provide correct and additional piping necessary to eliminate relocation of water closet.
- I. Do not use aerators on lavatories and sinks.

### **3.2 CLEANING**

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

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

**SECTION 22 62 00**  
**VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Central Laboratory and Healthcare Vacuum Systems: This section describes the labor, equipment, and services necessary for and incidental to the installation of piped medical vacuum systems. The scope of work shall include all necessary piping, fittings, valves, cabinets, station outlets and inlets, rough-ins, ceiling services, gages, alarms including low voltage wiring. Match existing station inlet terminal connections.
- B. The contractor shall provide all elements and accessories required for a complete system according to the most recent edition of NFPA 99C, Gas and Vacuum Systems.
- C. All necessary connections to owner furnished equipment shall be made as indicated on the documents. A separate construction isolation valve shall be made at the point of connection to an existing vacuum system.
- D. Pressure testing, cross connection testing and final testing per NFPA 99 most recent edition and using procedures shall be performed.
- E. The contractor shall retain a qualified third party medical vacuum verifier acceptable to the engineer and VA to perform and attest to final verification of the systems. The contractor shall make all corrections as determined by this third party verifier, including additional testing if necessary to attain full and unqualified certification.

**1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Sealing around pipe penetrations to maintain the integrity of time rated construction.
- B. Section 07 92 00, JOINT SEALANTS: Sealing around pipe penetrations through the floor to prevent moisture migration.
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General requirements and items common to more than one section of Division 22.
- D. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Alarm interface with ECC.

- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.
- F. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Control wiring.
- G. Section 26 27 26, WIRING DEVICES: Electrical wiring and accessories.
- H. Section 26 29 11, MOTOR CONTROLLERS: Motor starters.
- I. Section 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES: Laboratory and Healthcare Gases and Vacuum Alarms.
- J. Section 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES: Laboratory and Healthcare Gas Piping.
- K. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

### 1.3 QUALITY ASSURANCE

- A. Contractor shall include with submittals an affidavit attesting to compliance with all relevant paragraphs of NFPA 99 most recent edition. Personnel assembling medical vacuum and WAGD system shall meet NFPA 99 5.1.10.11.10 "Qualification of Installers" and hold medical gas endorsements as under ASSE Standard Series 6000. The Contractor shall, on company letterhead, furnish documentation attesting that all installed piping materials were purchased cleaned and complied with the requirements of NFPA 99 5.1.10.1 and 5.1.10.2. Electrical Control systems and Medical vacuum Alarms are to be UL listed as assemblies with label affixed. Medical vacuum and WAGD controls are to be wired in accordance with NEC.
- B. Equipment Installer: The equipment installer shall provide documentation proving that the personnel installing the equipment meet the standards set by ASSE Standard Series 6000. Show technical qualifications and previous experience in installing medical gas equipment on three similar projects. Submit names, phone numbers, and addresses of referenced projects. The equipment installer shall perform the following coordination functions:
  - 1. Coordinate with other trades to ensure timely installations and avoid conflicts and interferences.
  - 2. Coordinate and field verify with the metal stud partition installer and/or mason to ensure anchors, sleeves and similar items are

- provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.
3. Coordinate with VA to ensure medical vacuum inlets, whether owner supplied or contractor supplied, in walls, ceiling and all equipment is provided by the same Medical Vacuum Equipment Manufacturer satisfactory to the owner.
  4. The contractor shall coordinate with the Medical Vacuum System Verifier to deliver a complete, operational, and tested medical gas installation ready for owner's use.
- C. Equipment Supplier: The Equipment supplier shall demonstrate evidence of installing equivalent product at three installations similar to this project that has been in satisfactory and efficient operation for three years. Names, phone numbers, and addresses where the product is installed shall be submitted for verification.
- D. Medical Gas System Testing Organization: The Medical vacuum verifier shall show documentation proving that the medical gas verifier meets the standards set by ASSE Standard Series 6000. The testing shall be conducted by a party technically competent and experienced in the field of medical gas pipeline testing. Such testing shall be performed by a third party testing company independent of the installing and general contractor.
- E. Names of three projects where testing of vacuum systems has been performed by the testing agency shall be provided. The name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification shall be included in the documentation.
- F. The testing agency's detailed procedure shall be followed in the testing of this project and submitted to COR 10 working days prior to testing. In the testing agency's procedure documentation, include details of the testing sequence, procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, data on test methods,



types of equipment to be used, calibration sources and method references shall be submitted.

- G. Installation and Startup: The manufacturer shall provide factory authorized representatives to review the installation and perform the initial startup of the system. The factory authorized representatives shall submit a report to the COR and to the Contractor. The Contractor shall make all corrections identified by the factory authorized representative at no additional cost or time to the Government.
- H. Certification: The Final inspection 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 allowed by this specification.

#### **1.4 SUBMITTALS**

- A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Complete specifications for the product intended to be installed, dimensional drawings, and wiring schematics.
  - 2. Package drawing indicating package style, dimensions when complete, method of disassembly and sizes of subsections for rigging and installation.
  - 3. Piping.
  - 4. Valves.
  - 5. Inlet and outlet cocks
  - 6. Valve cabinets.
  - 7. Gages.
  - 8. Station inlets, and rough in assemblies.
  - 9. Vacuum switches.
  - 10. Vacuum bottle brackets.
- C. Station Inlets: A letter from manufacturer shall be submitted stating that inlets are designed and manufactured to comply with NFPA 99. Inlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation.

In lieu of above labels, certificate may be submitted by a nationally recognized independent testing laboratory, satisfactory to the Contracting Officer, certifying that materials, appliances and assemblies conform to published standards, including methods of tests, of above organizations.

- D. Certification: The completed systems have been installed, tested, purged and analyzed in accordance with the requirements of this specification. Certification shall be submitted to Contracting Officer Representative.
- E. A notarized affidavit from the verifier stating that the verifier undertakes to verify this project and thus agrees to disqualify themselves from supplying any equipment which will be included in the scope of their verification. No verifier who supplies equipment shall be permitted to verify that equipment. Statement declaring that the vacuum system manufacturer has no fiduciary interest in the verifier and that the verifier is not an agent or representative of the vacuum system manufacturer. Statement declaring that the contractor has no fiduciary interest in the third party verifier and that the third party verifier has no fiduciary interest in the contractor.

**1.5 TRAINING**

- A. The services of a competent instructor shall be provided for not less than two four-hour periods for instructing medical personnel in the operation and maintenance of the vacuum systems, on the dates requested by COR (Contracting Officer Representative).
- B. The other training requirements specified in Section 01 00 00, GENERAL REQUIREMENTS shall be coordinated with the above paragraph.

**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 test by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  - A13.1-2007 (R2013).....Scheme for the Identification of Piping Systems
  - B16.15-2013.....Cast Copper Alloy Threaded Fittings: Classes 125 and 250

- B16.22-2013.....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings
- B16.50-2013.....Wrought Copper and Copper Alloy Braze-Joint  
Pressure Fittings
- B40.100-2013..... Pressure Gauges and Gauge Attachments  
ASME Boiler and Pressure Code -  
BPVC Section IX-2015....Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):  
6000 Series-2012.....Professional Qualifications Standard for  
Medical Gas Systems Personnel
- D. American Society for Testing and Materials (ASTM):  
B43-2014.....Standard Specification for Seamless Red Brass  
Pipe, Standard Sizes  
B687-1999 (2011).....Standard Specification for Brass, Copper, and  
Chromium-Plated Pipe Nipples  
B819-2000 (R2011).....Standard Specification for Seamless Copper Tube  
for Medical Gas Systems  
D1785-2012.....Standard Specification for Poly (Vinyl  
Chloride) (PVC) Plastic Pipe, Schedules 40, 80,  
and 120
- E. American Welding Society (AWS):  
A5.8M/A5.8-2011-AMD1....Specification for Filler Metals for Brazing and  
Braze Welding  
B2.2/B2.2M-2010.....Specification for Brazing Procedure and  
Performance Qualification
- F. Compressed Gas Association (CGA):  
P-9-2008.....The Inert Gases: Argon, Nitrogen, and Helium
- G. Manufacturing Standardization Society (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
- H. National Electrical Manufacturers Association (NEMA):  
ICS 6-1993 (R2001, R2006) Industrial Control and Systems Enclosures

- I. National Fire Protection Association (NFPA):
  - 70-2014.....National Electrical Code
  - 99-2015.....Health Care Facilities Code

**1.7 WARRANTY**

- A. Warranty will be expressly complete, include all components of the system and be the responsibility of the vacuum system manufacturer of record only. Warranties limiting the responsibility of the vacuum system for any system component or which pass through to another manufacturer are not acceptable.
- B. Warranties shall include on site repairs including travel, labor and parts. Warranties requiring return of equipment for adjustment are not acceptable.

**1.8. MAINTENANCE SUPPORT**

- A. The medical vacuum equipment manufacturer shall demonstrate a national factory direct service capability able to perform major overhauls. The medical vacuum equipment manufacturer shall provide factory direct preventative maintenance contract. The medical vacuum equipment manufacturer shall provide formal maintenance training courses.

**1.9 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD and 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 shall be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 13 or later 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 GENERAL PRODUCT REQUIREMENTS**

- A. A single Medical Vacuum Equipment Manufacturer shall supply the medical vacuum system(s) and equipment to include outlets, valves and gauges, valve boxes, alarm panels.

### **2.2 PIPING**

- A. Copper Tubing: Copper tubing shall be type "K" or "L", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ANSI B16.22 or brazing fittings complying with MSS SP-73. The copper tubing size designated reflects nominal inside diameter. All tubing and fittings shall be labeled "ACR/OXY", "OXY", "OXY/MED", "ACR/MED", or "MED".
- B. Brazing Alloy: The brazing alloy shall comply with AWS A5.8, Classification BCuP, greater than 537 °C (1000 °F) melting temperature. Flux shall be strictly prohibited for copper to copper connections.
- C. Screw Joints: Screw joints shall use polytetrafluoroethylene (teflon) tape.

- D. Use only copper or stainless steel pipes for discharge from vacuum product (exhaust pipes).
- E. Memory metal couplings shall have temperature and pressure ratings not less than that of a brazed joint.
- F. Piping identification labels shall be applied at time of installation in accordance with current NFPA. Supplementary color identification shall be in accordance with CGA Pamphlet C-9.
- G. Special Fittings: The following special fittings shall be permitted to be used in lieu of brazed joints:
  - 1. Memory-metal couplings having temperature and pressure ratings joints not less than that of a brazed joint.
  - 2. Listed or approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.
  - 3. Dielectric fittings where required by the manufacturer of special medical equipment to electrically isolate the equipment from the piping distribution system.
  - 4. Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable.

### **2.3 EXPOSED LABORATORY AND HEALTHCARE VACUUM PIPING**

- A. Finished Room: Use full iron pipe size chrome plated brass piping shall be used for exposed laboratory and healthcare vacuum piping connecting fixtures, casework, cabinets, and equipment when not concealed by apron including those furnished by the Government or specified in other sections.
  - 1. Pipe: Fed. Spec. WW-P-351, standard weight.
  - 2. Fittings: Fittings shall comply with ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
  - 3. Nipples: Nipples shall comply with ASTM B 687, Chromium-plated.
  - 4. Unions: Unions shall comply with Mss SP-72, SP-110, Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

5. Valves: Valves shall comply with Mss SP-72, SP-110, Brass or bronze with chrome finish.

#### 2.4 VALVES

- A. Ball: Ball valves shall be in line, other than zone valves in cabinets.

1. Sixty five millimeter or DN65 (2-1/2 inches) and smaller: Ball valves shall be bronze/ brass body, Fed. Spec. MSS SP72 & SP 110 , Type II, Class 150, Style 1, with tubing extensions for brazed connections, full ported, three piece or double union end connections, teflon seat seals, full flow, 4125 kPa (600 psi) WOG minimum working pressure, with locking type handle.
2. Eighty millimeter or DN80 to 100 millimeter or DN100 (3" to 4" inches): Ball valves shall be bronze/ brass body, Fed. Spec. MSS SP72 & SP 110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full ported, three piece, double seal, teflon seals, full flow, 4125 kPa (600 psi) WOG minimum working pressure, with locking type handle.

- B. Check:

1. Check valves eighty millimeters (DN80) (3 inches) and smaller: brass and Bronze body, straight through design for minimum pressure drop, spring loaded, self aligning with teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into, 2750 kPa (400 psi) WOG minimum working pressure.
2. One hundred millimeter or DN100 (4 inches) and larger check valves shall be iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, 1025 kPa (150 psi) WSP.

- C. Zone valve in cabinet shall be ball valve with bronze/ brass body, double seal, three piece or double union end connections, replaceable teflon seat seals, teflon stem seal, 4125 kPa (600 psi) WOG, cold, non shock gas working pressure or vacuum service to 29 inch Hg, blowout proof stem, one quarter turn of handle to completely open or close. Tubing extensions, factory brazed, pressure tested, cleaned for oxygen service shall be provided. A 3 mm (1/8 inches) NPT gauge port shall be provided for a 50mm (2 inch) diameter monitoring gauge downstream of the shut off valve. Zone valves shall be securely attached to the

cabinet and provided with type-K copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color coded stick on labels. Valves shall be in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels is as follows:

| SERVICE LABEL  | IDENTIFICATION COLORS             | MFG. STD. CLR. |
|----------------|-----------------------------------|----------------|
| MEDICAL VACUUM | Black letters on white background | WHITE          |

**2.5 VALVE CABINETS**

- A. Valve cabinets shall be flush mounted, commercially available item for use with medical gas services, constructed from steel not lighter than 1.3 mm (18 gage) steel or extruded aluminum not lighter than 1.9 mm (14 gage). The valve cabinets shall be rigidly assembled, of adequate size to accommodate all valve(s) and fittings indicated. Holes shall be predrilled to receive pipe connections. These pipe connections shall be made outside of the valve box. Anchors shall be provided to secure cabinet to wall construction. Openings in cabinet shall be sealed to be dust tight. Bottom of cabinet shall be located 1375 mm (4 foot 6 inches) above finished floor.
- B. Engraved rigid plastic identification plate shall be mounted on the wall above or adjacent to the cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate shall be clearly visible at all times. Inscriptions shall be provided on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS." The final wording must be approved by the VA project manager.
- C. Cover plate: The cover plate shall be fabricated from 1.3 mm (18 gage) sheet metal with satin chromed finish, extruded anodized aluminum, or .85 mm (22 gage) stainless steel. A cover window shall be provided of replaceable plastic, with a corrosion resistant device or lever secured to window for emergency window removal. The following shall be permanently painted or stenciled on window: "FOR EMERGENCY SHUT-OFF



VALVES ONLY, SHUT OFF VALVES FOR PIPED GASES", or equivalent wording. The valve cabinet shall be configured such that it is not possible to install window with any valve in the closed position. Each valve shall have a pressure gauge upstream of valve and this pressure gauge shall be inside valve box.

- D. Cabinets and isolation valves shall be located and piped as shown, and at a minimum, so as to allow the isolation of each smoke compartment separately. Each cabinet shall serve no more than one smoke compartment.

## **2.6 GAGES**

### **A. Vacuum Gages:**

1. For vacuum line adjacent to source equipment the vacuum gages shall comply with ANSI B40.1, vacuum gage type, size 115 mm (4-1/2 inches), gage listed for vacuum, accurate to within 2-1/2 percent, with metal case. The vacuum gage range shall be 0 to -100 kPa (0-30 inches Hg). Dial graduations and figures shall be black on a white background, or white on a black background. Label shall be for vacuum service. A gage cock shall be installed. Compound gages shall be installed for Vacuum system.
2. For vacuum service upstream of main shutoff valve: A 40 mm (1-1/2 inches) diameter gage shall be provided with steel case, bourdon tube and brass movement, dial range 0 to -100 kPa (0-30 inches Hg). Compound gages shall be provided for Vacuum system.

## **2.7 STATION INLETS**

For all services: Brass, stainless steel or chromed metal non-interchangeable DISS connections for appropriate service to conform with CGA V-5. Equip each station inlet with an automatic valve to conform with NFPA 99. Place valves in the assembly to provide easy access after installation, for servicing and replacement, and to facilitate line blow-out, purging, and testing. Fasten each inlet securely to inlet rough-in to prevent floating, and provide each inlet with a capped stub length of 6 mm (1/4-inch) (10 mm (3/8-inch) outside diameter) tubing for connection to supply. Label stub tubing for

appropriate service. Adjustable to compensate for variations in plaster or cover thickness. Rough-in kits and test plugs for Prefabricated Bedside Patient Units (PBPU) are furnished under this specification but installed by manufacturer of PBPUs before initial tests specified herein. Install outlet completion kits (valve body and face plate) for the remainder of required tests.

**2.8 STATION INLET ROUGH-IN**

- A. Flush mounted, protected against corrosion. Anchor rough-in securely to unit or wall construction.
- B. Modular Cover Plate: Die cast plate, two-piece .85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal, secured to rough-in with stainless steel or chromium plated countersunk screws.
- C. Cover Plate for Prefabricated Bedside Patient Units (PBPU): One-piece with construction and material as indicated for modular cover plate.
- D. Provide permanent, metal or plastic, identification plates securely fastened at each inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

| SERVICE LABEL  | IDENTIFICATION PLATE COLORS       |
|----------------|-----------------------------------|
| MEDICAL VACUUM | Black letters on white background |

**2.9 VACUUM SWITCHES**

General purpose, contact or mercury type, allowing both high and low set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Use one orifice nipple (or DISS demand check valve) for each sensor switch.

**2.10 VACUUM BOTTLE BRACKET**

- A. Vacuum bottle bracket shall be single plate of one piece, 0.85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal or aluminum, finish matching cover of adjoining vacuum inlet. All components shall be of same material as plate and assembly and anchored

securely to structure. The bracket shall be provided and plastic vacuum bottle holder for each vacuum wall inlet.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. All installation shall be performed in strict accordance with NFPA 99 5.1.10. Brazing procedures shall be as detailed in NFPA 99 5.1.10.5. Brazing shall be performed only by brazers qualified under NFPA 99 5.1.10.10.11. Where piping runs underground, the installation shall be made in accordance with NFPA 99 5.1.10.10.5.
- B. Cast escutcheon shall be installed with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- C. Open ends of tube shall be capped or plugged at all times or otherwise sealed until final assembly.
- D. Piping shall be cut square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. the tubing shall be reamed to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. The tubing shall be worked into place without springing or forcing. The tubing shall be bottomed in socket so there are no gaps between tube and fitting. Care shall be exercised in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease from being introduced into the tubing. Where contamination has occurred, material shall be no longer suitable for vacuum service and new, sealed tube sections used..
- E. Piping shall be supported with pipe trays or hangers at intervals as shown on the drawings or as defined in NFPA 99 Table 5.1.10.10.4.5. Piping shall not be supported by other piping. Isolation of copper piping from dissimilar metals shall be of a firm, positive nature. Duct tape is not acceptable as an isolation material..
- F. Valves and other equipment shall be rigidly supported to prevent strain on tube or joints.
- G. Piping exposed to physical damage shall be protected.
- H. During any brazing operation, the interior of the pipe shall be purged continuously with oil free, dry nitrogen NF, following the procedure in

NFPA 99 5.1.10.5.5. At the completion of any section, all open pipe ends shall be capped using an EXTERNAL cap. The flow of purged gas shall be maintained until joint is cool to touch. The use of flux is prohibited when making of joints between copper to copper pipes and fittings.

- I. Threaded joints in piping systems shall be avoided whenever possible. Where unavoidable, make up the male threads with polytetrafluorofethylene (such as Teflon) tape. Liquid sealants shall not be used.
- J. Tubing shall not be bent. Fittings shall be used in all change of direction or angle.
- K. After installation of the piping, but before installation of the outlet valves, blow lines clear using nitrogen NF.
- L. Pressure and vacuum switches, transmitter and gauges shall be installed to be easily accessed, and provide access panel where installed above plaster ceiling. Pressure switch and sensors shall be installed with orifice nipple between the pipe line and switches/sensors.
- M. Pipe labeling shall be applied during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.
- N. After initial leakage testing is completed, the piping shall be allowed to remain pressurized with testing gas until testing agency performs final tests.
- O. Penetrations:
  - 1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, fire stopping 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 with the fire stopping material shall be completely filled and sealed..
  - 2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- P. Piping shall be labeled with name of service, identification color and direction of flow. Where non-standard pressures are piped, pressure

shall be labeled. Labels shall be placed at least once every 20 feet of linear run or once in each story (whichever is more frequent). A label shall additionally be placed immediately on each side of all wall or floor penetrations. Pipe labels shall be self adhesive vinyl type or other water resistant material with permanent adhesive colored in accordance with NFPA 99 Table 5.1.11 and shall be visible on all sides of the pipe. Each master alarm signal shall be labeled for function after ring out. Each zone valve shall be labeled and each area alarm labeled for the area of control or surveillance after test. Labels shall be permanent and of a type approved by the VAMC

- Q. Alarms and valves shall be labeled for service and areas monitored or controlled. Coordinate with the VAMC for final room or area designations. Valves shall be labeled with name and identification color of the gas and direction of flow.

### **3.2 INSTALLER TESTING**

- A. Prior to declaring the lines ready for final verification, the installing contractor shall strictly follow the procedures for verification as described in NFPA 99 5.1.12.2 and attest in writing over the notarized signature of an officer of the installing company the following;
1. That all brazing was conducted by brazers qualified to ASSE 6010 and holding current medical gas endorsements.
  2. That all brazing was conducted with nitrogen purging. (Procedure per NFPA 99 5.1.10.5.5).
  3. That the lines have been blown clear of any construction debris using oil free dry nitrogen or air are clean and ready for use. (Procedure per NFPA 99 5.1.12.2.2).
  4. That the assembled piping, prior to the installation of any devices, maintained a test pressure 1 1/2 times the standard pressures listed in NFPA 99 Table 5.1.11 without leaks. (Procedure per NFPA 99 5.1.12.2.3).
  5. That after installation of all devices, the pipeline was proven leak free for 24hours at a pressure 20% above the standard pressures listed in NFPA 99 Table 5.1.11. (Procedure per NFPA 99 5.1.12.2.2.6)

6. That the systems have been checked for cross connections and none were found. (Procedure per NFPA 99 5.1.12.2.4)
  7. That the manufacturer has started up all medical air compressors, medical vacuum pumps WAGD producers, liquid oxygen system(s) and manifolds, and that they are in operating order.
- B. Four originals of the affidavit, shall be distributed; (1) to the contracting officer representative, (1) to the general contractor and (1) to the verifier ([www.mgpho.org](http://www.mgpho.org)).

### **3.3 CONNECTION TO EXISTING LABORATORY VACUUM SYSTEM**

- A. Contactor shall test the existing system for hydrocarbons, dew point, etc. per NFPA 99. If problems are present, the COR would notify the facility of the results. The facility would then make the necessary repairs and/or maintenance.
- B. Double shut-off valves shall be installed at the connection of new line to existing line.
- C. Time for shutdown of the existing vacuum system shall be coordinated at least 10 work days prior to shutdown with the COR and VA Medical Center.
- D. Prior to any work being done, new pipeline shall be checked for particulate or other forms of contamination per NFPA 99.
- E. Ensure that the correct type of pipe tubing and fittings are being used.
- F. A spot check of the existing pipelines shall be made in the facility to determine the level of cleanness present.
- G. The tie-in shall be made as quickly as possible. A nitrogen purge is not required since this would require another opening in the pipe.
- H. After the tie-in is made and allowed to cool, slowly bleed the source vacuum back into the pipeline. Test the work area for leaks with soapy water and repair any leaks.
- I. After all leaks, if any, are repaired and the line is fully recharged, perform blow down and testing. Open the zone that is closest to the main to the system, access the closest outlet to the work, and blow the main through the inlet. After the inlet blows clear into a white cloth,

make an additional check at a zone most distant from the work. Perform all required NFPA 99 tests after connection.

### **3.4 COMMISSIONING**

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

### **3.5 VERIFIER TESTING**

- A. Prior to handing over the systems to VAMC, the contractor shall retain a Verifier acceptable to the engineer and owner who shall follow strictly the procedures for verification as described in NFPA 99 5.1.12.3 and provide a written report and certificate bearing the notarized signature of an officer of the verification company which contains at least the following:
  - 1. A current ACORD insurance certificate indicating professional liability coverage in the minimum amount of \$1 Million per occurrence, and general aggregate liability in the minimum amount of \$1 Million, valid and in force when the project is to be verified. General liability insurance is not alone acceptable.
  - 2. An affidavit bearing the notarized signature of an officer of the verification company stating that the verification company is not the supplier of any equipment used on this project or tested in this report and that the verification contractor has no relationship to, or pecuniary interest in, the manufacturer, seller, or installer of any equipment used on this project or tested in this report
  - 3. A listing of all tests performed, listing each source, outlet, valve and alarm included in the testing.
  - 4. An assertion that all tests were performed by a Medical Vacuum System Certified Medical Gas or vacuum Verifier or by individuals qualified to perform the work and holding valid qualifications to ASSE 6030 and under the immediate supervision a Verifier. Include the names, credential numbers and expiration dates for all individuals working on the project.

5. A statement that equipment used was calibrated at least within the last six months by a method traceable to a National Bureau of Standard Reference and enclosing certificates or other evidence of such calibration(s). Where outside laboratories are used in lieu of on site equipment, those laboratories shall be named and their original reports enclosed.
6. A statement that where and when needed, equipment was re calibrated during the verification process and describing the method(s) used.
7. A statement that the systems were tested and found to be free of debris to a procedure per NFPA 99 5.1.12.3.7.
8. The flow from each outlet when tested to a procedure per NFPA 99-5.1.12.3.10.
9. A statement that the systems were tested and found to have no cross-connections to a procedure per NFPA 99 5.1.12.3.3.
10. A statement that the systems were tested and found to be free of contaminants to a procedure per NFPA 99 5.1.12.3.8 except that the purity standard shall be 2 ppm difference for halogenated hydrocarbons and 1 ppm total hydrocarbons (as methane).
11. Statement that all local signals function as required under NFPA 99 5.1.3.4.7 and as per the relevant NFPA 99 sections relating to the sources.
12. A listing of local alarms, their function and activation per NFPA 99 5.1.12.3.14.
13. A listing of master alarms, their function and activation, including pressures for high and low alarms per NFPA 99 5.1.12.3.5.2.
14. A listing of area alarms, their function and activation pressures per NFPA 99 5.1.12.3.5.3.
15. A statement that the sources include all alarms required by NFPA 99 Table A.5.1.9.5.
16. The concentration of each component of NFPA 99 Table 5.1.12.3.12 in the medical air after 24 hours of operation of the medical air source.
17. The concentration of each gas at each outlet as specified in NFPA 99 5.1.12.3.11.



18. A statement that all valves and alarms are accurately labeled as to zone of control.
- B. Perform and document all cross connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with, current NFPA and the procedures set forth in pre-qualification documentation.
- C. Verify that the systems, as installed, meet or exceed the requirements of current NFPA, this specification, and that the systems operate as required.
- D. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 1000 liters (35 cubic feet) of gas through a clean white 0.45 micron filter at a minimum velocity of 100 mps (3.5 fpm). Filter shall show no discoloration, and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9.
- E. Inlet flow test:
1. Test all inlets for flow. Perform test with the use of an inert gas as described in CGA P-9.
  2. Vacuum inlets must draw no less than 85 Lpm (3.0 scfm) with adjacent inlet flowing, at a dynamic inlet pressure of 40 kPa (12-inches Hg), and a static vacuum of 50 kPa (15-inches Hg).

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**SECTION 22 63 00**  
**GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Central Laboratory and Healthcare Gas Systems: Consisting of oxygen, and compressed medical air services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets, rough-ins, gages, and alarms including low voltage wiring. Match existing station outlet and inlet terminal connections.
- B. Laboratory and healthcare gas system alarm wiring from equipment to alarm panels.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING: Sealing around pipe penetrations to maintain the integrity of time rated construction.
- F. Section 07 92 00, JOINT SEALANTS: Sealing around pipe penetrations through the floor to prevent moisture migration.
- G. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General requirements and items common to more than one section of Division 22.
- H. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT: Electric motors.
- I. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.
- J. SECTION 22 62 00, VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES: Vacuum Piping and Equipment.
- K. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Alarm interface with BAS.
- L. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Control wiring.
- M. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.
- N. Section 26 27 26, WIRING DEVICES: Electrical wiring and accessories.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  - A13.1-2007 (R2013).....Scheme for the Identification of Piping Systems
  - B16.15-2013.....Cast Copper Alloy Threaded Fittings: Classes 125 and 250
  - B16.22-2013.....Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
  - B16.50-2013.....Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
  - B40.100-2013.....Pressure Gauges and Gauge Attachments
  - ASME Boiler and Pressure Vessel Code -
  - BPVC Section VIII-2015..Rules for Construction of Pressure Vessels, Division I
  - BPVC Section IX-2015....Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):
  - 6000 Series-2012.....Professional Qualifications Standard for Medical Gas Systems Personnel
- D. American Society for Testing and Materials (ASTM):
  - B43-2014.....Standard Specification for Seamless Red Brass Pipe, Standard Sizes
  - B687-1999 (2011).....Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
  - B819-2000 (R2011).....Standard Specification for Seamless Copper Tube for Medical Gas Systems
  - D1785-2012.....Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- E. American Welding Society (AWS):
  - A5.8M/A5.8-2011.....Specification for Filler Metals for Brazing and Braze Welding
  - B2.2/B2.2M-2010.....Specification for Brazing Procedure and Performance Qualification
- F. Compressed Gas Association (CGA):
  - C-9-2013.....Standard Color Marking of Compressed Gas Containers for Medical Use
  - G-4.1-2009.....Cleaning Equipment for Oxygen Service
  - G-10.1-2008.....Commodity Specification for Nitrogen

P-9-2008.....The Inert Gases: Argon, Nitrogen, and Helium  
V-1-2013.....Standard for Compressed Gas Cylinder Valve  
Outlet and Inlet Connections

G. Manufacturing Standardization Society (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

H. National Electrical Manufacturers Association (NEMA):

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

I. National Fire Protection Association (NFPA):

99-2015.....Health Care Facilities 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 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES", with applicable paragraph identification.

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

1. Piping.

2. Valves.

3. Inlet and outlet cocks

4. Valve cabinets.

5. Gages.

6. Station outlets and rough-in assemblies.

7. Alarm controls and panels.

8. Pressure Switches.

D. Station Outlets: Submit letter from manufacturer stating that outlets are designed and manufactured to comply with NFPA 99. Outlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation.

E. Certification: The completed systems have been installed, tested, purged, analyzed and verified in accordance with the requirements of this specification. Certification shall be submitted to COR.

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

#### **1.5 QUALITY ASSURANCE**

- A. Materials and Installation: In accordance with NFPA 99 and as specified.
- B. Equipment Installer: Show technical qualifications and previous experience in installing laboratory and healthcare equipment on three similar projects. Submit names, phone numbers, and addresses of referenced projects. Installers shall meet the qualifications of ASSE Standard Series 6000.
- C. Equipment Supplier: Provide evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years. Submit names, phone numbers, and addresses where the product is installed.
- D. Laboratory and healthcare System Testing Organization: The testing shall be conducted by a party technically competent and experienced in the field of laboratory and healthcare pipeline testing. Testing and systems verification shall be performed by personnel meeting the qualifications of ASSE Standard Series 6000. Such testing shall be performed by a party other than the installing contractor.
- E. Provide the names of three projects where testing of medical or laboratory gases systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.
- F. Submit the testing agency's detailed procedure which shall be followed in the testing of this project. Include details of the testing sequence, procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.
- G. Certification: Provide COR documentation 10 working days prior to submitting request for final inspection to 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 allowed by this specification.

- H. "Hot taps" are prohibited for operating medical oxygen systems. Methods for connection and extension of active and pressurized medical gas systems without subsequent medical gas testing and verification are prohibited.

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

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD and inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 13 or later 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 PIPING AND FITTINGS**

- A. Copper Tubing: Type "K", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ASME B16.22 or brazing fittings complying with MSS SP-73. Size designated reflecting nominal inside diameter. All tubing and fittings shall be labeled "ACR/OXY", "OXY", "OXY/MED", "ACR/MED", or "MED".
- B. Brazing Alloy: AWS A5.8, Classification BCuP, greater than 537 °C (1000 °F) melting temperature. Flux is strictly prohibited for copper-to-copper connections.
- C. Screw Joints: Polytetrafluoroethylene (teflon) tape.
- D. Memory metal couplings: Temperature and pressure rating shall not be less than that of a brazed joint.
- E. Apply piping identification labels at the time of installation in accordance with current NFPA 99. Apply supplementary color identification in accordance with CGA Pamphlet C-9.
- F. Special Fittings: The following special fittings shall be permitted to be used in lieu of brazed joints:
  - 1. Memory-metal couplings having temperature and pressure ratings joints not less than that of a brazed joint.
  - 2. Listed or approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.
  - 3. Dielectric fittings where required by the manufacturer of special medical equipment to electrically isolate the equipment from the piping distribution system.
  - 4. Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable.

### **2.2 EXPOSED LABORATORY AND HEALTHCARE GASES PIPING**

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed laboratory and healthcare gas piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
  - 1. Pipe: Fed. Spec. WW-P-351, standard weight.
  - 2. Fittings: ASME B16.15 cast bronze threaded fittings with chrome finish, (125 and 250 PS1 Classes).

3. Nipples: ASTM B 687, Chromium-plated.
4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
5. Valves: Mss SP-72, SP-110, Brass or bronze with chrome finish.

### 2.3 VALVES

A. Ball: In-line, other than zone valves in cabinets:

1. 75 mm (3 inches) and smaller: Bronze/ brass body, MSS SP-72, MSS SP-110, Type II, Class 150, Style 1, with tubing extensions for brazed connections, full port, three-piece or double union end connections, Teflon seat seals, full flow, 4138 kPa (600 psig) WOG minimum working pressure, with locking type handle, cleaned for oxygen use and labeled for intended service.
2. 75 to 100 mm (3 to 4 inches): Bronze/ brass body, MSS SP-72 MSS SP-110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full port, three piece, double seal, Teflon seals, full flow, 4138 kPa (600 psig) WOG minimum working pressure, with locking type handle, cleaned for oxygen use and labeled for intended service.

B. Check:

1. 75 mm (3 inches) and smaller: Bronze/brass body, straight through design for minimum pressure drop, spring loaded, self-aligning with Teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into, cleaned for oxygen use and labeled for intended service, 2758 kPa (400 psig) WOG minimum working pressure.
2. 100 mm (4 inches) and larger: Iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, with flow direction arrow permanently cast into, cleaned for oxygen use and labeled for intended service, 1035 kPa (150 psig) WSP.

C. Zone Valve in Cabinet: Ball valve, bronze/ brass body, double seal, three piece or double union end connections, replaceable teflon seat seals, teflon stem seal, 4125 kPa (600 psi) WOG, cold, non-shock gas working pressure service to 100 kPa (29 inch Hg), cleaned for oxygen use and labeled for intended service, blowout proof stem, one quarter turn of handle to completely open or close. Provide tubing extensions factory brazed, and pressure tested. Provide 3 mm (1/8 inch) NPT gauge port for a 50mm (2 inch) diameter monitoring gauge downstream of the shut off valve. Zone valves shall be securely attached to the cabinet and



provided with type-K copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color coded stick-on labels. Install valves in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels is as follows:

| <b>SERVICE LABEL</b> | <b>IDENTIFICATION COLORS</b>                | <b>MFG. STD.<br/>CLR.</b> |
|----------------------|---|---------------------------|
| OXYGEN               | White letters on green background           | GREEN                     |
| MEDICAL AIR          | Black or white letters on yellow background | YELLOW                    |

#### 2.4 VALVE CABINETS

- A. Flush mounted commercially available item for use with laboratory and healthcare services, not lighter than 1.3 mm (18 gage) steel or 1.9 mm (14 gage) extruded aluminum, rigidly assembled, of adequate size to accommodate valve(s) and fittings. Punch or drill sides to receive tubing. Provide anchors to secure cabinet to wall construction. Seal openings in cabinet to be dust tight. Locate bottom of cabinet 1375 mm (4 foot 6 inches) above floor.
- B. Mount engraved rigid plastic identification plate on wall above or adjacent to cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate must be clearly visible at all times. Provide inscriptions on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS."
- C. Cover plate: Fabricate from 1.3 mm (18 gage) sheet metal with satin chromed finish, extruded anodized aluminum, or .85 mm (22 gage) stainless steel. Provide cover window of replaceable plastic, with a corrosion resistant device or lever secured to window for emergency window removal. Permanently paint or stencil on window: CAUTION-CLOSE ONLY IN EMERGENCY, SHUT-OFF VALVES FOR PIPED GASES", or equivalent wording. Configure such that it is not possible to install window with any valve in the closed position. Each valve shall have gauge upstream of valve inside valve box.
- D. Cabinets and isolation valves shall be located and piped as shown, and at a minimum, so as to allow the isolation of each smoke compartment separately. No cabinet shall serve more than one smoke compartment.

## 2.5 GAGES

- A. Pressure Gages: Includes gages temporarily supplied for testing purposes.
1. For line pressure use adjacent to source equipment: ASME B40.1, pressure gage, single, size 115 mm (4-1/2 inches), for compressed air, nitrogen and oxygen, accurate to within two percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on a white background, or white on a black background. Gage shall be cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Install with gage cock.
  2. For all services downstream of main shutoff valve: Manufactured for oxygen use, labeled for the appropriate service and marked "USE NO OIL", 40 mm (1-1/2 inch) diameter gage with dial range 1-690 kPa (1-100 psi) for air and oxygen services.

## 2.6 STATION OUTLETS

For all services: Brass, stainless steel or chromed metal non-interchangeable DISS connections for appropriate service to conform with CGA V-5. Equip each station outlet with an automatic valve and a secondary check valve to conform with NFPA 99. Equip each station inlet with an automatic valve to conform with NFPA 99. Place valves in the assembly to provide easy access after installation, for servicing and replacement, and to facilitate line blow-out, purging, and testing. Fasten each outlet securely to outlet rough-in to prevent floating, and provide each outlet with a capped stub length of 6 mm (1/4-inch) (10 mm (3/8-inch) outside diameter) tubing for connection to supply. Label stub tubing for appropriate service. Adjustable to compensate for variations in plaster or cover thickness. Rough-in kits and test plugs for Prefabricated Bedside Patient Units (PBPU) are furnished under this specification but installed by manufacturer of PBPU's before initial tests specified herein. Install outlet completion kits (valve body and face plate) for the remainder of required tests.

## 2.7 STATION OUTLET ROUGH-IN

- A. Flush mounted, protected against corrosion. Anchor rough-in securely to unit or wall construction.
- B. Modular Cover Plate: Die cast plate, two-piece .85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal, secured to

- rough-in with stainless steel or chromium plated countersunk screws.
- C. Cover Plate for PBP: One-piece with construction and material as indicated for modular cover plate.
  - D. Provide permanent, metal or plastic, identification plates securely fastened at each outlet and inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

| SERVICE LABEL | IDENTIFICATION PLATE COLORS       |
|---------------|-----------------------------------|
| OXYGEN        | White letters on green background |
| MEDICAL AIR   | Black or white letters on yellow  |

## 2.8 PRESSURE SWITCHES

General purpose, contact or mercury type, allowing both high and low pressure set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Use one orifice nipple (or DISS demand check valve) for each sensor or pressure switch.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. In accordance with current NFPA 99.
- B. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- C. Keep open ends of tube capped or plugged at all times or otherwise sealed until final assembly.
- D. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, material is no longer suitable for oxygen service.
- E. Spacing of hangers: Current NFPA 99.

- F. Rigidly support valves and other equipment to prevent strain on tube or joints.
- G. While being brazed, joints shall be continuously purged with *oil free* nitrogen. The flow of purged gas shall be maintained until joint is cool to touch.
- H. Do not bend tubing. Use fittings.
- I. Install pressure switches, transmitter and gauges to be easily accessed, and provide access panel where installed above plaster ceiling. Install pressure switch and sensors with orifice nipple between the pipe line and switches/sensors.
- J. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.
- K. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.
- L. Penetrations:
  - 1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with intumescent materials only. Completely fill and seal clearances between raceways and openings with the fire stopping material.
  - 2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- M. Provide 40 mm (1-1/2 inch) diameter line pressure gage downstream of zone valve in cabinets.
- N. Provide zone valves in cabinets where indicated and outside each Operating Room and a minimum one zone valve assembly for each 18 outlet set.

### 3.2 TESTS

- A. Initial Tests: Blow down, and high and low pressure leakage tests as required by current NFPA with documentation.
- B. Laboratory and healthcare testing agency shall perform the following:
  - 1. Perform and document all cross connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with, current NFPA and the procedures set forth in pre-qualification documentation.

2. Verify that the systems, as installed, meet or exceed the requirements of current NFPA, this specification, and that the systems operate as required.
3. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 35 cubic feet (1000 liters) of gas through a clean white 0.45 micron filter at a minimum velocity of 3.5 scfm (100 Lpm). Filter shall show no discoloration, and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9.
4. Piping purity test: For each positive pressure system, verify purity of piping system. Test each zone at the most remote outlet for dew point, carbon monoxide, total hydrocarbons (as methane), and halogenated hydrocarbons, and compare with source gas. The two tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Perform test with the use of an inert gas as described in CGA P-9.
5. Outlet and inlet flow test:
  - a. Test all outlets for flow. Perform test with the use of an inert gas as described in CGA P-9.
  - b. Oxygen and air outlets must deliver 100 Lpm (3.5 scfm) with a pressure drop of no more than 35 kPa (5 psi), and static pressure of 350 kPa (50 psi).
6. Source Contamination Test: Analyze each pressure gas source for concentration of contaminants, by volume. Take samples for air system test at the intake and at a point immediately downstream of the final filter outlet. The compared tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Allowable concentrations are below the following:

|                                      |  |
|--------------------------------------|--|
| Dew point, air                       | 4 degrees C (39 degrees F) pressure dew point at 690 kPa (100 psi) |
| Carbon monoxide, air                 | 10 mg/L (ppm)  |
| Carbon dioxide, air                  | 500 mg/L (ppm)   |
| Gaseous hydrocarbons as methane, air | 25 mg/L (ppm)  |
| Halogenated hydrocarbons, air        | 2 mg/L (ppm)   |

7. Analysis Test:

- a. Analyze each pressure gas source and outlet for concentration of gas, by volume.
- b. Make analysis with instruments designed to measure the specific gas dispensed.
- c. Allowable concentrations are within the following:
  - 1) Laboratory air 19.5 percent to 23.5 percent oxygen.

|             |                                     |
|-------------|-------------------------------------|
| Oxygen      | >=97 plus percent oxygen            |
| Medical air | 19.5 percent to 23.5 percent oxygen |

8. Maximum Allowable Variation: Between comparative test results required are as follows:

|                               |                            |
|-------------------------------|----------------------------|
| Dew point                     | 2 degrees C (36 degrees F) |
| Carbon monoxide               | 2 mg/L (ppm)               |
| Total hydrocarbons as methane | 1 mg/L (ppm)               |
| Halogenated hydrocarbons      | 2 mg/L (ppm)               |

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

**3.3 COMMISSIONING**

- A. Provide commissioning documentation accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

**3.4 DEMONSTRATION AND TRAINING**

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

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- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

- - - E N D - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
  - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 07 84 00, FIRESTOPPING.
- D. Section 07 92 00, JOINT SEALANTS.
- E. Section 09 91 00, PAINTING.
- F. Section 23 07 11, HVAC INSULATION.
- G. Section 23 36 00, AIR TERMINAL UNITS.
- H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- I. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- J. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- K. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 QUALITY ASSURANCE**

- A. The 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 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.
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
  - 1. The allowable vibration tolerance is specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Equipment specifications require factory balancing of equipment to this tolerance.



2. After air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.

D. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. 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.
2. Equipment Service: Products shall be supported by a service organization which maintains a complete inventory of repair parts and is located reasonably close to the site. 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. Submit names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming.
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. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local, if the local codes are more stringent than those specified. Refer any conflicts to 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.
- E. 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. 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.
- G. 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 COR for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the COR at least two weeks 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, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract drawings to the COR for resolution.
  3. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.
- H. Guaranty: GENERAL CONDITIONS.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 11, COMMON WORK RESULTS FOR HVAC," with applicable "Group" number.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- 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. 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.
- G. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete.
- H. Ungrouped submittal items, which may be submitted individually, include, but are not limited to:
  - 1. Pipe, valves and fittings identified as to service application.
  - 2. Strainers.
  - 3. Safety valves and drip pan ells.
  - 4. Temperature control valves, sensors.
  - 5. Thermometers and pressure gauges and accessories.
  - 6. Flexible connectors, hose, braided.
  - 7. Heating and ventilating equipment.
  - 8. Vibration isolators.
  - 9. Supports and braces for pipe.
  - 10. Pressure gauge test kit.
  - 11. Insulation, field-applied.
- I. Samples: Samples will not be required, except for insulation or where materials offered differ from specification requirements. Samples shall

be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made as provided under Article CHANGES of GENERAL CONDITIONS.

- I. Layout Drawings: In accordance with GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves and other items. Show the access means for all items requiring access for operations and maintenance. Do not install equipment foundations, equipment or piping until layout drawings have been approved. Provide detailed layout drawings of all piping and duct systems. In addition provide details of the following.
1. Mechanical equipment rooms.
  2. Hangers, inserts, supports, and bracing.
  3. Pipe sleeves.
  4. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- J. 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 COR.
  2. Submit electric motor data and variable speed drive data with the driven equipment.
  3. Equipment and materials identification.
  4. Fire-stopping materials.
  5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  6. Wall, floor, and ceiling plates.
- K. 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.



- H. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
  - SP-58-93.....Pipe Hangers and Supports-Materials, Design and Manufacture
  - SP 69-2003.....Pipe Hangers and Supports-Selection and Application
- I. National Electrical Manufacturers Association (NEMA):
  - MG1-2003, Rev. 1-2004...Motors and Generators
- J. National Fire Protection Association (NFPA):
  - 31-06.....Standard for Installation of Oil-Burning Equipment
  - 54-06.....National Fuel Gas Code
  - 70-05.....National Electrical Code
  - 85-04.....Boiler and Combustion Systems Hazard Code
  - 90A-96.....Installation of Air Conditioning and Ventilating Systems
  - 101-97.....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 COR. 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. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

## **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 complete and fully operational per the contract requirements.

### **2.3 BELT DRIVES**

- A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.

- C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  - 1. Material: Pressed steel, or close grained cast iron.
  - 2. Bore: Fixed or bushing type for securing to shaft with keys.
  - 3. Balanced: Statically and dynamically.
  - 4. Groove spacing for driving and driven pulleys shall be the same.
  - 5. Minimum Diameter of V-Belt Sheaves (ANSI/RMA recommendations) in millimeters and inches:

| Fractional Horsepower |                 | Standard      |                 | High Capacity |                 |
|-----------------------|-----------------|---------------|-----------------|---------------|-----------------|
| Cross Section         | Min. od mm (in) | Cross Section | Min. od mm (in) | Cross Section | Min. od mm (in) |
| 2L                    | 20 (0.8)        | A             | 83 (3.25)       | 3V            | 67 (2.65)       |
| 3L                    | 38 (1.5)        | B             | 146 (5.75)      | 4V            | 180 (7.10)      |
| 4L                    | 64 (2.5)        | C             | 239 (9.40)      | 5V            | 318 (12.50)     |
| 5L                    | 89 (3.5)        | D             | 345 (13.60)     |               |                 |
|                       |                 | E             | 554 (21.80)     |               |                 |

- I. Drive Types, Based on ARI 435:
  - 1. Provide fixed-pitch drives for all drives.
  - 2. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

**2.4 DRIVE GUARDS**

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to



equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.

- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

## **2.5 LIFTING ATTACHMENTS**

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

## **2.6 ELECTRIC MOTORS**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT; Section 26 29 11, MOTOR CONTROLLERS; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient motors as scheduled. Unless otherwise specified for a particular application use electric motors with the following requirements.
- B. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

- C. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- D. Rating: Continuous duty at 100 percent capacity in an ambient temperature of 40 degrees centigrade (104 degrees F); minimum horsepower as shown on drawings; maximum horsepower in normal operation not to exceed nameplate rating without service factor.
- E. 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 time or cost to the Government.
  2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
  3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
    - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
    - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
    - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
  4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
  5. Motors utilized with variable frequency drives shall be rated "inverter-ready" per NEMA Standard, MG1, Part 31.4.4.2.
- F. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient" and the requirements generally exceed those of the Energy Policy Act of 1992 (EPACT). Motors not specified as "high efficiency" shall comply with EPACT.

- G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

## **2.7 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Coordinate nomenclature, symbols, and equipment numbers with VA facilities personnel. 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.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- 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. HVAC: Provide for all valves.
  2. 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.
  3. 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.
  4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

## **2.8 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 AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

## **2.9 GALVANIZED REPAIR COMPOUND**

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

## 2.10 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- B. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the National Uniform Seismic Installation Guidelines (NUSIG), most current edition. Submittals based on either the NUSIG guidelines or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in a state where the project is located. Support of suspended equipment over 227kg (500 pounds) shall be submitted for approval of the COR in all cases. See paragraph 2.8.M for lateral force design requirements.
- C. Supports For Roof Mounted Items:
  - 1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
  - 2. Pipe/duct pedestals: Provide a galvanized unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
- D. Type Numbers Specified: MSS SP-58. For selection and application refer to MSS SP-69.
- E. 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 102 mm (four inches) thick when approved by the COR 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 COR for each job condition.
- F. 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 23mm (7/8-inch) outside diameter.
- G. For Attachment to Wood Construction: Wood screws or lag bolts.

- H. 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.
- I. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 41mm by 41mm (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.
- J. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
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. 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.
2. HVAC Piping (Other Than General Types):
  - a. Medium and high pressure steam:
    - 1) Provide eye rod or Type 17 eye nut near the upper attachment.
    - 2) 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.
  - b. Spring Supports (Expansion and contraction of vertical piping):
    - 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.
- K. 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.

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

## **2.12 SPECIAL 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: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- D. 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.

## **2.13 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. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **2.14 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 COR 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 COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
  - 3. Do not penetrate membrane waterproofing.
- F. 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. Electrical and Pneumatic Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- I. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations

- and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced.
2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- 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. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
  2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
  3. 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 COR. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the COR for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After COR approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
- M. Switchgear 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.
- 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 RIGGING**

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to COR for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

### **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 COR.
- 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 HVAC DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the COR. Such access shall be provided without additional cost or time to the Government.
- B. Completely remove all piping, concrete pads, isolation pads, wiring, conduit, controls, 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.
- C. 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.

### 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 -- 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 MOTOR AND DRIVE ALIGNMENT**

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.

- B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

### **3.8 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 COR 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.

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

Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

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

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and 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 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.

**3.11 OPERATION AND MAINTENANCE MANUALS**

- A. Provide four bound copies. Deliver to COR not less than 30 days prior to completion of a phase or final inspection.
- B. Include all new and temporary equipment and all elements of each assembly.
- C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, other data.
- D. Manufacturer's installation, maintenance, repair, and operation instructions for each device. Include assembly drawings and parts lists. Include operating precautions and reasons for precautions.
- E. Lubrication instructions including type and quantity of lubricant.
- F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications.
- G. Set points of all interlock devices.
- H. Trouble-shooting guide for control systems.
- I. Operation of the combustion control system.
- J. Emergency procedures.

**3.12 INSTRUCTIONS TO VA PERSONNEL**

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

- - - E N D - - -



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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

1. Planning systematic TAB procedures.
2. Design Review Report.
3. Systems Inspection report.
4. Duct Air Leakage test report.
5. Systems Readiness Report.
6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
7. Vibration and sound measurements.
8. Recording and reporting results.

B. Definitions:

1. Basic TAB used in this Section: "Testing, Adjusting and Balancing" section 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 and heating hot 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 flow rate from values (design) in the contract documents.

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General Mechanical Requirements.
- B. Section 23 07 11, HVAC INSULATION: Piping and Equipment Insulation.
- C. Section 23 36 00, AIR TERMINAL UNITS: Terminal Units Performance.
- D. Section 23 31 00, HVAC DUCTS AND CASINGS: Duct Leakage.

- E. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Controls and Instrumentation Settings.
- F. Section 23 34 00, HVAC FANS.
- G. Section 23 21 13, HYDRONIC PIPING.
- H. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training.

### 1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Qualifications:
  - 1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
  - 2. The TAB agency shall be either a certified member of AABC 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 COR 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 COR 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 COR. 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", 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 ASHRAE Handbook "HVAC Applications", as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
  - a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
  - b. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
  - c. Exhaust systems: 0 percent to plus 10 percent.
  - d. Minimum outside air: 0 percent to plus 10 percent.
  - e. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
  - f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
  - g. 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 COR for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the COR) and one hydronic system (pumps and three coils) as follows:
  - a. When field TAB work begins.
  - b. During each partial final inspection and the final inspection for the project if requested by VA.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the COR staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.

- D. Submit Following for Review and Approval:
1. Design Review Report within 90 days for 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.
- E. 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):
- 2007 .....HVAC Applications ASHRAE Handbook, Chapter 37, Testing, Adjusting, and Balancing and Chapter 47, Sound and Vibration Control
- C. Associated Air Balance Council (AABC):
- 2002.....AABC National Standards for Total System Balance
- D. National Environmental Balancing Bureau (NEBB):
- 7<sup>th</sup> Edition 2005 .....Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- 2nd Edition 2006 .....Procedural Standards for the Measurement of Sound and Vibration
- 3<sup>rd</sup> Edition 2009 .....Procedural Standards for Whole Building Systems Commissioning of New Construction
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
- 3<sup>rd</sup> Edition 2002 .....HVAC 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 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 COR 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. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated on drawings. Submit report of findings to the COR.
- B. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to the COR in standard format and forms prepared and or approved by the Commissioning Agent.
- C. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the COR.

### **3.6 TAB REPORTS**

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

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



- c. Adjust operating pressure control setpoint to maintain the design flow to each space with the lowest setpoint.
5. Record final measurements for air handling equipment performance data sheets.
- F. Water Balance and Equipment Test: Include circulating pumps, convertors, and coils:
  1. Adjust flow rates for equipment. Set coils 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 VIBRATION TESTING**

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

### **3.9 SOUND TESTING**

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
  1. Take readings in rooms, approximately fifteen (15) percent of all rooms. The COR may designate the specific rooms to be tested.
- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.

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

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

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

- e. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.
  - 2. When sound power levels are specified:
    - a. Perform steps 1.a. thru 1.d., as above.
    - b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
    - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 10 meters (30 feet) for sound level location.

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

### **3.10 MARKING OF SETTINGS**

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

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

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

### **3.12 PHASING**

- A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.
- B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

### **3.13 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

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B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - E N D - - -

**SECTION 23 07 11**  
**HVAC INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for
  - 1. HVAC piping, ductwork and equipment.
- B. Definitions
  - 1. ASJ: All service jacket, white finish facing or jacket.
  - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
  - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
  - 4. Concealed: Ductwork and piping above ceilings and in chases and pipe spaces.
  - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
  - 6. FSK: Foil-scrim-kraft facing.
  - 7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC equipment or piping handling media above 41 degrees C (105 degrees F).
  - 8. Density: kg/m<sup>3</sup> - 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. HHWS: Hot water heating supply.
21. HHWR: 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. CHWS: Chilled water supply.
37. CHWR: 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 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Piping and equipment.
- D. Section 23 21 13, HYDRONIC PIPING: Hot water, chilled water, and glycol piping.
- E. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training.

## 1.3 QUALITY ASSURANCE

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

- B. Criteria:

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

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

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

**4.3.3.1.2** The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

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

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

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

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

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

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

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

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

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

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

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

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



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

(1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides

(2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in *NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

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

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

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

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

#### **1.4 SUBMITTALS**

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

B. Shop Drawings:

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

a. Insulation materials: Specify each type used and state surface burning characteristics.

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

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

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

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
  - L-P-535E (2)- 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/m<sup>3</sup> (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-5, Density 32 kg/m<sup>3</sup> (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 MINERAL WOOL OR REFRACTORY FIBER**

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

## **2.3 RIGID CELLULAR PHENOLIC FOAM**

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

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

- A. Comply with Standard ASTM C177, C518, density 120 kg/m<sup>3</sup> (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.

## **2.5 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.

**2.6 CALCIUM SILICATE**

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- C. Equipment Insulation: ASTM C533, Type I and Type II
- D. Characteristics:

| <b>Insulation Characteristics</b>  |                 |                  |
|--|-----------------|------------------|
| <b>ITEMS</b>   | <b>TYPE I</b>   | <b>TYPE II</b>   |
| Temperature, maximum degrees C<br>(degrees F)  | 649 (1200)      | 927 (1700)       |
| Density (dry), Kg/m <sup>3</sup> (lb/ ft <sup>3</sup> )  | 232 (14.5)      | 288 (18)         |
| Thermal conductivity:<br>Min W/ m K (Btu in/h ft <sup>2</sup> degrees F)@<br>mean temperature of 93 degrees C<br>(200 degrees F) | 0.059<br>(0.41) | 0.078<br>(0.540) |
| Surface burning characteristics:<br>Flame spread Index, Maximum  | 0               | 0                |
| Smoke Density index, Maximum   | 0               | 0                |

**2.6 INSULATION FACINGS AND JACKETS**

- A. Vapor Retarder, higher strength with low water permeance  $\leq$  0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.

- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) 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. Weather proof if utilized for outside service.
- F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.

## **2.7 REMOVABLE INSULATION JACKETS**

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

**2.8 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 insulation of the same thickness as adjacent insulation.

| <b>Nominal Pipe Size and Accessories Material (Insert Blocks)</b> |                           |
|---|---------------------------|
| 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 cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation.

**2.9 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.

**2.10 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.

#### **2.11 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.

#### **2.12 FIRESTOPPING MATERIAL**

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

#### **2.13 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 COR for application of

- insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, 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. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- F. 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. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. HVAC work not to be insulated:
1. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
  2. Equipment: Expansion tanks, hot water pumps, steam condensate pumps.

3. In hot piping: Unions, flexible connectors, control valves, PRVs, 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.
  - I. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
  - J. 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.
  - K. 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
  - K. Provide metal jackets over insulation as follows:
    1. All piping and ducts exposed to outdoor weather.
    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.
    - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
    - c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
  3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics:
    - a. 50 mm (2 inch) thick insulation faced with ASJ (white all service jacket): Supply air duct.
    - b. 40 mm (1-1/2 inch) thick insulation faced with ASJ: Return air duct, mixed air plenums and prefilter housing.
    - c. Outside air intake ducts: 50 mm (two inch) thick insulation faced with ASJ.
  4. Exposed, unlined ductwork exposed to outdoor weather:
    - a. Supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a maximum water vapor permeability of 0.001 perms.
  5. Cold equipment: 40 mm (1-1/2inch) thick insulation faced with ASJ.
    - a. Chilled water pumps, water filter, chemical feeder pot or tank.
  6. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
    - a. Convertors, air separators, steam condensate pump receivers.
    - b. Reheat coil casing and separation chambers on steam humidifiers located above ceilings.

B. Flexible Mineral Fiber Blanket:

1. Adhere insulation to metal with 75 mm (3 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.
3. Concealed supply air ductwork.
  - a. Above ceilings at a roof level, in attics, and duct work exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with FSK.
  - b. Above ceilings for other than roof level: 40 mm (1 ½ inch) thick insulation faced with FSK.
4. Concealed return air duct:
  - a. Above ceilings at a roof level, unconditioned areas, and in chases with external wall 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.
5. Concealed outside air duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.

C. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal

- insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
2. Contractor's options for fitting, flange and valve insulation:
    - a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
    - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
    - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
    - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
  3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.
- D. 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.
  2. Cold equipment: 50 mm (2 inch) thick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, air separators and air purgers.
  3. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a water vapor permeability of 0.00 perms.

### 3.3 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS for all inspection,

start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.8 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 |
| 122-177 degrees C (251-350 degrees F)<br>(HPS, MPS)  | Mineral Fiber (Above ground piping only) | 75 (3)                                 | 100 (4)          | 113 (4.5)        | 113 (4.5)         |
| 93-260 degrees C (200-500 degrees F)<br>(HPS, HPR)   | Calcium Silicate                         | 100 (4)                                | 125 (5)          | 150 (6)          | 150 (6)           |
| 100-121 degrees C (212-250 degrees F)<br>(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)<br>(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  | Mineral Fiber (Above ground              | 38                                     | 38 (1.5)         | 50 (2.0)         | 50 (2.0)          |

|  |   |             |          |          |          |
|--|---|-------------|----------|----------|----------|
| (100-200 degrees F)<br>(LPR, PC, HHWS,<br>HHWR)  | piping only)  | (1.5)       |          |          |          |
| 38-99 degrees C<br>(100-211 degrees F)<br>(LPR, PC, HHWS,<br>HHWR)                             | Rigid Cellular<br>Phenolic Foam   | 38<br>(1.5) | 38 (1.5) | 50 (2.0) | 50 (2.0) |
| 38-94 degrees C<br>(100-200 degrees F)<br>(LPR, PC, HHWS,<br>HHWR)                             | Flexible<br>Elastomeric<br>Cellular<br>Thermal (Above<br>ground piping<br>only) | 38<br>(1.5) | 38 (1.5) | -----    | -----    |
|  |   |             |          |          |          |
| 4-16 degrees C<br>(40-60 degrees F)<br>(RS for DX<br>refrigeration)                            | Rigid Cellular<br>Phenolic Foam   | 38<br>(1.5) | 38 (1.5) | 38 (1.5) | 38 (1.5) |
| 4-16 degrees C<br>(40-60 degrees F)<br>(CHWS, CHWR, and RS<br>for DX<br>refrigeration)         | Cellular<br>Glass Closed-<br>Cell   | 38<br>(1.5) | 38 (1.5) | 38 (1.5) | 38 (1.5) |
| 4-16 degrees C<br>(40-60 degrees F)<br>(CHWS and CHWR<br>within pipe chase<br>and underground) | Cellular<br>Glass Closed-<br>Cell   | 50<br>(2.0) | 50 (2.0) | 75 (3.0) | 75 (3.0) |

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**SECTION 23 08 00  
COMMISSIONING OF HVAC SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIRMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

**1.2 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**1.3 SUMMARY**

- A. This Section includes requirements for commissioning the Facility HVAC, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

**1.4 DEFINITIONS**

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

**1.5 COMMISSIONED SYSTEMS**

- A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 23, is required in cooperation with the VA and the Commissioning Agent.
- B. The Facility HVAC systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements.

## **1.6 SUBMITTALS**

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

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

## **PART 3 - EXECUTION**

### **3.1 CONSTRUCTION INSPECTIONS**

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

### **3.2 PRE-FUNCTIONAL CHECKLISTS**

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

type of equipment will be returned to the Contractor for correction and resubmission. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

### **3.3 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### **3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:**

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

### **3.5 TRAINING OF VA PERSONNEL**

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

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June 17, 2016

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Enhance/Consolidate Mental Health Services  
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REQUIREMENTS and Division 23 Sections for additional Contractor  
training requirements.

----- END -----

**SECTION 23 09 23**  
**DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The control system(s) shall be as indicated on the project documents, point list, drawings and described in these specifications. This scope of work shall include a complete and working system including all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
- B. Temperature controls shall be Andover. All controls work shall interface with existing Andover building control system and existing Tridium control system.
- C. Engineering Control Center (ECC) shall include:
  - 1. Operator Workstation Web-Browser User Interface (UI).
  - 2. Ethernet, IP Supervisory Network.
  - 3. Graphic Operational Interface.
  - 4. Software Configuration Tools (SCT).
  - 5. Scheduling and Alarm Management software.
  - 6. Local ACC-LON or Infinet-2 networks.
  - 7. Network Area Controllers (NAC).
  - 8. Unitary Control Units (UCU).
  - 9. Connected I/O devices.
  - 10. Third party system Data Integration.
- D. The Controls Contractor's work shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required by the Contract for the complete and fully functional Controls Systems.
- E. Following control devices and systems shall be used to provide the functional requirements of HVAC equipment and systems.
  - 1. Direct Digital Control (DDC) of HVAC equipment and systems.
  - 2. Terminal units and similar units for control of room environment conditions may be equipped with integral controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project documents.

- F. Base bid includes connecting into the ECC and the installation of new DDC controls as indicated on the temperature control diagrams and the I/O Points List.
- G. Connect the new work into the existing ECC system operator workstation located in the HVAC facilities shop. System shall operate and function as one complete system including one database of control point objects and global control logic capabilities. Facility operators shall have complete operations and control capability over all systems, new and existing including; monitoring, trending, graphing, scheduling, alarm management, global point sharing, global strategy deployment, graphical operations interface and custom reporting as specified. Modify the existing ECC, if necessary, to accommodate the additional control points.
- H. The control subcontractor shall supply as required, the necessary equipment to interface between any existing and new system Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices, hardware and software points provided. Network area controllers are same as remote controller units (RCU).
- I. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. Temperature Controls contractor shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.
- J. The Top End of the NAC shall communicate using American Society of Heating and Refrigerating Engineers/American National Standards Institute (ASHRAE/ANSI) Standard 135(BACnet) protocol. The NAC shall reside on the IP Ethernet (ISO 8802-3) local area network, and provide information via standard object types and application services. The Bottom End of the NAC, the unit level controllers and all other field devices shall reside on the ACC-LON or Infinet-2 networks, and provide data using standard network variable types and configuration properties.
- K. The intent of this specification is to provide a peer-to peer networked, distributed control system.
- L. The control system shall accommodate simultaneously multiple user operation and the access to the system should be limited only by operator password.

## 1.2 RELATED WORK

- A. Section 28 31 00, FIRE DETECTION AND ALARM.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. Section 23 21 13, HYDRONIC PIPING.
- D. Section 23 36 00, AIR TERMINAL UNITS.
- E. Section 23 31 00, HVAC DUCTS AND CASINGS.
- F. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- H. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- I. Section 26 05 19, LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES.
- J. Section 26 27 26, WIRING DEVICES.

## 1.3 DEFINITION

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.
- B. ACU: Auxiliary Control Unit (ACU) used for controls of air handling units, reports to RCU.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.
- D. BACnet: Building Automation Control Network Protocol, ASHRAE Standard 135.
- E. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- F. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.
- G. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.
- H. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- I. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls. In this specification, there are three types of control units are used; Unitary Control Unit (UCU), Auxiliary Control Unit (ACU), and Remote Control Unit (RCU).

- J. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).
- K. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- L. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- M. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.
- N. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- O. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- P. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- Q. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.
- R. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- S. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- T. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.



- U. FTT-10A: Echelon Transmitter-Free Topology Transceiver.
- V. GIF: Abbreviation of Graphic interchange format.
- W. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.
- X. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.
- Y. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI, digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- Z. I/P: Internet Protocol-global network, connecting workstations and other host computers, servers etc. to share the information.
- AA. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- BB. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- CC. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- DD. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- EE. LonWorks: Network technology developed by the Echelon Corporation.
- FF. Network: A set of computers or other digital devices communicating with each other over a medium such as wire, coax, fiber optics cable etc.
- GG. Network Area Controller: Digital controller, supports a family of auxiliary control units and unitary control units, and communicates with peer-to-peer network for transmission of global data.
- HH. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.
- II. MS/TP: Master-slave/token-passing.
- JJ. Operating system (OS): Software, which controls the execution of computer application programs.

- KK. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.
- LL. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- MM. Peer-to-Peer: A networking architecture that treats all network stations as equal partners.
- NN. PICS: Protocol Implementation Conformance Statement.
- OO. UCU: Unitary Control Unit, digital controller, dedicated to a specific piece of equipment, such as VAV boxes, chillers, fan coil units, heat exchangers etc.

#### **1.4 QUALITY ASSURANCE**

##### A. Criteria:

1. The core control system equipment shall be compatible with the existing control system (existing control system by Andover Continuum by Schneider Electric). Compatibility includes communication between existing and new controls and visibility and/or control of all new and existing points.
2. The Controls and Instrumentation System Contractor shall be a primary equipment manufacturer's partner that is regularly engaged in the engineering, programming, installation and service of total integrated Facility Management Systems of similar size, scope and complexity to the EEC specified in this Contract. Distributors and wholesalers will not be acceptable.
3. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegates the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.
4. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
4. The controls subcontractor shall provide a list of no less than ten similar projects, which have building control systems as specified in this Section. These projects must be on-line and functional such that

the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.

5. The controls subcontractor shall have (minimum of ten years) experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than five years. Failure to disclose this information will be a ground for disqualification of the supplier.
6. The controls subcontractor shall have in-place facility within 70 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
7. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

B. Codes and Standards:

1. All work shall conform to the applicable Codes and Standards.
2. Electronic equipment shall conform to the requirements of FCC Regulation, Class A or CFR 47 Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.
3. Peer-to-peer controllers, unitary controllers shall conform to the requirements of UL/CUL 916, FCC CFR 47 Part 15, ICES-003, EN55022, AS/NZS 3548, Class A, CE.

**1.5 PERFORMANCE**

A. The system shall conform to the following:

1. Graphic Display: The system shall display up to 4 graphics on a single screen with a minimum of (75) dynamic points per graphic. All current data shall be displayed within (10) seconds of the request.
2. Graphic Refresh: The system shall update all dynamic points with current data within (10) seconds. Data refresh shall be automatic, without operator intervention.

3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be (10) seconds. Analog objects shall start to adjust within (3) seconds.
4. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior (10) seconds.
5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed (10) seconds.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every five (5) seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within (5) seconds of each other.
9. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values reported by the specified system:

| <b>Measured Variable</b>      | <b>Reported Accuracy</b>         |
|-------------------------------|----------------------------------|
| Space temperature             | ±0.5 degrees C (±1 degrees F)    |
| Ducted air temperature        | ±1.0 degrees C [±2 degrees F]    |
| Outdoor air temperature       | ±1.0 degrees C [±2 degrees F]    |
| Water temperature             | ±0.5 degrees C [±1 degrees F]    |
| Relative humidity             | ±2 percent RH                    |
| Water flow                    | ±5 percent of full scale         |
| Air flow (terminal)           | ±10 percent of reading           |
| Air flow (measuring stations) | ±5 percent of reading            |
| Air pressure (ducts)          | ±25 Pa [±0.1 "W.G.]              |
| Air pressure (space)          | ±3 Pa [±0.001 "W.G.]             |
| Water pressure                | ±2 percent of full scale *Note 1 |
| Electrical Power              | 5 percent of reading             |

Note 1: for both absolute and differential pressure

#### **1.6 WARRANTY**

- A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in GENERAL CONDITIONS.
- B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.
- C. The on-line support service shall allow the Controls supplier to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to the job site to resolve the problem within 24 hours after the problem is reported.
- D. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the construction period until final commissioning, training of facility operators and acceptance of the project by VA.

#### **1.7 SUBMITTALS**

- A. Submit shop drawings in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA and SAMPLES.
- B. Manufacturer's literature and data for all components including the following:
  1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.
  2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.
  3. Control dampers and control valves schedule, including the size and pressure drop.
  4. Installation instructions for smoke dampers and combination smoke/fire dampers, if furnished.

5. Catalog cut sheets of all equipment used. This includes, but is not limited to DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it supposed to represent.
  6. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
  7. Color prints of proposed graphics with a list of points for display.
- C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.
- D. As Built Control Drawings:
1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.
  2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
  3. Furnish one (1) CD-ROM in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.
- E. Operation and Maintenance (O/M) Manuals):
1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.
  2. Include the following documentation:
    - a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.
    - b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
    - c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
    - d. Complete troubleshooting procedures and guidelines for all systems.
    - e. Complete operating instructions for all systems.

- f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
- g. Licenses, guaranty, and other pertaining documents for all equipment and systems.
- h. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.

F. Submit Performance Report to COR prior to final inspection.

#### **1.8 INSTRUCTIONS**

A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS, and as noted below.

1. First Phase: Formal instructions to the VA facilities personnel for a total of 24 hours (in 4 hour increments), conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the VA.
2. Second Phase: This phase of training shall comprise of on the job training during start-up, checkout period, and performance test period. VA facilities personnel will work with the Contractor's installation and test personnel on a daily basis during start-up and checkout period. During the performance test period, controls subcontractor will provide 48 hours of instructions to the VA facilities personnel.
3. The O/M Manuals shall contain approved submittals as outlined in Article 1.7, SUBMITTALS. The Controls subcontractor will review the manual contents with VA facilities personnel during second phase of training.

#### **1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)**

- A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35 degrees C (65 to 90 degrees F) at a relative humidity of 20 to 80 percent non-condensing.
- B. The CUs and associated equipment used in controlled environment shall be mounted in NEMA 1 enclosures for operation at 0 to 49 degrees C (32 to

120 degrees F) at a relative humidity of 10 to 95 percent non-condensing.

- C. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 65 degrees C (-40 to 150 degrees F).
- D. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- E. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

**1.10 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - 135-01.....BACNET Building Automation and Control Networks
- C. American Society of Mechanical Engineers (ASME):
  - B16.18-01.....Cast Copper Alloy Solder Joint Pressure Fittings.
  - B16.22-01.....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. American Society of Testing Materials (ASTM):
  - B32-02.....Specification for Solder Metal
  - B88-02.....Specifications for Seamless Copper Tube
  - B88M-99.....Specification for Seamless Copper Tube (Metric)
  - B280-02.....Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service
  - D2737-03.....Specification for Polyethylene Tube
- E. Federal Communication Commission (FCC):
  - Rules and Regulations Volume II-July, Part A Radio Frequency Devices.
- F. Institute of Electrical and Electronic Engineers (IEEE):
  - 802.3-03.....Information Technology-Telecommunications and Information Exchange between Systems-Local and Metropolitan Area Networks- Specific Requirements-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
- G. Instrument Society of America (ISA):
  - S7.0.01-00.....Quality Standard for Instrument Air
- H. National Fire Protection Association (NFPA):
  - 70-05.....National Electric Code



90A-03.....Standard for Installation of Air-Conditioning  
and Ventilation Systems

I. Underwriter Laboratories Inc (UL):

94-01.....Test for Flammability of Parts and Devices and  
Appliances

294-01.....Access Control System Units

486A-01.....Wire Connectors and Soldering Lugs for Use with  
Copper Conductors

486B-01.....Wire Connectors for use with Aluminum Conductors

555S-03.....Leakage Ratings for Dampers for Use in Smoke  
Control Systems

916-02.....Energy Management

1076-99.....Proprietary Burglar Alarm Units and Systems

**PART 2 - PRODUCTS**

**2.1 CONTROLS SYSTEM ARCHITECTURE**

A. General

1. The Controls System shall consist of multiple Nodes and associated equipment connected by industry standard digital and communication network arrangements.
2. The Operator Workstations, Servers and principal network computer equipment shall be standard products of recognized major manufacturers available through normal PC and computer vendor channels - not "Clones" assembled by a third-party subcontractor.
3. Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.
4. The networks shall, at minimum, comprise, as necessary, the following:
  - a. Operator Workstations - fixed and portable as required by the Specifications.
  - b. Network computer processing, data storage and communication equipment including Servers and digital data processors.
  - c. Routers, bridges, switches, hubs, modems, interfaces and the like communication equipment.
  - d. Active processing network area controllers connected to programmable field panels and controllers together with their power supplies and associated equipment.
  - e. Addressable elements, sensors, transducers and end devices.
  - f. Third-party equipment interfaces as required by the Contract Documents.



reporting, for network information management, for alarm annunciation, for Operator Interface tasks, for Controls Application management and the like. These Server(s) shall utilize IT industry standard data base platforms such as Microsoft Windows 2000 Server or Windows Server 2003, with Microsoft SQL Server 2000.

## **2.2 DIRECT DIGITAL CONTROLLERS**

- A. (NAC) Network Area Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital processor complete with all hardware, software, and communications interfaces, power supplies. The Controls System shall be designed and implemented entirely for use and operation on the Internet. NACs shall have access to data within the industry standard IT network to the Data Server and other NACs as needed to accomplish required global control strategies.
1. NACs shall provide both standalone and networked direct digital control of mechanical and electrical building system controllers as required by the Specifications. The primary NAC shall support a minimum of [5,000] field points together with all associated features, sequences, schedules, applications required for a fully functional distributed processing operation.
  2. NACs shall monitor and report communication status to the Controls Systems Application. The Controls Systems shall provide a system advisory upon communication failure and restoration.
  3. All NACs on the network shall be equipped with all software functionality necessary to operate the complete user interface, including graphics, via a Browser connected to the Node on the network or directly via a local port on the NAC.
  4. All NAC shall be provided with face mounted LED type annunciation to continually display its operational mode, power and communications.
  5. The controllers shall reside on the Ethernet local area network and provide Read (Initiate) and Write (Execute) services as defined in Clauses 15.5 and 15.8. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.
  6. Each NAC shall be provided with the necessary un-interruptible power facilities to ensure its continued normal operation during periods of line power outages of, at minimum, 1-minute duration. Normal functionality shall include all normal software processing, communication with powered field devices and network communications with other powered Controls Systems NAC, Data Servers and OWS. Each NAC shall report its communication status to the Application. The

- Application shall provide a system advisory upon communication failure and restoration. Each NAC shall retain program, control algorithms, and set point information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.
7. All NACs shall have sufficient memory to support its operating system, database, and program requirements, including the following:
    - a. Device and network management.
    - b. Data sharing.
    - c. Alarm and event management including custom alarm messages for each level alarm for the points noted in the I/O Schedule.
    - d. Energy management.
    - e. Historical trend data for points specified.
    - f. Maintenance report.
    - g. Scheduling.
    - h. Dial up and network communications.
    - i. Manual override monitoring.
  8. Each NAC shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of secondary system controllers, point capacity and programming functions.
  9. Each NAC shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
  10. Each NAC shall monitor the status of all overrides and inform the operator that automatic control has inhibited, and allow the operator to manually override automatic or centrally executed command.
  11. Provide the capability to generate and modify the Controls Systems Application software-based sequences, database elements, associated operational definition information and user-required revisions to same at any designated Workstation together with the means to download same to the associated System Controllers.
  12. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.
- B. Auxiliary Control Units (ACUs) shall be stand-alone, multi-tasking, multi-user, real time digital processor complete with all hardware,

software and communication interfaces, power supplies, and input/output modular devices.

1. ACUs shall either reside on the ACC-LON or Infinet-2 networks.
  2. All ACUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
  3. Each ACU shall have sufficient memory to support its operating system, database including the following:
    - a. Data sharing.
    - b. Device and network management.
    - c. Alarm and event management.
    - d. Scheduling.
    - e. Energy Management.
  4. Each ACU shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of I/O functions. The type of spares shall be in the same proportion as the implemented functions on the controller, but in no case there shall be less than one point of each implemented I/O type.
  5. Each ACU shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
  6. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.
- C. Unitary Control Units (UCUs) shall be capable of stand-alone, microprocessor-based and shall continue to provide control functions.
1. Unitary Control Units shall either reside on the ACC-LON or Infinet-2 networks.
  2. Each UCU shall have sufficient memory to support its own operating system, including data sharing.
  3. All UCUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
  4. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

- D. Provide I/O module that connects sensors and actuators onto the field bus network for use by the direct digital controllers. I/O devices shall support the communication technology specified for each controller.
1. Analog input shall allow the monitoring of low voltage (0-5 VDC, 0-10 VDC), current (4-20 ma), or resistance signals (thermistor, 0-10,000 Ohm) Analog input shall be compatible with, and field configurable to commonly available sensing devices. Analog output shall provide a modulating signal for these control devices.
  2. Binary inputs shall allow the monitoring of on/off signals from remote devices. Binary inputs shall provide a wetting current of at least 12 milliamps to be compatible with commonly available control devices. Binary outputs shall provide on/off operation, or a pulsed low voltage signal for pulse width modulation control. Outputs shall be selectable for either normally open or normally closed operation.
  3. Binary outputs on remote and auxiliary controllers shall have 3-position (on/off/auto) override switches and status lights. Analog outputs on remote and auxiliary controllers shall have status lights and a 3-position (on/off/auto) switch and manually adjustable potentiometer for manual override.
  4. Each output point shall be provided with a light emitting diode (LED) to indicate status of outputs.
- E. Communication Ports:
1. NACs controllers in the DDC systems shall be connected in a system local area network using IP/Ethernet protocol.
  2. The control supplier shall provide connectors, repeaters, hubs, and routers necessary for inter-network communication.
  3. Minimum baud rate between the peer-to-peer controllers in the system LAN shall be maintained at the rate of 10/100 Mbps. Minimum baud for the low level controllers between UCUs and ACUs, ACUs and NAC's shall be maintained at the rate of 19,200 Kbps.
  4. Database, such as points; status information, reports, system software, custom programs of any one controller shall be readable by any other controller on the network.
- F. Electric Outlet: Provide a single phase, 120 VAC electrical receptacles inside or within 2 meters (6 feet) of the NAC and ACU enclosures for use with test equipment.
- G. Spare Equipment:
1. Provide spare digital controller (CU) boards and spare I/O boards as required. It shall be possible for trained hospital personnel to replace CU boards and load software via the ECC.

2. Provide a minimum of one spare digital controller board of each type and associated parts including batteries to make at least one complete set of DDC control equipment spares.
3. If I/O boards are separate from the CU boards, provide two spare I/O boards for each spare CU board provided above.

### **2.3 DIRECT DIGITAL CONTROLLER SOFTWARE**

- A. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under Microsoft Windows 2000 or Windows XP.
- B. All points shall be identified by up to 96-character point name and ~~16~~ 32-character point descriptor. The same names shall be used at the operator workstation.
- C. All control functions shall execute within the stand-alone control units via DDC algorithms. The VA shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.
- D. All CU's shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the ECC workstation. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
- E. All DDC control loops shall be able to utilize any of the following control modes:
  1. Two position (on-off, slow-fast) control.
  2. Proportional control.
  3. Proportional plus integral (PI) control.
  4. Proportional plus integral plus derivative (PID) control. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.
  5. Automatic tuning of control loops.
- F. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him.

A minimum of 1,024 levels of security for operator access shall be provided. System shall be capable of unlimited passwords/users.

- G. Application Software: The CUs shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the operator workstation or via a portable workstation, when it is necessary, to access directly the programmable unit. System shall have a non-compile program editor.
1. Economizer: An economizer program shall be provided for VAV systems. This program shall control the position of air handler relief, return, and outdoors dampers. If the outdoor air dry bulb temperature falls below changeover set point the energy control center will modulate the dampers to provide 100 percent outdoor air. The operator shall be able to override the economizer cycle and return to minimum outdoor air operation at any to time.
  2. Night Setback/Morning Warm up Control: The system shall provide the ability to automatically adjust set points for this mode of operation.
  3. Optimum Start/Stop (OSS): Optimum start/stop program shall automatically be coordinated with event scheduling. The OSS program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by the time of occupancy, and it shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions. The OSS program shall operate on both outside weather conditions as well as inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. Space temperature input is to be the highest value of zones served in the cooling mode and the lowest of zones served in the heating mode. It shall be possible to assign occupancy start times on a per air handler unit basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via operator's workstation.
  4. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign



- variable time advances/delays between each successive start or stop within that group. Scheduling shall be calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:
- a. Time, day.
  - b. Commands such as on, off, auto.
  - c. Time delays between successive commands.
  - d. Manual overriding of each schedule.
  - e. Allow operator intervention.
5. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.
6. Remote Communications: The system shall have the ability to dial out in the event of an alarm to workstations and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using dial up communications. Remote access shall allow the operator to function the same as local access.
7. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.

#### **2.4 SENSORS (AIR, WATER AND STEAM)**

- A. Temperature and Humidity Sensors:
1. Electronic Sensors: Provide all remote sensors as required for the systems. All sensors shall be vibration and corrosion resistant for wall, immersion, and/or duct mounting.

- a. Temperature Sensors: Thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.
    - 1) Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.
    - 2) Immersion sensors shall be provided with a separable well made of stainless steel, bronze or monel material. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
    - 3) Space sensors shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on the drawings. Locking cover where required.
    - 4) Outdoor air temperature sensors shall have watertight inlet fittings and shielded from direct sunlight.
    - 5) Room security sensors shall have stainless steel cover plate with insulated back and security screws.
    - 6) Wire: Twisted, non-shielded pair cable.
    - 7) Output Signal: 10,000 Ohms.
  - b. Humidity Sensors: Bulk polymer sensing element type.
    - 1) Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of  $\pm 2$  to  $\pm 5$  percent RH, including hysteresis, linearity, and repeatability. Sensors shall be capable of being calibrated in the field.
  - c. Static Pressure Sensors: Non-directional, temperature compensated.
    - 1) 4-20 ma, 0-5 VDC or 0-10 VDC output signal.
    - 2) 0 to 5 inches wg for duct static pressure range.
    - 3) -0.25 to 0.25 inch wg for Building static pressure range.
- B. Water Flow Sensors:
- 1. Sensor shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minute 1 mm (0.05 inch); wetted parts shall be constructed of stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.
  - 2. Performance characteristics:

- a. Ambient conditions: -40 to 60 degrees C (-40 to 140 degrees F), 5 to 100 percent humidity.
  - b. Operating conditions: 850 kPa (125 psig), 0 to 120 degrees C (30 to 250 degrees F), 0.15 to 12 m per second (0.5 to 40 feet per second) velocity.
  - c. Nominal range (turn down ratio): 10 to 1.
  - d. Overall accuracy plus or minus one percent of reading.
  - e. Repeatability: plus or minus 0.25 percent of reading.
  - f. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet). Preamplifier for bi-directional flow measurement shall provide a directional contact closure from a relay mounted in the preamplifier.
  - g. Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 100 mm (4 inches).
  - h. Ambient temperature effects, less than 0.005 percent calibrated span per degree C (degree F) temperature change.
  - i) RFI effect - flow meter shall not be affected by RFI.
  - j) Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.
- C. Flow switches:
- 1. Shall be either paddle or differential pressure type.
    - a. Paddle-type switches (liquid service only) shall be UL Listed, SPDT snap-acting, adjustable sensitivity with NEMA 4 enclosure.
    - b. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap acting, NEMA 4 enclosure, with scale range and differential suitable for specified application.
- D. Current Switches: Current operated switches shall be self powered, solid state with adjustable trip current as well as status, power, and relay command status LED indication. The switches shall be selected to match the current of the application and output requirements of the DDC systems.

## **2.5 CONTROL CABLES**

As specified in Division 26.

## **2.6 THERMOSTATS AND HUMIDISTATS**

- A. Strap-on thermostats shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.

- B. Freeze stats shall have a minimum of 300 mm (one linear foot) of sensing element for each 0.093 square meter (one square foot) of coil area. A freezing condition at any increment of 300 mm (one foot) anywhere along the sensing element shall be sufficient to operate the thermostatic element.

## **2.7 FINAL CONTROL ELEMENTS AND OPERATORS**

- A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, and smoke or fire protection.
- B. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.
- C. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.
  - 1. Leakage: Maximum leakage in closed position shall not exceed 7 L/S (15 CFMs) differential pressure for outside air and exhaust dampers and 200 L/S/ square meter (40 CFM/sq. ft.) at 50 mm (2 inches) differential pressure for other dampers.
  - 2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.
  - 3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.
  - 4. Bearing shall be nylon, bronze sleeve or ball type.
  - 5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.
- D. Operators shall be electric as required for proper operation.
  - 1. Dampers that require manual reset or link replacement after actuation shall not be acceptable. See drawings for required control operation.
  - 2. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel.
  - 3. Maximum air velocity and pressure drop through free area the dampers:
    - a. Smoke damper in air handling unit; 210 meter per minute (700 fpm).
    - b. Duct mounted damper; 600 meter per minute (2000 fpm).
    - c. Maximum static pressure loss, 50 Pascal (0.20 inches water gage).
- E. Control Valves:

1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).
2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.
3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.
4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.
5. Flow characteristics:
  - a. Three way valves shall have a linear relation or equal percentage relation of flow versus valve position.
  - b. Two-way valves position versus flow relation shall be linear for steam and equal percentage for water flow control.
6. Maximum pressure drop:
  - a. Two position steam control: 20 percent of inlet gauge pressure.
  - b. Modulating Steam Control: 80 percent of inlet gauge pressure (acoustic velocity limitation).
  - c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.
  - d. Two position water valves shall be line size.

F. Damper and Valve Operators and Relays:

1. Electric damper operator shall provide full modulating control of dampers. A linkage and pushrod shall be furnished for mounting the actuator on the damper frame internally in the duct or externally in the duct or externally on the duct wall, or shall be furnished with a direct-coupled design.

**2.8 AIR FLOW CONTROL**

- A. Airflow and static pressure shall be controlled via digital controller (CUs) with inputs from airflow control measuring stations and static pressure inputs as specified. Controller outputs shall be true analog output signals to DDC positioners or variable frequency drives. Pulse width modulation outputs are not acceptable. The CUs shall include the capability to control via simple proportional (P) control, proportional plus integral (PI), proportional plus integral plus derivative (PID), and on-off. The airflow control programs shall be factory-tested programs that are documented in the literature of the control manufacturer.
- B. Air Flow Measuring Station -Electronic Type:

1. Airflow measuring stations shall measure airflow by the pitot tube traverse method. Each unit shall consist of the following:
  - a. Air Volume Transducer: with square root extractor, scaling multiplier, and output filter.
    - 1) Provide individual airflow transducers selected for the required design airflow rate of the primary element served. Each transducer shall be selected for its respective duty. Supply and Return Airflow Transducers shall provide analog output signal linear to air volume that are factory set for a full scale value equal to 110% of the maximum design capacity of the airflow measuring element served for variable air volume applications, or 200% of the design operating value for constant volume applications.
    - 2) The transducer(s) shall be solid state electronic type, with infinite output resolution, capable of performing dedicated air volume measurement. Microprocessor based transducers with time sharing of multiple square root extractors and/or controllers are not acceptable.
    - 3) Each transducer's output shall not be affected by direction of mounting (attitude) or external vibrations, and shall be furnished with a factory calibrated span that matches the application.
    - 4) Transducer performance shall be equal to or better than the following:
      - Accuracy: 0.5% F.S. (Terminal Point) 0.35%/ F.S. (BFSL)
      - Temperature Effects: <0.03% F.S./°F
      - Over-pressure: 5 PSIG Proof / 10 PSIG Burst
      - Response: <0.25 seconds for full span input
      - Noise Filtration: Low Pass Filter, factory set @ 3.2Hz
  - b. Insertion Type Airflow Sensing Element: Multiple elements shall be manifolded together, external to the ductwork.
    - 1) Provide where indicated and/or scheduled airflow traverse elements capable of continuously monitoring the duct air volumes they serve.
    - 2) Each element shall be designed and built to comply with, and provide results in accordance with, accepted practice for duct system traversing as defined in the ASHRAE Handbook of Fundamentals, AMCA publication #203, as well as the Industrial Ventilation Handbook. The number of sensing ports on each element, and the quantity of elements utilized at each installation, shall comply with ASHRAE Standard #111 for equal area duct traversing.
    - 3) Each element shall be of a dual integral chambered design. Each airflow measuring element shall contain multiple total and static pressure sensing ports placed along the leading edge of the cylinder. The static pressure chamber shall incorporate dual offset static taps on opposing sides of the averaging chamber, so as to be insensitive to flow angle variations of as much as ±20 degrees in the approaching airstream.
    - 4) The airflow traverse elements shall be capable of producing steady, non-pulsating signals of true total and static

pressure, with an accuracy of 2% of actual flow for operating velocities as low as 100 feet per minute (fpm). Signal amplifying sensors requiring flow correction (K factors) for field calibration are not acceptable.

- 5) The airflow traverse elements shall not induce a measurable pressure drop, greater than 0.18 inch at 4,000 fpm. The units shall have a self-generated sound rating of less than NC40 and the sound level within the duct shall not be amplified, nor shall additional sound be generated.
  - 6) Where primary flow elements are located outside of the manufacturer's published installation guidelines the manufacturer shall be consulted, and approve of any special configurations, such as air equalizers and/or additional and strategically placed measuring points, as may be required.
2. Each station shall contain noncombustible sensors, which shall be incapable of producing toxic gases or fumes in the event of elevated duct temperatures.
  3. Each air flow measuring station shall be installed to meet at least the manufacturer's minimum installation conditions and shall not amplify the sound level within the duct.
  4. Differential pressure transducers shall measure and transmit pressure signals to the direct digital controller CU.
  5. Electronics Panel:
    - a. Electronics panel shall consist of a surface mounted enclosure complete with solid-state microprocessor and software.
    - b. Electronic panel shall be A/C powered 120 VAC 24 VAC and shall have the capability to transmit signals of 0-5 VDC, 0-10 VCD or 4-20 ma for use in control of the HVAC Systems.
  6. Flow sensors and its electronics shall be installed as per manufacturer's instructions. The number of sensors shall be such that accuracy of the total flow rate shall no way be different than what is specified in Article 1.5 above.
    - a. Static/Total Pressure Sensors: A network of total and static pressure sensors shall be positioned on the equal traverse principle, with a maximum of 0.02 square meters (36 square inches) per total pressure sensor and 0.10 square meter (144 square inches) per static pressure sensor on units. Interconnecting sensor manifolds shall average and relate each type of sensor measurement into one total pressure and one static pressure metering port. The manifold mounting hardware shall not penetrate the manifold tubes and shall be so constructed as to eliminate any possible violation of the integrity of the total or static pressure measurements. The meter tubing for the averaged total static pressure shall not be exposed to internal duct conditions.

- b. Static Pressure Control: Systems shall consist of one or more static pressure sensors and transmitters along with relays or auxiliary devices as required for a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 25 Pascal (0.1 inch) W.G. of the true input pressure.
- 1) Static pressure sensors shall have the same requirements as Airflow Measuring Devices except that total pressure sensors are optional, and only multiple static pressure sensors positioned on an equal area basis connected to a network of headers are required.
  - 2) For systems with multiple major trunk supply duct, furnish a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected and this shall be the input signal to the CU.
  - 3) The CU shall receive the static pressure transmitter signal and CU shall provide a control output signal to the supply fan capacity control device. The control mode shall be proportional plus integral (PI) (automatic reset) and where required shall also include derivative mode.
  - 4) In systems with multiple static pressure transmitters, provide a switch located near the fan discharge to prevent excessive pressure during abnormal operating conditions.
- C. Constant Volume Control: Systems shall consist of a differential pressure transmitter along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its primary total pressure and static pressure signal from the flow measuring station and shall have a span not exceeding three times this differential pressure at the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. The CU shall provide proportional plus integral (PI) (automatic reset) control mode and where required also inverse derivative mode. Overall system accuracy shall be plus or minus the equivalent of 2 Pascal (0.008 inch) velocity pressure as measured by the flow station.
- D. Airflow Synchronization:
1. Systems shall consist of a differential pressure transmitter for each supply and return ducts, the CU and such relays, as required, to



- provide a complete functional system that will maintain a constant difference between supply and return air to meet the accuracy specified below. In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow, provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representative of total flow.
2. The total flow signals from supply and return air shall be the input signals to the CU. This CU shall track the return air fan capacity in proportion to the supply air flow under all conditions.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

##### **A. General:**

1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to COR for resolution before proceeding for installation.
2. Work Coordination: GENERAL CONDITIONS.
3. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
4. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
5. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
6. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
7. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
8. Install equipment level and plumb.

##### **B. Electrical Wiring Installation:**

1. Install conduits and wiring in accordance with Specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
2. Install signal and communication cables in accordance with Specification Section 26 05 19, LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES.
3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation,

- miscellaneous alarm points, thermostats, and relays as shown on the drawings. All wiring shall be installed in conduits.
4. Install all system components in accordance with local Building Code and National Electric Code.
    - a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
    - b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 300 mm (12 inches) long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
    - c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
    - d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
  5. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.
  6. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
  7. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.
- C. Install Sensors and Controls:
1. Temperature Sensors:
    - a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
    - b. Calibrate sensors to accuracy specified, if not factory calibrated.
    - c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
    - d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.

- e. Mount sensors rigidly and adequately for the environment within which the sensor operates.
  - f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
  - g. All pipe mounted temperature sensors shall be installed in wells.
  - h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
  - i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
2. Pressure Sensors:
- a. Install duct static pressure sensor tips facing directly downstream of airflow.
  - b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
  - c. Install snubbers and isolation valves on steam pressure sensing devices.
3. Actuators:
- a. Mount and link damper and valve actuators according to manufacturer's written instructions.
  - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
  - c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.
4. Flow Switches:
- a. Install flow switch according to manufacturer's written instructions.
  - b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
  - c. Assure correct flow direction and alignment.
  - d. Mount in horizontal piping-flow switch on top of the pipe.
- D. Installation of Network:

1. Ethernet:
    - a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.
    - b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity:  
10 Base 2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors),  
10 Base T (Twisted-Pair RJ-45 terminated UTP cabling).
  2. Third Party Interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.
- E. Installation of Digital Controllers and Programming:
1. Provide a separate digital controller for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.
  2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
  3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
  4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.
  5. Provide graphics for each piece of equipment and floor plan in the building. This includes each air handling unit, fan, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.
- F. Field Test and Inspection:
1. General:
    - a. Engage a factory-authorized representative and furnish personnel, instrumentation, and equipment necessary to perform complete testing of the installed HVAC systems, including piping and electrical connections. Field test will demonstrate proper calibration of input and output devices, and the operation of specific equipment.
    - b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.

- c. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
  - d. Contractor shall schedule the performance verification test with the COR.
  - e. During and after completion of the field tests, contractor shall determine causes, calibrate, repair, or replace equipment that fails to meet contract requirements, and subsequently deliver a written report to the VA.
2. Field Performance Tests:
- a. Perform tests in accordance with Articles-Quality Assurance and Performance.
  - b. Test and adjust controls and safeties.
  - c. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
  - d. Demonstrate the software ability to edit the control program off-line.
  - e. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms receive at the assigned location, including operator workstations.
  - f. Demonstrate ability of software program that it functions for the intended applications-trend reports, change in status etc.
  - g. Demonstrate via graphed trends to show the sequence of operation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., seasonal change, occupied/unoccupied mode, and warm-up condition.
  - h. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.
  - i. Demonstrate to the VA graphed trends of control loops to demonstrate that the control loop is stable and the set points are maintained.
  - j. Control loop shall respond to set points and stabilize in one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.
3. Performance Verification Test:
- The contractor shall verify the performance of the control systems by running a continuous test, after the system has been completely tested and debugged, for 80 hours and submit the report to the VA.

Bid Issue  
June 17, 2016

VAMC WADE PARK  
Enhance/Consolidate Mental Health Services  
Project No. 541-16-104

----- END -----

**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, heating hot water, and drain piping.
  - 2. Extension of domestic water make-up piping.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 07 11, HVAC INSULATION: Piping insulation.
- E. Section 23 09 23, DIRECT-DIGITAL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.

**1.3 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.
- C. For mechanical pressed sealed fittings, only tools of fitting manufacturer shall be used.
- D. Mechanical pressed fittings shall be installed by factory trained workers.
- E. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be the same manufacturer as the grooved components.
  - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

#### 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. Grooved joint couplings and fittings.
  - 6. Valves of all types.
  - 7. Strainers.
  - 8. Flexible connectors for water service.
  - 9. Pipe alignment guides.
  - 10. Expansion joints.
  - 11. All specified hydronic system components.
  - 12. Water flow measuring devices.
  - 13. Gages.
  - 14. Thermometers and test wells.
- C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels.
- D. Submit the welder's qualifications in the form of a current (less than one year old) and formal certificate.
- E. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.
  - 1. One wall-mounted stick file with complete set of prints. Mount stick file in the chiller plant or control room along with control diagram stick file.
  - 2. One complete set of reproducible drawings.
  - 3. One complete set of drawings in electronic Autocad and pdf format.



**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 Fittings B16.18-01 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
- C177-04 ..... Standard 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

**1.6 SPARE PARTS**

- A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

**PART 2 - PRODUCTS**

**2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

- A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**2.2 PIPE AND TUBING**

- A. Chilled Water, Heating Hot 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. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.

- C. Cooling Coil Condensate Drain Piping:
  - 1. From air handling units: Copper water tube, ASTM B88, Type M piping.
  - 2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.
- D. Pipe supports, including insulation shields, for above ground piping:  
Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

### **2.3 FITTINGS FOR STEEL PIPE**

- A. 50 mm (2 inches) and Smaller: Screwed or welded joints.
  - 1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
  - 2. Forged steel, socket welding or threaded: ASME B16.11.
  - 3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
  - 4. Unions: ASME B16.39.
  - 5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.
- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Contractor's option: Grooved mechanical couplings and fittings are optional.
  - 1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
  - 2. Welding flanges and bolting: ASME B16.5:
    - a. Water service: Weld neck or slip-on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
      - 1) Contractor's option: Convolute, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
    - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and 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 FITTINGS FOR PLASTIC PIPING**

- A. Schedule 40, socket type for solvent welding.
- B. Schedule 40 PVC drain piping: Drainage pattern.
- C. Chemical feed piping for condenser water treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F439.

#### **2.6 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.

#### **2.7 SCREWED JOINTS**

- A. Pipe Thread: ANSI B1.20.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

## 2.8 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 2400 mm (8 feet) or more above the floor or operating platform.
- D. 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 4140 kPa (600 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
  - 2. Butterfly Valves (Pipe Sizes 2-1/2" and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS-SP 67, flange lug type or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.
    - a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
    - b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
    - c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
      - 1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.

- 2) Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.
- 3) 3. Gate Valves (Contractor's Option in lieu of Ball or Butterfly Valves):
  - a) 50 mm (2 inches) and smaller: MSS-SP 80, Bronze, 1034 kPa (150 psig), wedge disc, rising stem, union bonnet.
  - b) 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke. MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves

1. Globe Valves

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

2. Angle Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle.

F. Check Valves

1. Swing Check Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.
- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.

- a. Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.



- b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62.  
Seats may be elastomer material.
- G. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.
  - 1. Ball style valve.
  - 2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
  - 3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of 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.
  - 4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

## **2.9 WATER FLOW MEASURING DEVICES**

- A. Minimum overall accuracy plus or minus three percent over a range of 70 to 110 percent of design flow. Select devices for not less than 110 percent of design flow rate.
- B. Venturi Type: Bronze, steel, or cast iron with bronze throat, with valved pressure sensing taps upstream and at the throat.
- C. Wafer Type Circuit Sensor: Cast iron wafer-type flow meter equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral

check valve designed to minimize system fluid loss during the monitoring process.

- D. Self-Averaging Annular Sensor Type: Brass or stainless steel metering tube, shutoff valves and quick-coupling pressure connections. Metering tube shall be rotatable so all sensing ports may be pointed down-stream when unit is not in use.
- E. Insertion Turbine Type Sensor: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HAVC.
- F. Flow Measuring Device Identification:
  - 1. Metal tag attached by chain to the device.
  - 2. Include meter or equipment number, manufacturer's name, meter model, flow rate factor and design flow rate in l/m (gpm).
- G. Permanently Mounted Water Flow Indicating Meters: Minimum 150 mm (6 inch) diameter, or 450 mm (18 inch) long scale, for 120 percent of design flow rate, direct reading in lps (gpm), with three valve manifold and two shut-off valves.

## **2.10 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.
- B. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

## **2.11 FLEXIBLE CONNECTORS FOR WATER SERVICE**

- A. Flanged Spool Connector:
  - 1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
  - 2. Working pressures and temperatures shall be as follows:
    - a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165psig) at 121 degrees C (250 degrees F).

- b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
- 3. Provide ductile iron retaining rings and control units.
- B. Mechanical Pipe Couplings:  
See other fittings specified under Part 2, PRODUCTS.

## 2.12 EXPANSION JOINTS

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- C. Bellows - Internally Pressurized Type:
  - 1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
  - 2. Internal stainless steel sleeve entire length of bellows.
  - 3. External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
  - 4. Welded ends.
  - 5. Design shall conform to standards of EJMA and ASME B31.1.
  - 6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
  - 7. Integral external cover.
- D. Bellows - Externally Pressurized Type:
  - 1. Multiple corrugations of Type 304 stainless steel.
  - 2. Internal and external guide integral with joint.
  - 3. Design for external pressurization of bellows to eliminate squirm.
  - 4. Welded ends.
  - 5. Conform to the standards of EJMA and ASME B31.1.
  - 6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
  - 7. Integral external cover and internal sleeve.
- E. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature,

date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

- F. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.
- G. Supports: Provide saddle supports and frame or hangers for heat exchanger. Mounting height shall be adjusted to facilitate gravity return of steam condensate. Construct supports from steel, weld joints.

### **2.13 HYDRONIC SYSTEM COMPONENTS**

- A. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 28 kPa (4 psig) above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 861 kPa (125 psig) working pressure at 107 degrees C (225 degrees F).
- B. Pressure Relief Valve: Bronze or iron body and bronze or stainless steel trim, with testing lever. Comply with ASME Code for Pressure Vessels, Section 8, and bear ASME stamp.
- C. Automatic Air Vent Valves (where shown): Cast iron or semi-steel body, 1034 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

### **2.14 WATER FILTERS AND POT CHEMICAL FEEDERS**

See section 23 25 00, HVAC WATER TREATMENT, Article 2.2, CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS.

### **2.15 GAGES, PRESSURE AND COMPOUND**

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window,

suitable for board mounting. Provide red "set hand" to indicate normal working pressure.

- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.
- C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.

#### **2.16 PRESSURE/TEMPERATURE TEST PROVISIONS**

- A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.
- B. Provide one each of the following test items to the COR:
  - 1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug.
  - 2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, -- 100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
  - 3. 0 - 104 degrees C (220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

#### **2.17 THERMOMETERS**

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (6 inch) brass stem, straight, fixed or adjustable angle as required for each in reading.
- B. Case: Chrome plated brass or aluminum with enamel finish.
- C. Scale: Not less than 225 mm (9 inches), range as described below, two degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges:
  - 1. Chilled Water: 0-38 degrees C (32-100 degrees F).
  - 2. Hot Water: -1 - 116 degrees C (30-240 degrees F).

#### **2.18 FIRESTOPPING MATERIAL**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

## **2.19 PRE-INSULATED PIPING**

- A. Carrier pipe shall be Schedule 40 steel, ASTM A-53, Grade B ERW.
- B. Insulation shall be a minimum 2.0" of closed cell polyurethane foam with 2.0 lbs/ft<sup>2</sup> minimum density. Foam shall have a minimum compressive strength of 30 psi and thermal conductivity of no greater than .15 (BTU·in/h·ft<sup>2</sup>·°F).
- C. Jacketing material shall be high density polyethylene (HDPE) with minimum wall thickness of 100 mils. Inner surface of jacket shall be oxidized to enhance bond and deter water entry between jacket and foam insulation.
- D. Fittings for pre-insulated piping including ells, loops, and tees shall conform to the same standards for piping, insulation, and conduit set forth in these specifications for straight runs.
- E. Straight run joints shall be field insulated per manufacturer's instructions using polyurethane foam in an HDPE sleeve, sealed with heat shrink tape.
- F. All joints shall be butt-welded.

## **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, 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. Install heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

- 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. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
  - 1. Water treatment pot feeders and condenser water treatment systems.
  - 2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- J. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- K. 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 INSULATION.
- L. 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.
- 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. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.
- D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.
- E. Solvent Welded Joints: As recommended by the manufacturer.

### 3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding.



### **3.4 LEAK TESTING ABOVE GROUND PIPING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the COR. Tests may be either of those below, or a combination, as approved by the COR.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

### **3.5 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
  - 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 COR.
  - 2. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not

- removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

### **3.6 WATER TREATMENT**

- A. Install water treatment equipment and provide water treatment system piping.
- B. Close and fill system as soon as possible after final flushing to minimize corrosion.
- C. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
- D. Utilize this activity, by arrangement with the COR, for instructing VA operating personnel.

### **3.7 OPERATING AND PERFORMANCE TEST AND INSTRUCTION**

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

### **3.8 PRE-INSULATED PIPING - ALL SYSTEMS**

- A. System shall be provided with all straight pipe and fittings factory pre-insulated and pre-fabricated to job dimensions.
- B. Contractor shall excavate, string conduit, weld test, place in trench, backfill, and otherwise install system as per plans and specifications.
- C. Underground systems shall be buried in a trench not less than two feet deeper than the top of the pipe. A minimum of 24" of compacted backfill shall be placed over top of pipe.

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- D. Perform a hydrostatic pressure test of piping at 150 psig or 1.5 times the normal operating pressure, whichever is greater, for two hours.

- - - E N D - - -

**SECTION 23 31 00  
HVAC DUCTS AND CASINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Ductwork and accessories for HVAC including the following:
  - 1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
  - 2. Exhaust duct for "wet exhaust" ducts.
- B. Definitions:
  - 1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
  - 2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
  - 3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
  - 4. Exposed Duct: Exposed to view in a finished room, [exposed to weather.]

**1.2 RELATED WORK**

- A. Fire Stopping Material: Section 07 84 00, FIRESTOPPING.
- B. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION
- D. Plumbing Connections: Section 22 11 00, FACILITY WATER DISTRIBUTION
- E. Air Flow Control Valves and Terminal Units: Section 23 36 00, AIR TERMINAL UNITS.
- F. Return Air and Exhaust Air Fans: Section 23 34 00, HVAC FANS.
- G. Duct Mounted Instrumentation: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- H. 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. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Rectangular ducts:
    - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
    - b. Duct liner.
    - c. Sealants and gaskets.
    - d. Access doors.
  - 2. Round duct construction details:
    - a. Manufacturer's details for duct fittings.
    - b. Sealants and gaskets.
    - c. Access sections.
    - d. Installation instructions.
  - 3. Volume dampers, back draft dampers.
  - 4. Upper hanger attachments.
  - 5. Flexible ducts and clamps, with manufacturer's installation instructions.
  - 6. Flexible connections.
  - 7. Instrument test fittings.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11 - Common Work Results for HVAC.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Civil Engineers (ASCE):
  - 1. ASCE7-05 Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
  - 1. A167-99(2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - 2. A653-09 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
  - 3. 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

4. B209-07 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  5. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
  6. E84-09a Standard Test Method for Surface Burning Characteristics of Building Materials
- D. National Fire Protection Association (NFPA):
1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems
  2. 96-08 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
1. 2nd Edition - 2005 HVAC Duct Construction Standards, Metal and Flexible
  2. 1st Edition - 1985 HVAC Air Duct Leakage Test Manual
  3. 6th Edition - 2003 Fibrous Glass Duct Construction Standards
- F. Underwriters Laboratories, Inc. (UL):
1. 181-08 Factory-Made Air Ducts and Air Connectors

## **PART 2 - PRODUCTS**

### **2.1 DUCT MATERIALS AND SEALANTS**

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, 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.
- D. Approved factory made joints may be used.

## 2.2 DUCT CONSTRUCTION AND INSTALLATION

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
  - 1. 0 to 50 mm (2 inch)
  - 2. > 50 mm to 75 mm (2 inch to 3 inch)
  - 3. > 75 mm to 100 mm (3 inch to 4 inch)
  - 4. Show pressure classifications on the floor plans.
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Round 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.
- 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.
- G. Ductwork in excess of 620 cm<sup>2</sup> (96 square inches) shall be protected unless the duct has one dimension less than 150 mm (6 inches) if it passes through the areas listed below. Refer to the Mission Critical Physical Design Manual for VA Facilities. This applies to the following:
  - 1. Agent cashier spaces
  - 2. Perimeter partitions of caches
  - 3. Perimeter partitions of computer rooms
  - 4. Perimeter of a COOP sites
  - 5. Perimeter partitions of Entrances
  - 6. Security control centers (SCC)

## 2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS

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

4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
  1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
  2. For round duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

#### **2.4 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.



## **2.5 FLEXIBLE DUCT CONNECTIONS**

- A. Where duct connections are made to fans, air terminal units, and air handling units, install a non-combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to insure that no vibration is transmitted.

## **2.6 PREFABRICATED ROOF CURBS**

- A. Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

## **2.7 FIRESTOPPING MATERIAL**

- A. Refer to Section 07 84 00, FIRESTOPPING.

## **2.8 DUCT MOUNTED Temperature sensor (AIR)**

- A. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

## **2.9 INSTRUMENT TEST FITTINGS**

- A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.
- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

## **2.10 AIR FLOW CONTROL VALVES (AFCV)**

- A. Refer to Section 23 36 00 AIR TERMINAL UNITS.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC, particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:

1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
  2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, 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. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- E. 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.
- F. 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.
- G. 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.

- H. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- I. 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 COR. 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. [Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the COR on ductwork constructed to the 500 Pa (2" WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 500 Pa (2" WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.]
- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the COR and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the COR 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 COR.
- 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)**

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

### **3.4 OPERATING AND PERFORMANCE TESTS**

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

- - - E N D - - -

**SECTION 23 34 00**  
**HVAC FANS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Fans for heating, ventilating and air conditioning.
- B. Product Definitions: AMCA Publication 99, Standard 1-66.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- E. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- F. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Fans and power ventilators shall be listed in the current edition of AMCA 261, and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
  - 1. Testing and Rating: AMCA 210.
  - 2. Sound Rating: AMCA 300.
- E. Performance Criteria:
  - 1. The fan schedule shall show the design air volume and static pressure. Select the fan motor HP by increasing the fan BHP by 10 percent to account for the drive losses and field conditions.
  - 2. Select the fan operating point as follows:
    - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point
    - b. Air Foil, Backward Inclined, or Tubular: At or near the peak static efficiency.
- F. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.
- G. Corrosion Protection:
  - 1. Except for fans in fume hood exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint

system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.

2. Fans for general purpose fume hoods, or chemical hoods, and radioisotope hoods shall be constructed of materials compatible with the chemicals being transported in the air through the fan.
- H. Spark resistant construction: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), the fan construction shall be as recommended by AMCA's Classification for Spark Resistant Construction. Drive set shall be comprised of non-static belts for use in an explosive.

#### 1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturers Literature and Data:
  1. Fan sections, motors and drives.
  2. Centrifugal fans, motors, drives, accessories and coatings.
    - a. In-line centrifugal fans.
    - b. Utility fans and vent sets.
  3. Prefabricated roof curbs.
  4. Power roof and wall ventilators.
- C. Certified Sound power levels for each fan.
- D. Motor ratings types, electrical characteristics and accessories.
- E. Roof curbs.
- F. Belt guards.
- G. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- H. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.

#### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Movement and Control Association International, Inc. (AMCA):  
99-86.....Standards Handbook

- 210-06.....Laboratory Methods of Testing Fans for  
Aerodynamic Performance Rating
- 261-09.....Directory of Products Licensed to bear the AMCA  
Certified Ratings Seal - Published Annually
- 300-08.....Reverberant Room Method for Sound Testing of  
Fans
- C. American Society for Testing and Materials (ASTM):
  - B117-07a.....Standard Practice for Operating Salt Spray (Fog)  
Apparatus
  - D1735-08.....Standard Practice for Testing Water Resistance  
of Coatings Using Water Fog Apparatus
  - D3359-08.....Standard Test Methods for Measuring Adhesion by  
Tape Test
  - G152-06.....Standard Practice for Operating Open Flame  
Carbon Arc Light Apparatus for Exposure of Non-  
Metallic Materials
  - G153-04.....Standard Practice for Operating Enclosed Carbon  
Arc Light Apparatus for Exposure of Non-Metallic  
Materials
- D. National Fire Protection Association (NFPA):
  - NFPA 96-08.....Standard for Ventilation Control and Fire  
Protection of Commercial Cooking Operations
- E. National Sanitation Foundation (NSF):
  - 37-07.....Air Curtains for Entrance Ways in Food and Food  
Service Establishments
- F. Underwriters Laboratories, Inc. (UL):
  - 181-2005.....Factory Made Air Ducts and Air Connectors

**1.6 EXTRA MATERIALS**

- A. Provide one additional set of belts for all belt-driven fans.

**PART 2 - PRODUCTS**

**2.1 CENTRIFUGAL FANS**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the fan or furnish to the Contractor.
- B. Fan arrangement, unless noted or approved otherwise:
  - 1. DWDI fans: Arrangement 3.
  - 2. SWSI fans: Arrangement 1, 3, 9 or 10.

- C. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA standards.
1. Housing: Low carbon steel, arc welded throughout, braced and supported by structural channel or angle iron to prevent vibration or pulsation, flanged outlet, inlet fully streamlined. Provide lifting clips, and casing drain. Provide manufacturer's standard access door. Provide 12.5 mm (1/2 inches) wire mesh screens for fan inlets without duct connections.
  2. Wheel: Steel plate with die formed blades welded or riveted in place, factory balanced statically and dynamically.
  3. Shaft: Designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fans class.
  4. Bearings: Heavy duty ball or roller type sized to produce a B10 life of not less than 50,000 hours, and an average fatigue life of 200,000 hours. Extend filled lubrication tubes for interior bearings or ducted units to outside of housing.
  5. Belts: Oil resistant, non-sparking and non-static.
  6. Belt Drives: Factory installed with final alignment belt adjustment made after installation.
  7. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15HP, fixed pitch for use with motors larger than 15HP. Select pulleys so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
  8. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for specifications. Provide protective sheet metal enclosure for fans located outdoors.
  9. Furnish variable speed fan motor controllers where shown on the drawings. Refer to Section, MOTOR STARTERS. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for controller/motor combination requirements.
- D. In-line Centrifugal Fans: In addition to the requirements of paragraphs A and 2.2.C3 thru 2.2.C9, provide minimum 18 Gauge galvanized steel housing with inlet and outlet flanges, backward inclined aluminum centrifugal fan wheel, bolted access door and supports as required. Motors shall be factory pre-wired to an external junction box.
- E. Utility Fans, Vent Sets and Small Capacity Fans: Class 1 design, arc welded housing, spun intake cone. Applicable construction specification, paragraphs A and C, for centrifugal fans shall apply for wheel diameters 300 mm (12 inches) and larger. Requirement for AMCA seal is waived for

wheel diameters less than 300 mm (12 inches) and housings may be cast iron.

- F. Spark Resistant/Explosion Proof Fans: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), provide AMCA construction option: A, B or C as indicated. Drive set shall be comprised of non-static belts for use in an explosive atmosphere. Motor shall be explosion proof type if located in air stream. This shall apply to exhaust fan (EF-6-3) serving paint booth.

## **2.2 POWER ROOF VENTILATOR**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.
- B. Type: Centrifugal fan, backward inclined blades. Provide down-blast or up-blast type as indicated.
- C. Construction: Steel or aluminum, completely weatherproof, for curb mounting, exhaust cowl or entire drive assembly readily removable for servicing, aluminum bird screen on discharge, UL approved safety disconnect switch, conduit for wiring, vibration isolators for wheel, motor and drive assembly. Provide self acting back draft damper. Provide electric motor operated damper where indicated.
- D. Motor and Drive: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Bearings shall be pillow block ball type with a minimum L-50 life of 200,000 hours. Motor shall be located out of air stream.
- E. Prefabricated Roof Curb: As specified in paragraph 2.3 of this section.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install fan, motor and drive in accordance with manufacturer's instructions.
- B. Align fan and motor sheaves to allow belts to run true and straight.
- C. Bolt equipment to curbs with galvanized lag bolts.
- D. Install vibration control devices as shown on drawings and specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

### **3.2 PRE-OPERATION MAINTENANCE**

- A. Lubricate bearings, pulleys, belts and other moving parts with manufacturer recommended lubricants.



- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.
- C. Clean fan interiors to remove foreign material and construction dirt and dust.

**3.3 START-UP AND INSTRUCTIONS**

- A. Verify operation of motor, drive system and fan wheel according to the drawings and specifications.
- B. Check vibration and correct as necessary for air balance work.

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**SECTION 23 36 00  
AIR TERMINAL UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Air terminal units.

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- B. Section 23 31 00, HVAC DUCTS AND CASINGS: Ducts and flexible connectors.
- C. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.
- D. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: Flow rates adjusting and balancing.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Air Terminal Units: Submit test data.
- C. Samples: Provide one typical air terminal unit for approval by the COR. These units will be returned to the Contractor after all similar units have been shipped and deemed acceptable at the job site.
- D. Certificates:
  - 1. Compliance with paragraph, QUALITY ASSURANCE.
  - 2. Compliance with specified standards.
- E. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning and Refrigeration Institute (AHRI)/(ARI):  
880-08.....Air Terminals Addendum to ARI 888-98  
incorporated into standard posted 15<sup>th</sup> December  
2002
- C. National Fire Protection Association (NFPA):  
90A-09.....Standard for the Installation of Air  
Conditioning and Ventilating Systems
- D. Underwriters Laboratories, Inc. (UL):  
181-08.....Standard for Factory-Made Air Ducts and Air  
Connectors
- E. American Society for Testing and Materials (ASTM):  
C 665-06.....Standard Specification for Mineral-Fiber  
Blanket Thermal Insulation for Light Frame  
Construction and Manufactured Housing

**1.6 GUARANTY**

In accordance with the GENERAL CONDITIONS.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. Coils:
  - 1. Provide copper fins and copper coils for all hot water reheat coils.
- B. Labeling: Control box shall be clearly marked with an identification label that lists such information as nominal CFM, maximum and minimum factory-set airflow limits, coil type and coil connection orientation, where applicable.
- C. Factory calibrate air terminal units to air flow rate indicated. All settings including maximum and minimum air flow shall be field adjustable.
- D. Dampers with internal air volume control: See section 23 31 00, HVAC DUCTS and CASINGS.

- E. Terminal Sound Attenuators: See Section 23 31 00, HVAC DUCTS AND CASINGS.

## **2.2 AIR TERMINAL UNITS (VAV BOXES)**

- A. General: Factory built, pressure independent units, factory set-field adjustable air flow rate, suitable for single duct applications. Use of dual-duct air terminal units is not permitted. Clearly show on each unit the unit number and factory set air volumes corresponding to the contract drawings. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC work assumes factory set air volumes. Coordinate flow controller sequence and damper operation details with the drawings and Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. All air terminal units shall be brand new products of the same manufacturer.
- B. Sound Power Levels: Acoustic performance of the air terminal units shall be based on the design noise levels for the spaces stipulated in Section 23 05 41 (Noise and Vibration Control for HVAC Piping and Equipment). Equipment schedule shall show the sound power levels in all octave bands. Terminal sound attenuators shall be provided, as required, to meet the intent of the design.
- C. Casing: Unit casing shall be constructed of galvanized steel no lighter than 0.85 mm (22 Gauge). Provide hanger brackets for attachment of supports.
1. Lining material: Suitable to provide required acoustic performance, thermal insulation and prevent sweating. Meet the requirements of NFPA 90A and comply with UL 181 for erosion as well as ASTM C 665 antimicrobial requirements. Insulation shall consist of 13 mm (1/2 IN) thick non-porous foil faced rigid fiberglass insulation of 4-lb/cu.ft, secured by full length galvanized steel z-strips which enclose and seal all edges. Tape and adhesives shall not be used. Materials shall be non-friable and with surfaces, including all edges, fully encapsulated and faced with perforated metal or coated so that the air stream will not detach material.
  2. Access panels (or doors): Provide panels large enough for inspection, adjustment and maintenance without disconnecting ducts, and for cleaning heating coils attached to unit, even if there are no moving parts. Panels shall be insulated to same standards as the

- rest of the casing and shall be secured and gasketed airtight. It shall require no tool other than a screwdriver to remove.
3. Total leakage from casing: Not to exceed 2 percent of the nominal capacity of the unit when subjected to a static pressure of 750 Pa (3 inch WG), with all outlets sealed shut and inlets fully open.
  4. Octopus connector: Octopus connectors are not permitted.
- D. Construct dampers and other internal devices of corrosion resisting materials which do not require lubrication or other periodic maintenance.
1. Damper Leakage: Not greater than 2 percent of maximum rated capacity, when closed against inlet static pressure of 1 kPa (4 inch WG).
- E. Provide multi-point velocity pressure sensors with external pressure taps.
1. Provide direct reading air flow rate table pasted to box.
- F. Provide static pressure tubes.
- G. Externally powered DDC variable air volume controller and damper actuator to be furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for factory mounting on air terminal units. The DDC controller shall be electrically actuated.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- B. Handle and install units in accordance with manufacturer's written instructions.
- C. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.
- D. Locate air terminal units to provide a straight section of inlet duct for proper functioning of volume controls.

#### **3.2 OPERATIONAL TEST**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air outlets and inlets.

**1.2 RELATED WORK**

- A. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. 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.
- B. Fire Safety Code: Comply with NFPA 90A.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Diffusers, registers, grilles and accessories.
  - 2. Gravity ventilators.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Diffusion Council Test Code:
  - 1062 GRD-84.....Certification, Rating, and Test Manual 4<sup>th</sup> Edition
- C. American Society of Civil Engineers (ASCE):
  - ASCE7-98.....Minimum Design Loads for Buildings and Other Structures
- D. American Society for Testing and Materials (ASTM):

- A167-99.....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
- A653-01.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
- A1011-02.....Standard Specification for Steel Sheet and Strip Hot rolled Carbon structural, High-Strength Low-Alloy and High Strength Low-Alloy with Improved Formability
- B209-01.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- E84-01.....Standard Test Method for Surface Burning Characteristics of Building Materials
- E. National Fire Protection Association (NFPA):
  - 90A-99.....Standard for the Installation of Air Conditioning and Ventilating Systems
  - 96-01.....Ventilation Control and Fire Protection of Commercial Cooking Operations
- F. Underwriters Laboratories, Inc. (UL):
  - 33-93.....UL Standard for Safety Heat Responsive Links for Fire Protection Service

**PART 2 - PRODUCTS**

**2.1 EQUIPMENT SUPPORTS**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**2.2 AIR OUTLETS AND INLETS**

A. Materials:

1. Refer to Schedule. Provide manufacturer's standard gasket.
2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.

B. Performance Test Data: In accordance with Air Diffusion Council Code 1062GRD. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT for NC criteria.

C. Air Supply Outlets:

1. (S1) Ceiling diffuser of sizes and mounting types as designated by the plans and schedules. Diffusers shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct. An inner plaque assembly shall be incorporated that drops no more than ¼" below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near diffuser neck.

D. Return and Exhaust Registers and Grilles:

1. (R1, R2, and E1) Perforated face return/exhaust air grilles of sizes and mounting styles as shown on plans and schedules. The outlet shall have square or round necks as indicated on the drawings or schedules. Back pan shall be snap-in assembly with extruded aluminum borders. Framed perforated face panel sub-assembly shall have spring clip latch arrangement to permit an easy removal and access. Face panel when installed shall be flush with the border frame. Back pan shall be painted black.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC, particularly regarding coordination with other trades and work in existing buildings.
- B. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating determined by COR. 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.

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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. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.
- D. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

**1.2 MINIMUM REQUIREMENTS**

- A. The 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 four hours of receipt of notification that service is needed. Submit name and address of service organizations.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. Applicable publications listed in all Sections of Division 26 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.

D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

#### **1.11 EQUIPMENT IDENTIFICATION**

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 12 mm (1/2 inch) high. Identification signs shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.

C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall show specific and correct information for specific equipment based on its arc flash calculations. Label shall show the followings:

1. Nominal system voltage.
2. Arc flash boundary (inches).
3. Available arc flash incident energy at the corresponding working distance (calories/cm<sup>2</sup>).
4. Required PPE category and description.
5. Limited approach distance (inches), restricted approach distance (inches).
6. Equipment/bus name, date prepared, and manufacturer name and address.

#### **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. Layout Drawings: In accordance with GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than (1/4-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves, junction boxes, splice boxes, and other items. Show the access means for all items requiring access for operations and maintenance. Do not install equipment foundations, equipment or piping until layout drawings have been approved. Provide detailed layout drawings of all piping and duct systems. In addition provide details of the following.
1. Mechanical equipment rooms.
  2. Electrical equipment rooms.
  3. Conduit sleeves.
  4. Cable Tray, conduit or equipment penetrations of floors, walls, ceilings, or roofs.
- G. 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.
- H. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.
- I. After approval and prior to installation, furnish the COR with one sample of each of the following:
  1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
  2. Each type of conduit coupling, bushing, and termination fitting.
  3. Conduit hangers, clamps, and supports.
  4. Duct sealing compound.
  5. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

**1.13 SINGULAR NUMBER**

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

**1.14 ACCEPTANCE CHECKS AND TESTS**

- A. The Contractor shall furnish the instruments, materials, and labor for tests.
- B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Government.
- C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests. Repair, replacement, and retesting shall be accomplished at no additional cost to the Government.

**1.15 WARRANTY**

- A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer Representative for the Government.

**1.16 INSTRUCTION**

- A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.
- B. Furnish the services of competent 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 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):
1. D2301-10 Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
  2. D2304-10 Test Method for Thermal Endurance of Rigid Electrical Insulating Materials
  3. D3005-10 Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- C. National Electrical Manufacturers Association (NEMA):
1. WC 70-09 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- D. National Fire Protection Association (NFPA):
1. 70-11 National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
1. 44-10 Thermoset-Insulated Wires and Cables
  2. 83-08 Thermoplastic-Insulated Wires and Cables
  3. 467-07 Grounding and Bonding Equipment
  4. 486A-486B-03 Wire Connectors
  5. 486C-04 Splicing Wire Connectors
  6. 486D-05 Sealed Wire Connector Systems
  7. 486E-09 Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
  8. 493-07 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
  9. 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. 12 AWG and larger: Stranded.

3. No. 14 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.
3. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

4. 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. |         |           |

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

**2.2 SPLICES**

- A. Splices shall be in accordance with NEC and UL.
- B. Above Ground Splices for No. 10 AWG and Smaller:
  1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
  2. The integral insulator shall have a skirt to completely cover the stripped conductors.
  3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.
- C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:
  1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
  2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
  3. Splice and insulation shall be product of the same manufacturer.

4. All bolts, nuts, and washers used with splices shall be [zinc-plated] [cadmium-plated] steel.

D. Above Ground Splices for 250 kcmil and Larger:

1. Long barrel "butt-splice" or "sleeve" type compression connectors, with minimum of two compression indents per wire, listed for use with copper 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.

E. Splice and insulation shall be product of the same manufacturer.

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

### **2.3 CONNECTORS AND TERMINATIONS**

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

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

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

### **2.4 CONTROL WIRING**

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

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

### **2.5 WIRE LUBRICATING COMPOUND**

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

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 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 FEEDER CONDUCTOR IDENTIFICATION**

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

**3.5 EXISTING CONDUCTORS**

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

**3.6 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.

**3.7 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.

**3.8 ACCEPTANCE CHECKS AND TESTS**

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests: Inspect physical condition.
  - 2. Electrical tests:
    - a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
    - b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
    - c. Perform phase rotation test on all three-phase circuits.

---END---

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- D. Section 26 22 00, LOW-VOLTAGE TRANSFORMERS: Low-voltage transformers.
- E. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.

**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 COR.
  - 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):
  - 1. B1-07 Standard Specification for Hard-Drawn Copper Wire
  - 2. B3-07 Standard Specification for Soft or Annealed Copper Wire
  - 3. B8-11 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 1. 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):
  - 1. 70-11 National Electrical Code (NEC)
  - 2. 70E-12 National Electrical Safety Code
  - 3. 99-12 Health Care Facilities
- E. Underwriters Laboratories, Inc. (UL):
  - 1. 44-10 Thermoset-Insulated Wires and Cables
  - 2. 83-08 Thermoplastic-Insulated Wires and Cables
  - 3. 467-07 Grounding and Bonding Equipment

## PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be insulated stranded copper for all sizes larger than No. 14 AWG. 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 for all sizes larger than No. 14 AWG. 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. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.
- B. Above Grade:



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

### **2.3 EQUIPMENT RACK AND CABINET GROUND BARS**

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

### **2.4 GROUND TERMINAL BLOCKS**

- A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

### **2.5 GROUNDING BUS BAR**

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

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Install grounding equipment in accordance with the NEC, as shown on the drawings, and as specified herein.
- B. System Grounding:
  1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
  2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- C. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

- D. For patient care area electrical power system grounding, conform to 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. Metallic Piping, Building Structural Steel, and Supplemental Electrode(s):
  - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.
  - 2. Provide a supplemental ground electrode as shown on the drawings and bond to the grounding electrode system.
- 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.
- C. Transformers:
  - 1. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the nearest metal water pipe grounding electrode or structural metal grounding electrode.

### **3.4 RACEWAY**

- A. Conduit Systems:
  - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
  - 2. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.
- B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.
- C. Boxes, Cabinets, Enclosures, and Panelboards:
  - 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
  - 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
- D. Wireway Systems:

1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
  2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).
  3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
  4. Use insulated No. 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).
- E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
- F. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.
- H. Panelboard Bonding in Patient Care Areas: The equipment grounding terminal buses of the normal and essential branch circuit panel boards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than No. 10 AWG, installed in rigid metal conduit.

### **3.5 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 CONDUCTIVE PIPING**

- A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In operating rooms and at intensive care and coronary care type beds, bond the medical gas piping and medical vacuum piping at the outlets directly to the patient ground bus.

### **3.7 ACCEPTANCE CHECKS AND TESTS**

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

---END---

**SECTION 26 05 33**  
**RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

**1.2 RELATED WORK:**

- A. Section 06 10 00, ROUGH CARPENTRY: Mounting oard for telephone closets.
- B. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- C. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

**1.3 QUALITY ASSURANCE:**

- A. 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):
  1. C80.1-05 Electrical Rigid Steel Conduit
  2. C80.3-05 Steel Electrical Metal Tubing
  3. C80.6-05 Electrical Intermediate Metal Conduit
- C. National Fire Protection Association (NFPA):
  1. 70-11 National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  1. 1-05 Flexible Metal Conduit
  2. 5-11 Surface Metal Raceway and Fittings
  3. 6-07 Electrical Rigid Metal Conduit - Steel
  4. 50-95 Enclosures for Electrical Equipment
  5. 360-13 Liquid-Tight Flexible Steel Conduit
  6. 467-13 Grounding and Bonding Equipment
  7. 514A-13 Metallic Outlet Boxes
  8. 514B-12 Conduit, Tubing, and Cable Fittings
  9. 514C-07 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
  10. 651-11 Schedule 40 and 80 Rigid PVC Conduit and Fittings
  11. 651A-11 Type EB and A Rigid PVC Conduit and HDPE Conduit
  12. 797-07 Electrical Metallic Tubing
  13. 1242-06 Electrical Intermediate Metal Conduit - Steel
- E. National Electrical Manufacturers Association (NEMA):
  1. TC-2-13 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
  2. TC-3-13 PVC Fittings for Use with Rigid PVC Conduit and Tubing
  3. FB1-12 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
  4. 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)

5. FB2.20-12 Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable

F. American Iron and Steel Institute (AISI):

1. 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 0.75-inch unless otherwise shown. Where permitted by the NEC, 0.75-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 0.75-inch.
  2. Rigid Steel Conduit (RMC): Shall conform to UL 6 and ANSI C80.1.
  3. Rigid aluminum: Shall conform to UL 6A and ANSI C80.5.
  4. Rigid Intermediate Steel Conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.
  5. 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.
  6. Flexible Metal Conduit: Shall conform to UL 1.
  7. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
  8. Surface Metal Raceway: Shall conform to UL 5.
- C. Conduit Fittings:
1. Rigid Steel and Intermediate Metallic Conduit Fittings:
    - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
    - b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
    - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
    - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
    - e. Erickson (Union Type) and Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

- f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
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. Couplings and Connectors: Concrete-tight and rain-tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
    - 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. Surface Metal Raceway Fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
  6. 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.
- F. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

### **PART 3 - EXECUTION**

#### **3.1 PENETRATIONS:**

- A. Cutting or Holes:
1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COR prior to drilling through structural elements.
  2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except when permitted by the COR where working space is limited.
- B. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight.

#### **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. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
  13. Do not use aluminum conduits in wet locations.
- 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.
- F. Coordination:
1. Refer to 26 05 11 Submittals for Layout Drawing requirements.
  2. All conduits shall be installed as to not interfere with manufacturer equipment clearances. Any violation of code or manufacturer clearances shall be fixed at contractor's expense.

### 3.3 CONCEALED WORK INSTALLATION:

- A. In Concrete:

1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
  2. Align and run conduit in direct lines.
  3. Install conduit through concrete beams only:
    - a. Where shown on the structural drawings.
    - b. As approved by the COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
  4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
    - a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
    - b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
    - c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (0.75-inch) of concrete around the conduits.
  5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.
- B. Above Furred or Suspended Ceilings and in Walls:
1. Conduit for Conductors Above 600 V: Rigid steel . Mixing different types of conduits in the same system is prohibited.
  2. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the same system is prohibited.
  3. Align and run conduit parallel or perpendicular to the building lines.
  4. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
  5. Tightening set screws with pliers is prohibited.
  6. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.
- 3.4 EXPOSED WORK INSTALLATION:**
- A. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical and electrical rooms.
  - B. Conduit for Conductors Above 600 V: Rigid steel . Mixing different types of conduits in the system is prohibited.
  - C. Conduit for Conductors 600 V and Below: Rigid steel, 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 WET OR DAMP LOCATIONS:**

- A. Use rigid steel or IMC conduits unless as shown on drawings.
- B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
- C. Use rigid steel or IMC conduit within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.
- D. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

**3.6 MOTORS AND VIBRATING EQUIPMENT:**

- A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- B. Use liquid tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.
- C. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.

**3.7 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.

**3.8 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.

**3.9 BOX INSTALLATION:**

- A. Boxes for Concealed Conduits:

1. Flush-mounted.
2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.
- C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.
- D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap in metal covers for sheet metal boxes.
- E. Outlet boxes mounted back to back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.
- F. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.
- G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
- H. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG FA JB No. 1."
- I. On all branch circuit junction box covers, identify the circuits with black marker.

- - - E N D - - -

**SECTION 26 05 73**  
**OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the overcurrent protective device coordination study, indicated as the study in this section.
- B. A short-circuit and selective coordination study shall be prepared for the electrical overcurrent devices to be installed under this project.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. The study shall be prepared by the equipment manufacturer.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Product data on the software program to be used for the study. Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.
  - 2. Complete study as described in paragraph 1.6. Submittal of the study shall be well-coordinated with submittals of the shop drawings for equipment in related specification sections.
  - 3. Certifications: Two weeks prior to final inspection, submit the following.
    - a. Certification by the Contractor that the overcurrent protective devices have been set in accordance with the approved study.

**1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. 242-01 Protection and Coordination of Industrial and Commercial Power Systems
  - 2. 399-97 Industrial and Commercial Power Systems Analysis
  - 3. 1584a-04 Guide for Performing Arc-Flash Hazard Calculations


## 1.6 STUDY REQUIREMENTS

- A. The study shall include one line diagram, short-circuit and ground fault analysis, and protective coordination plots for all overcurrent protective devices.
- B. One Line Diagram:
  1. Show all electrical equipment and wiring to be protected by the overcurrent devices.
  2. Show the following specific information:
    - a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.
    - b. Relay, circuit breaker, and fuse ratings.
    - c. Generator kW/kVA and transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
    - d. Voltage at each bus.
    - e. Identification of each bus, matching the identification on the drawings.
    - f. Conduit, conductor, and busway material, size, length, and X/R ratios.
- C. Short-Circuit Study:
  1. The study shall be performed using computer software designed for this purpose. Pertinent data and the rationale employed in developing the calculations shall be described in the introductory remarks of the study.
  2. Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate applicable motor and/or generator contribution in determining the momentary and interrupting ratings of the overcurrent protective devices.
  3. Present the results of the short-circuit study in a table. Include the following:
    - a. Device identification.
    - b. Operating voltage.
    - c. Overcurrent protective device type and rating.
    - d. Calculated short-circuit current.
- D. Coordination Curves:
  1. Prepare the coordination curves to determine the required settings of overcurrent protective devices to demonstrate selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between devices, including the utility company upstream device if applicable. Plot the specific time-current characteristics of each overcurrent protective device in such a manner that all devices are clearly depicted.
  2. The following specific information shall also be shown on the coordination curves:
    - a. Device identification.
    - b. Potential transformer and current transformer ratios.

- c. Three-phase and single-phase ANSI damage points or curves for each cable, transformer, or generator.
  - d. Applicable circuit breaker or protective relay characteristic curves.
  - e. No-damage, melting, and clearing curves for fuses.
  - f. Transformer in-rush points.
3. Develop a table to summarize the settings selected for the overcurrent protective devices. Include the following in the table:
- a. Device identification.
  - b. Protective relay or circuit breaker potential and current transformer ratios, sensor rating, and available and suggested pickup and delay settings for each available trip characteristic.
  - c. Fuse rating and type.
- E. Provide arch flash labels for all new panelboards, switchboards, switchgear, etc. Labels shall be adhesive and include the following information:
- a. Flash Hazard Boundary.
  - b. Flash Hazard.
  - c. Level including required clothing/protection.
  - d. Shock hazard voltage.
  - e. Glove Class.
  - f. Limited Approach distance.
  - e. Restrictive Approach distance.
  - g. Prohibited Approach distance.
- F. Contractor shall follow existing size and format as shown in example below.

Arc Flash Adhesive Label Example



|   |   |
|---|---|
| <b>WARNING</b>  |   |
| <b>Arc Flash and Shock Hazard</b>   |   |
| <b>Appropriate PPE Required</b>   |   |
| <b>2 ft 3 in</b>  | Flash Hazard Boundary   |
| <b>2.4 cal/cm<sup>2</sup></b>   | Flash Hazard at <b>1 ft 6 in</b>  |
| <b>Level 1</b>  | Arc-rated shirt & pants or arc-rated coverall                               |
| <b>480 VAC</b>  | Shock Hazard when cover is removed  |
| <b>00</b>   | Glove Class   |
| <b>3 ft 6 in</b>  | Limited Approach  |
| <b>1 ft</b>   | Restricted Approach   |
| <b>1 in</b>   | Prohibited Approach   |
| <b>Location:</b>  | <b>DPD1</b>   |
|   | VAMC Louis Stokes Medical Center<br>10701 East Blvd, Cleveland, OH<br>44106 |
| <b>Job#:</b>  | <b>541-13-112</b>   |
| <b>Prepared on:</b>   | <b>09/24/14</b>   |
| <b>By:</b>  | <b>FF&amp;H</b>   |
| Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements |   |

**1.7 ANALYSIS**

- A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose solutions to effectively protect the underrated equipment.

**1.8 ADJUSTMENTS, SETTINGS, AND MODIFICATIONS**

- A. Final field settings and minor modifications of the overcurrent protective devices shall be made to conform with the study, without additional cost to the Government.

**PART 2 - PRODUCTS (Not used)**

**PART 3 - EXECUTION (Not used)**

---END---

**SECTION 26 08 00**  
**COMMISSIONING OF ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 26.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

**1.2 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**1.3 SUMMARY**

- A. This Section includes requirements for commissioning the Facility electrical systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

**1.4 DEFINITIONS**

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

**1.5 COMMISSIONED SYSTEMS**

- A. Commissioning of a system or systems specified in Division 26 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 26, is required in cooperation with the VA and the Commissioning Agent.
- B. The Facility electrical systems commissioning will include the systems listed in Section 01 19 00 General Commissioning Requirements:

**1.6 SUBMITTALS**

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

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

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

**3.1 CONSTRUCTION INSPECTIONS**

- A. Commissioning of Electrical systems will require inspection of individual elements of the electrical systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 19 00 and the Commissioning plan to schedule electrical systems inspections as required to support the Commissioning Process.

**3.2 PRE-FUNCTIONAL CHECKLISTS**

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

**3.3 CONTRACTORS TESTS**

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

**3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING**

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

**3.5 TRAINING OF VA PERSONNEL**

- A. Training of the VA operation and maintenance personnel is required in cooperation with the COR and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 19 00. The instruction shall be scheduled in coordination with the VA COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 26 Sections for additional Contractor training requirements.

----- END -----

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

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

**1.2 RELATED WORK:**

- A. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Interface of lighting controls with HVAC control systems.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- E. Section 26 24 16, PANELBOARDS: Panelboard enclosure and interior bussing used for lighting control panels.
- F. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.
- G. 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):
  1. GC-12-03 Occupancy Sensors
- C. National Electrical Manufacturer's Association (NEMA):
  1. 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
  2. ICS-1-08 Standard for Industrial Control and Systems General Requirements
  3. 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
  4. ICS-6-11 Standard for Industrial Controls and Systems Enclosures
- D. National Fire Protection Association (NFPA):
  1. 70-14 National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  1. 20 Standard for General-Use Snap Switches
  2. 773-95 Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
  3. 773A-06 Nonindustrial Photoelectric Switches for Lighting Control
  4. 98-04 Enclosed and Dead-Front Switches
  5. 916-07 Standard for Energy Management Equipment Systems
  6. 917-06 Clock Operated Switches
  7. 924-06 Emergency Lighting and Power Equipment (for use when controlling emergency circuits).

## **PART 2 - PRODUCTS**

### **2.1 Ceiling-Mounted Photoelectric Switches:**

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

### **2.2 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.

**2.3 INDOOR VACANCY SENSOR SWITCH:**

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

**PART 3 - EXECUTION**

**3.1 INSTALLATION:**

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.
- B. Aim outdoor photoelectric sensor according to manufacturer's recommendations. Set adjustable window slide for 1 footcandle turn-on.
- C. Aiming for wall-mounted and ceiling-mounted motion sensor switches shall be per manufacturer's recommendations.
- D. Set occupancy sensor "on" duration to 15 minutes unless otherwise noted on plans or occupancy sensor details.
- E. Locate photoelectric sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the available light level at the typical work plane for that area.
- F. Label time switches and contactors with a unique designation.
- G. Program lighting control panels per schedule on drawings.

**3.2 ACCEPTANCE CHECKS AND TESTS:**

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



- E. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placements.

**3.3 FOLLOW-UP VERIFICATION:**

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

- - - E N D - - -

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of low-voltage dry-type general-purpose transformers, indicated as transformers in this section.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.

**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, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, accessories, and device nameplate data.
  - 2. Manuals:
    - a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.
      - 1) Schematic signal and control diagrams, with all terminals identified, matching terminal identification in the transformers.
      - 2) Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.
    - 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 transformers conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the transformers 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):
  1. IBC-12 International Building Code
- C. National Fire Protection Association (NFPA):
  1. 70-11 National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):
  1. TP1-02 Guide for Determining Energy Efficiency for Distribution Transformers
  2. TR1-00 Transformers, Regulators, and Reactors
- E. Underwriters Laboratories, Inc. (UL):
  1. UL 506-08 Standard for Specialty Transformers
  2. UL 1561-11 Dry-Type General Purpose and Power Transformers
- F. United States Department of Energy
  1. 10 CFR Part 431 Energy Efficiency Program for Certain Commercial and Industrial Equipment

### **PART 2 - PRODUCTS**

#### **2.1 TRANSFORMERS**

- A. Unless otherwise specified, transformers shall be in accordance with NEMA, NEC, UL and as shown on the drawings.
- B. Transformers shall have the following features:
  1. Self-cooled by natural convection, isolating windings, [indoor] [and outdoor] dry-type. Autotransformers will not be accepted, except as specifically allowed for buck-boost applications.
  2. Rating and winding connections shall be as shown on the drawings.
  3. Ratings shown on the drawings are for continuous duty without the use of cooling fans.
  4. Copper windings.
  5. Insulation systems:
    - a. Transformers 30 kVA and larger: UL rated 220 °C (428 °F) system with an average maximum rise by resistance of 150 °C (302 °F) in a maximum ambient of 40 °C (104 °F).

- b. Transformers below 30 kVA: Same as for 30 kVA and larger or UL rated 185 °C (365 °F) system with an average maximum rise by resistance of 115 °C (239 °F) in a maximum ambient of 40 °C (104 °F).
6. Core and coil assemblies:
- a. Rigidly braced to withstand the stresses caused by short-circuit currents and rough handling during shipment.
  - b. Cores shall be grain-oriented, non-aging, and silicon steel.
  - c. Coils shall be continuous windings without splices except for taps.
  - d. Coil loss and core loss shall be minimized for efficient operation.
  - e. Primary and secondary tap connections shall be brazed or pressure type.
  - f. Coil windings shall have end filters or tie-downs for maximum strength.
7. Certified sound levels, determined in accordance with NEMA, shall not exceed the following:

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

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

14. Transformers shall meet the minimum energy efficiency values per NEMA TP1 as listed below:

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

## 2.2 NONLINEAR TRANSFORMERS

- A. Shall be as specified in Paragraph 2.1, with additional features as specified below.
- B. Transformers shall be designed to withstand the overheating effects caused by harmonics resulting from non-linear (non-sinusoidal) loads.
- C. Neutral rating shall be 200% of rated secondary phase current.
- D. Minimum efficiency designed to supply circuits with a harmonic profile equal to or less than a K factor of 13, without exceeding specified temperature rise. Transformers with K factor of 13 shall be provided, if K factor is not shown on contract drawings. Table below applies to K-13 transformers only.

| Harmonic         | K-13 (%) |
|------------------|----------|
| Fundamental      | 100      |
| 3 <sup>rd</sup>  | 70       |
| 5 <sup>th</sup>  | 42       |
| 7 <sup>th</sup>  | 5        |
| 9 <sup>th</sup>  | 3        |
| 11 <sup>th</sup> | 3        |
| 13 <sup>th</sup> | 1        |
| 15 <sup>th</sup> | 0.7      |
| 17 <sup>th</sup> | 0.6      |

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.

- B. Anchor transformers with rustproof bolts, nuts, and washers, in accordance with manufacturer's instructions, and as shown on drawings.
- C. Install transformers with manufacturer's recommended clearance from wall and adjacent equipment for air circulation. Minimum clearance shall be 150 mm (6 inches).
- D. Install transformers on vibration pads designed to suppress transformer noise and vibrations.

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

- A. Perform tests in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical and mechanical condition.
    - c. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections.
    - d. Perform specific inspections and mechanical tests as recommended by manufacturer.
    - e. Verify correct equipment grounding.
    - f. Verify proper secondary phase-to-phase and phase-to-neutral voltage after energization and prior to connection to loads.

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

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

---END---

**SECTION 26 24 16**  
**PANELBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

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

**1.2 RELATED WORK:**

- A. Section 09 91 00, PAINTING: Painting of panelboards.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- F. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.
- G. Section 26 09 23, LIGHTING CONTROLS: Lighting controls integral to panelboards.

**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 electronic 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, materials, required clearances, terminations, weight, circuit breakers, wiring and connection diagrams, accessories, and nameplate data.
    - c. with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and experience data or other methods.
  - 2. Manuals:
    - a. Submit, simultaneously information for ordering circuit breakers and replacement parts.

- 1) Include schematic diagrams, with all terminals identified, matching terminal identification in the panelboards.
- 2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
- b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
  - a. Certification by the manufacturer that the panelboards conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the panelboards have been properly installed, adjusted, and tested.

**1.5 APPLICABLE PUBLICATIONS:**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. International Code Council (ICC):
  1. IBC-12 International Building Code
- C. National Electrical Manufacturers Association (NEMA):
  1. PB 1-11 Panelboards
  2. 250-08 Enclosures for Electrical Equipment (1,000V Maximum)
- D. National Fire Protection Association (NFPA):
  1. 70-11 National Electrical Code (NEC)
  2. 70E-12 Standard for Electrical Safety in the Workplace
- E. Underwriters Laboratories, Inc. (UL):
  1. 50-95 Enclosures for Electrical Equipment
  2. 67-09 Panelboards
  3. 489-09 Molded Case Circuit Breakers and Circuit Breaker Enclosures

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS:**

- A. Panelboards shall be in accordance with NEC, NEMA, UL, as specified, and as shown on the drawings.
- B. Panelboards shall have main breaker or main lugs, bus size, voltage, phases, number of circuit breaker mounting spaces, top or bottom feed, flush or surface mounting, branch circuit breakers, and accessories as shown on the drawings.
- C. Panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories as shown on the drawings or specified herein.



- D. Non-reduced size copper bus bars, rigidly supported on molded insulators, and fabricated for bolt-on type circuit breakers.
- E. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type.
- F. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys listed for use with the conductors to which they will be connected.
- G. Neutral bus shall be 200% rated, mounted on insulated supports.
- H. Grounding bus bar shall be equipped with screws or lugs for the connection of equipment grounding conductors.
- I. Bus bars shall be braced for the available short-circuit current as shown on the drawings, but not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
- J. In two-section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type panelboards, and have field-installed cable connections to the second section as shown on the drawings. Panelboard sections with tapped bus or crossover bus are not acceptable.
- K. Series-rated panelboards are not permitted.

## **2.2 ENCLOSURES AND TRIMS:**

### **A. Enclosures:**

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

### **B. Trims:**

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

**2.3 MOLDED CASE CIRCUIT BREAKERS:**

- A. Circuit breakers shall be per UL, NEC, as shown on the drawings, and as specified.
- B. Circuit breakers shall be bolt-on type.
- C. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
  - 1. 120/208 V Panelboard: 10,000 A symmetrical.
  - 2. 120/240 V Panelboard: 10,000 A symmetrical.
  - 3. 277/480 V Panelboard: 14,000 A symmetrical.
- D. Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for less than 400 A frame. Circuit breakers with 400 A frames and above shall have magnetic trip, adjustable from 5x to 10x. Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
- E. Circuit breaker features shall be as follows:
  - 1. A rugged, integral housing of molded insulating material.
  - 2. Silver alloy contacts.
  - 3. Arc quenchers and phase barriers for each pole.
  - 4. Quick-make, quick-break, operating mechanisms.
  - 5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
  - 6. Electrically and mechanically trip free.
  - 7. An operating handle which indicates closed, tripped, and open positions.
  - 8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
  - 9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.
  - 10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory accordingly.

**PART 3 - EXECUTION**

**3.1 INSTALLATION:**

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Locate panelboards so that the present and future conduits can be conveniently connected.

- C. In seismic areas, panelboards shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- D. Install a printed schedule of circuits in each panelboard after approval by the COR. Schedules shall reflect final load descriptions, room numbers, and room names connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards
- E. Mount panelboards such that the maximum height of the top circuit breaker above the finished floor shall not exceed 1980 mm (78 inches).
- F. Provide blank cover for each unused circuit breaker mounting space.
- G. For panelboards located in areas accessible to the public, paint the exposed surfaces of the trims with finishes to match surrounding surfaces after the panelboards have been installed. Do not paint nameplates.
- H. Rust and scale shall be removed from the inside of existing enclosures where new interior components are to be installed. Paint inside of enclosures with rust-preventive paint before the new interior components are installed. Provide new trim. Trim shall fit tight to the enclosure.
- I. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.
- J. Install arc fault adhesive label to panel after approval of COR. Refer to SECTION 26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY for additional information.

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

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Verify appropriate anchorage and required area clearances.
    - d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
    - e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.
    - f. Vacuum-clean enclosure interior. Clean enclosure exterior.

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

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

---END---

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of wiring devices.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- E. Section 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):
  - 1. 70-11 National Electrical Code (NEC)
  - 2. 99-12 Health Care Facilities
- C. National Electrical Manufacturers Association (NEMA):
  - 1. WD 1-10 General Color Requirements for Wiring Devices
  - 2. WD 6-08 Wiring Devices - Dimensional Specifications
- D. Underwriter's Laboratories, Inc. (UL):
  - 1. 5-11 Surface Metal Raceways and Fittings
  - 2. 20-10 General-Use Snap Switches
  - 3. 231-07 Power Outlets
  - 4. 467-07 Grounding and Bonding Equipment
  - 5. 498-07 Attachment Plugs and Receptacles
  - 6. 943-11 Ground-Fault Circuit-Interrupters
  - 7. 1449-07 Surge Protective Devices
  - 8. 1472-96 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 plated steel, with break-off plaster ears and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
  - 2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four minimum) and side wiring from four captively held binding screws.
- B. Duplex Receptacles: 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 white in color.
  - 2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The lower receptacle shall be unswitched.
  - 3. Duplex Receptacles on Emergency Circuit:

- a. In rooms without emergency powered general lighting, the emergency receptacles shall be of the self-illuminated type.
4. Ground Fault Interrupter Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box, with end-of-life indication and provisions to isolate the face due to improper wiring.
  - a. Ground fault interrupter shall be consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of 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.
5. Safety Type 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. Receptacles; 20, 30, and 50 ampere, 250 Volts: Shall be complete with appropriate cord grip plug.
- D. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
- E. Surge Protective (TVSS) Receptacles shall have integral surge suppression in line to ground, line to neutral, and neutral to ground modes.
  1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 Volts and minimum single transient pulse energy dissipation of 210 Joules.
  2. Active TVSS Indication: LED, visible in face of device to indicate device is active or no longer in service.

## 2.2 TOGGLE SWITCHES

- A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles shall be ivory in color unless otherwise specified or shown on the drawings.
  1. Switches installed in hazardous areas shall be explosion-proof type in accordance with the NEC and as shown on the drawings.
  2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
  3. Switches shall be rated 20 amperes at 120-277 Volts AC.

### **2.3 MANUAL DIMMING CONTROL**

- A. Electronic full-wave manual slide dimmer with on/off switch and audible frequency and EMI/RFI suppression filters.
- B. Manual dimming controls shall be fully compatible with fluorescent electronic dimming ballasts and approved by the ballast manufacturer LED dimming driver and be approved by the driver manufacturer, shall operate over full specified dimming range, and shall not degrade the performance or rated life of the electronic dimming ballast and lamp.
- C. Provide single-pole or three-way, as shown on the drawings.
- D. Manual dimming control and faceplates shall be ivory in color unless otherwise specified.

### **2.4 WALL PLATES**

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

### **2.5 SURFACE MULTIPLE-OUTLET ASSEMBLIES**

- A. Shall have the following features:
  - 1. Enclosures:
    - a. Thickness of steel shall be not less than 1 mm (0.040 inch) for base and cover. Nominal dimensions shall be 40 mm x 70 mm (1-1/2 inches by 2-3/4 inches) with inside cross sectional area not less than 2250 square mm (3-1/2 square inches). The enclosures shall be thoroughly cleaned, phosphatized, and painted at the factory with primer and the manufacturer's standard baked enamel finish.
  - 2. Receptacles shall be duplex, hospital grade. See paragraph 'RECEPTACLES' in this Section. Device cover plates shall be the manufacturer's standard corrosion resistant finish and shall not exceed the dimensions of the enclosure.
  - 3. Unless otherwise shown on drawings, receptacle spacing shall be 600 mm (24 inches) on centers.
  - 4. Conductors shall be as specified in Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE.
  - 5. Installation fittings shall be the manufacturer's standard bends, offsets, device brackets, inside couplings, wire clips, elbows, and other components as required for a complete system.
  - 6. Bond the assemblies to the branch circuit conduit system.

### **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 multigang outlet boxes to comply with the NEC.
- F. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
- G. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades.
- H. Install wall switches 1.2 M (48 inches) above floor, with the toggle OFF position down.
- I. Install wall dimmers 1.2 M (48 inches) above floor.
- J. Install receptacles 450 mm (18 inches) above floor, and 152 mm (6 inches) above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.
- K. Install vertically mounted receptacles with the ground pin up. Install horizontally mounted receptacles with the ground pin to the right.
- L. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.
- M. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

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

- A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations. In addition, include the following:
  - 1. Visual Inspection and Tests:
    - a. Inspect physical and electrical condition.
    - 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.



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- d. Test GFCI receptacles.
- 2. Healthcare Occupancy Tests:
  - a. Test hospital grade receptacles for retention force per NFPA 99.

---END---

**SECTION 26 29 11**  
**MOTOR CONTROLLERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of motor controllers, including all low- and medium-voltage motor controllers and manual motor controllers, indicated as motor controllers in this section, and low-voltage variable speed motor controllers.
- B. Motor controllers, whether furnished with the equipment specified in other sections or otherwise (with the exception of elevator motor controllers specified in Division 14 and fire pump controllers specified in Division 21), shall meet this specification and all related specifications.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.

**1.3 QUALITY ASSURANCE**

- A. 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.

**1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
  - 1. 519-92 Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
  - 2. C37.90.1-02 Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- C. International Code Council (ICC):
  - 1. IBC-12 International Building Code
- D. National Electrical Manufacturers Association (NEMA):

1. ICS 1-08 Industrial Control and Systems: General Requirements
  2. ICS 1.1-09 Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
  3. ICS 2-05 Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts
  4. ICS 4-05 Industrial Control and Systems: Terminal Blocks
  5. ICS 6-06 Industrial Control and Systems: Enclosures
  6. ICS 7-06 Industrial Control and Systems: Adjustable-Speed Drives
  7. ICS 7.1-06 Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems
  8. MG 1 Part 31 Inverter Fed Polyphase Motor Standards
- E. National Fire Protection Association (NFPA):
1. 70-11 National Electrical Code (NEC)
- F. Underwriters Laboratories Inc. (UL):
1. 508A-07 Industrial Control Panels
  2. 508C-07 Power Conversion Equipment
  3. UL 1449-06 Surge Protective Devices

## **PART 2 - PRODUCTS**

### **2.1 MOTOR CONTROLLERS**

- A. Motor controllers shall comply with IEEE, NEMA, NFPA, UL, and as shown on the drawings.
- B. Motor controllers shall be separately enclosed, unless part of another assembly. For installation in motor control centers, provide plug-in, draw-out type motor controllers up through NEMA size 4. NEMA size 5 and above require bolted connections.
- C. Motor controllers shall be combination type, with magnetic controller per Paragraph 2.3 below and with circuit breaker disconnecting means, with external operating handle with lock-open padlocking positions and ON-OFF position indicator.
1. Circuit Breakers:
    - a. Bolt-on thermal-magnetic type with a minimum interrupting rating as indicated on the drawings.
    - b. Equipped with automatic, trip free, non-adjustable, inverse-time, and instantaneous magnetic trips for less than 400A. The magnetic trip shall be adjustable from 5x to 10x for breakers 400A and greater.
    - c. Additional features shall be as follows:
      - 1) A rugged, integral housing of molded insulating material.
      - 2) Silver alloy contacts.
      - 3) Arc quenchers and phase barriers for each pole.
      - 4) Quick-make, quick-break, operating mechanisms.

- 5) A trip element for each pole, a common trip bar for all poles, and one operator for all poles.
2. Fused Switches:
    - a. Quick-make, quick-break type.
    - b. Minimum duty rating shall be NEMA classification General Duty (GD) for 240 Volts and NEMA classification Heavy Duty (HD) for 480 Volts.
    - c. Horsepower rated, and shall have the following features:
      - 1) Copper blades, visible in the OFF position.
      - 2) An arc chute for each pole.
      - 3) Fuse holders for the sizes and types of fuses specified or as shown on the drawings.
  3. Motor Circuit Protectors:
    - a. Magnetic trip only.
    - b. Bolt-on type with a minimum interrupting rating as indicated on the drawings.
    - c. Equipped with automatic, adjustable magnetic trip. Magnetic trip shall be adjustable up to 1300% of the motor full load amperes.
- D. Enclosures:
1. Enclosures shall be NEMA-type rated 1, 3R, or 12 as indicated on the drawings or as required per the installed environment.
  2. Enclosure doors shall be interlocked to prevent opening unless the disconnecting means is open. A "defeater" mechanism shall allow for inspection by qualified personnel with the disconnect means closed. Provide padlocking provisions.
  3. All metal surfaces shall be thoroughly cleaned, phosphatized, and factory primed prior to applying light gray baked enamel finish.
- E. Motor control circuits:
1. Shall operate at not more than 120 Volts.
  2. Shall be grounded, except where the equipment manufacturer recommends that the control circuits be isolated.
  3. For each motor operating over 120 Volts, incorporate a separate, heavy duty, control transformer within each motor controller enclosure.
  4. Incorporate primary and secondary overcurrent protection for the control power transformers.
- F. Overload relays:
1. Thermal or Induction type. Devices shall be NEMA type.
  2. One for each pole.
  3. External overload relay reset pushbutton on the door of each motor controller enclosure.
  4. Overload relays shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

5. Thermal overload relays shall be tamperproof, not affected by vibration, manual reset, sensitive to single-phasing, and shall have selectable trip classes of 10, 20 and 30.
6. Induction overload relays shall have changeable heater elements, manual reset, ambient temperature compensation, sensitivity to single-phasing, and shall have selectable trip classes of 10, 20 and 30.
7. Temperature probe relays shall be connected to thermistors or resistance temperature detectors (RTD) embedded in the motor winding.
- G. Electronic overload relays shall utilize internal current transformers and electro-mechanical components. The relays shall have ambient temperature compensation, single-phase protection, manual or automatic reset, and trip classes of 10, 15, 20 and 30. The relay shall provide fault cause indication, including jam/stall, ground fault, phase loss, and overload.
- H. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular controller. H-O-A switch shall be operable without opening enclosure door. H-O-A switch is not required for manual motor controllers.
- I. Incorporate into each control circuit a 120 Volt, electronic time-delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time-delay relay is not required where H-O-A switch is not required.
- J. Unless noted otherwise, equip each motor controller with not less than two normally open (N.O.) and two normally closed (N.C.) auxiliary contacts.
- K. Provide green (RUN) and red (STOP) pilot lights.
- L. Motor controllers incorporated within equipment assemblies shall also be designed for the specific requirements of the assemblies.
- M. Additional requirements for specific motor controllers, as indicated in other specification sections, shall also apply.

## **2.2 MANUAL MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Manual motor controllers shall have the following features:
  1. Controllers shall be general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
  2. Units shall include thermal overload relays, on-off operator, red pilot light, normally open and normally closed auxiliary contacts.
- C. Fractional horsepower manual motor controllers shall have the following features:
  1. Controllers shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
  2. Units shall include thermal overload relays, red pilot light, and toggle operator.

## **2.3 MAGNETIC MOTOR CONTROLLERS**

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

- B. Controllers shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum NEMA size 0.
- C. Where combination motor controllers are used, combine controller with protective or disconnect device in a common enclosure.
- D. Provide phase loss protection for each controller, with contacts to de-energize the controller upon loss of any phase.
- E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced-voltage or variable speed controllers as shown on the drawings. Equip controllers with 120 VAC coils and individual control transformer unless otherwise noted.

#### **2.4 REDUCED VOLTAGE MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable portions of 2.1 above.
- B. Shall have closed circuit transition.
- C. Shall limit inrush currents to not more than 70 percent of the locked rotor current.
- D. Provide phase loss protection for each motor controller, with contacts to de-energize the motor controller upon loss of any phase.

#### **2.5 LOW-VOLTAGE VARIABLE SPEED MOTOR CONTROLLERS (VSMC)**

- A. VSMC shall be in accordance with applicable portions of 2.1 above.
- B. VSMC shall be electronic, with adjustable frequency and voltage, three phase output, capable of driving standard NEMA B three-phase induction motors at full rated speed. The control technique shall be pulse width modulation (PWM), where the VSMC utilizes a full wave bridge design incorporating diode rectifier circuitry. Silicon controlled rectifiers or other control techniques are not acceptable.
- C. VSMC shall be suitable for variable torque loads, and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.
- D. VSMC shall be capable of operating within voltage parameters of plus 10 to minus 15 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- E. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
- F. The displacement power factor of the VSMC shall not be less than 95 percent under any speed or load condition.
- G. VSMC current and voltage harmonic distortion shall not exceed the values allowed by IEEE 519.
- H. VSMC shall include an input circuit breaker which will disconnect all input power, interlocked with the door so that the door cannot be opened with the circuit breaker in the closed position.
- I. VSMC shall include a 5% line reactor and a RFI/EMI filter.
- J. Surge Suppression: Provide three-phase protection against damage from supply voltage surges in accordance with UL 1449.

- K. VSMC shall include front-accessible operator station, with sealed keypad and digital display, which allows complete programming, operating, monitoring, and diagnostic capabilities.
1. Typical control functions shall include but not be limited to:
    - a. HAND-OFF-AUTOMATIC-RESET, with manual speed control in HAND mode.
    - b. NORMAL-BYPASS.
    - c. NORMAL-TEST, which allows testing and adjusting of the VSMC while in bypass mode.
  2. Typical monitoring functions shall include but not be limited to:
    - a. Output frequency (Hz).
    - b. Motor speed and status (run, stop, fault).
    - c. Output voltage and current.
  3. Typical fault and alarm functions shall include but not be limited to:
    - a. Loss of input signal, under- and over-voltage, inverter overcurrent, motor overload, critical frequency rejection with selectable and adjustable deadbands, instantaneous line-to-line and line-to-ground overcurrent, loss-of-phase, reverse-phase, and short circuit.
    - b. System protection indicators indicating that the system has shutdown and will not automatically restart.
- L. VSMC shall include two N.O. and two N.C. dry contacts rated 120 Volts, 10 amperes, 60 Hz.
- M. Communications protocols: As required for communications with control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- N. Bypass controller: Provide contactor-style bypass, arranged to bypass the inverter.
1. Inverter Output Contactor and Bypass Contactor: Load-break NEMA-rated contactor.
  2. Motor overload relays.
  3. HAND-OFF-AUTOMATIC bypass control.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motor controllers in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. In seismic areas, motor controllers shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.
- C. Install manual motor controllers in flush enclosures in finished areas.
- D. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and electronic overload relay pickup and trip ranges.

- E. Program variable speed motor controllers per the manufacturer's instructions and in coordination with other trades so that a complete and functional system is delivered.
- F. Adjust trip settings of circuit breakers and motor circuit protectors with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficiency motors if required). Where these maximum settings do not allow starting of a motor, notify COR before increasing settings.
- G. Set the taps on reduced-voltage autotransformer controllers at 80 percent of line voltage.

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

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

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

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

### **3.4 SPARE PARTS**

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



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**3.5 INSTRUCTION**

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

---END---

**SECTION 26 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):
  1. C78.1-91 Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
  2. C78.376-01 Chromaticity of Fluorescent Lamps
- C. American Society for Testing and Materials (ASTM):
  1. C635-07 Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
- D. Environmental Protection Agency (EPA):
  1. 40 CFR 261 Identification and Listing of Hazardous Waste
- E. Federal Communications Commission (FCC):
  1. CFR Title 47, Part 15 Radio Frequency Devices
  2. CFR Title 47, Part 18 Industrial, Scientific, and Medical Equipment
- F. Illuminating Engineering Society (IES):
  1. LM-79-08 Electrical and Photometric Measurements of Solid-State Lighting Products
  2. LM-80-08 Measuring Lumen Maintenance of LED Light Sources
  3. 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):
  1. C62.41-91 Surge Voltages in Low Voltage AC Power Circuits
- H. International Code Council (ICC):

1. IBC-12 International Building Code
- I. National Fire Protection Association (NFPA):
  1. 70-11 National Electrical Code (NEC)
  2. 101-12 Life Safety Code
- J. National Electrical Manufacturer's Association (NEMA):
  1. C82.1-04 Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts
  2. C82.2-02 Method of Measurement of Fluorescent Lamp Ballasts
  3. C82.4-02 Lamp Ballasts - Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
  4. C82.11-11 Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts
  5. LL-9-09 Dimming of T8 Fluorescent Lighting Systems
  6. SSL-1-10 Electronic Drivers for LED Devices, Arrays, or Systems
- K. Underwriters Laboratories, Inc. (UL):
  1. 496-08 Lampholders
  2. 542-0599 Fluorescent Lamp Starters
  3. 844-12 Luminaires for Use in Hazardous (Classified) Locations
  4. 924-12 Emergency Lighting and Power Equipment
  5. 935-01 Fluorescent-Lamp Ballasts
  6. 1029-94 High-Intensity-Discharge Lamp Ballasts
  7. 1029A-06 Ignitors and Related Auxiliaries for HID Lamp Ballasts
  8. 1598-08 Luminaires
  9. 1574-04 Track Lighting Systems
  10. 2108-04 Low-Voltage Lighting Systems
  11. 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. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- F. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- G. Metal Finishes:
  - 1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
  - 2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
  - 3. Exterior finishes shall be as shown on the drawings.
- H. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
- I. Light Transmitting Components for Fluorescent Fixtures:
  - 1. Shall be 100 percent virgin acrylic.
  - 2. Flat lens panels shall have not less than 3 mm (1/8 inch) of average thickness.
  - 3. Unless otherwise specified, lenses, reflectors, diffusers, and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction without distortion or cracking.
- J. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Division areas as defined in NFPA 70.
- K. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballast integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures.

## 2.2 BALLASTS

- A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V), electronic [instant-start] [programmed-start] [rapid-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.
  12. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.
  13. Dimming ballasts shall be as per above, except dimmable from 100% to 5 % of rated lamp lumens. Dimming ballasts shall be fully compatible with the dimming controls.
- B. Low-Frequency Linear T8 Fluorescent Lamp Ballasts (allowed for Surgery Suites, Critical Care Units, and Animal Labs): Multi-voltage (120 - 277V), hybrid electronic-electromagnetic rapid-start type, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output. Ballasts shall include the following features:
1. Automatic lamp starting after lamp replacement.
  2. Sound Rating: Class A.
  3. Total Harmonic Distortion (THD): 20 percent or less.
  4. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

5. Operating Frequency: 60 Hz.
  6. Lamp Current Crest Factor: 1.7 or less.
  7. Ballast Factor: 0.85 or higher unless otherwise indicated.
  8. Power Factor: 0.90 or higher.
  9. Interference: Comply with CFR Title 47 Part 18 for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
  10. 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.
  11. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.
- C. Compact Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V), electronic programmed rapid-start type, designed for type and quantity of lamps indicated. Ballast 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.
  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: 0.95 or higher unless otherwise indicated.
  9. Power Factor: 0.98 or higher.
  10. Interference: Comply with CFR Title 47 Part 18 for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
  11. Dimming ballasts shall be as per above, except dimmable from 100% to 5 % of rated lamp lumens. Dimming ballasts shall be fully compatible with the dimming controls.
- D. Ballasts for HID fixtures: Multi-tap voltage (120 - 480V) electromagnetic ballast for high intensity discharge lamps. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
  2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
  3. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
  4. Open-circuit operation that will not reduce average life.
  5. Low-Noise Ballasts: Manufacturers' standard epoxy- encapsulated models designed to minimize audible fixture noise.
- E. Electronic ballast for HID metal-halide lamps shall include the following features unless otherwise indicated:
1. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
  2. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
  3. Lamp end-of-life detection and shutdown circuit.
  4. Sound Rating: Class A.
  5. Total Harmonic Distortion (THD): 20 percent or less.
  6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  7. Lamp Current Crest Factor: 1.5 or less.
  8. Power Factor: 0.90 or higher.
  9. Interference: Comply with CFR Title 47 Part 18 for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
  10. Protection: Resettable thermal.

### **2.3 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] [cast aluminum]. 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.



## 2.4 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 4000° 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. Over the beds in Intensive Care, Coronary Care, Recovery, Life Support, and Observation and Treatment areas; Electromyographic, Autopsy (Necropsy), Surgery, and certain dental rooms (Examination, Oral Hygiene, Oral Surgery, Recovery, Labs, Treatment, and X-Ray) use color corrected lamps having a CRI of 85 or above and a correlated color temperature between 5000 and 6000°K, as shown on the drawings.
  - b. Other areas as shown on the drawings.
2. Lamps shall comply with EPA Toxicity Characteristic Leachate Procedure (TCLP) requirements.

### B. Compact Fluorescent Lamps:

1. T4, CRI 80 (minimum), color temperature 3500°K, average rated life equal to or greater than 12,000 hours (based on 3 hour starts), and suitable for use with dimming ballasts, unless otherwise indicated.
2. Lamps shall comply with EPA Toxicity Characteristic Leachate Procedure (TCLP) requirements.

## 2.5 LED EXIT LIGHT FIXTURES

- A. Exit light fixtures shall meet applicable requirements of NFPA and UL.
- B. Housing and door shall be die-cast aluminum.
- C. For general purpose exit light fixtures, door frame shall be hinged, with latch. For vandal-resistant exit light fixtures, door frame shall be secured with tamper-resistant screws.
- D. Finish shall be satin or fine-grain brushed aluminum.
- E. There shall be no radioactive material used in the fixtures.
- F. Fixtures:
  1. Inscription panels shall be cast or stamped aluminum a minimum of 2.25 mm (0.090 inch) thick, stenciled with 150 mm (6 inch) high letters, baked with red color stable plastic or fiberglass. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass.
  2. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
  3. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.
- G. Voltage: Multi-voltage (120 - 277V).

## **2.6 LED LIGHT FIXTURES**

### **A. General:**

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
  - a. Minimum efficiency: 85% at full load.
  - b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
  - c. Input Voltage: 120 - 277V (+10%) at 60 Hz.
  - d. Integral short circuit, open circuit, and overload protection.
  - e. Power Factor:  $\geq 0.95$ .
  - f. Total Harmonic Distortion:  $\leq 20\%$ .
  - g. Comply with FCC 47 CFR Part 15.
4. LED modules shall include the following features unless otherwise indicated:
  - a. Comply with IES LM-79 and LM-80 requirements.
  - b. Minimum CRI 80 and color temperature 3000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
  - c. Minimum Rated Life: 50,000 hours per IES L70.
  - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

### **B. LED Downlights:**

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

### **C. LED Troffers:**

1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
2. Housing, LED driver, and LED module shall be products of the same manufacturer.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, manufacturer's instructions, and as shown on the drawings or specified.
- B. Align, mount, and level the lighting fixtures uniformly.
- C. Wall-mounted fixtures shall be attached to the studs in the walls, or to a 20 gauge metal backing plate that is attached to the studs in the walls. Lighting fixtures shall not be attached directly to gypsum board.
- D. Lighting Fixture Supports:

1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.
  2. Shall maintain the fixture positions after cleaning and relamping.
  3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
  4. Surface mounted lighting fixtures:
    - a. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts (or stud-clips) shall be minimum 6 mm (1/4 inch) bolt, secured to main ceiling runners and/or secured to cross runners. Non-turning studs may be attached to the main ceiling runners and cross runners with special non-friction clip devices designed for the purpose, provided they bolt through the runner, or are also secured to the building structure by 12 gauge safety hangers. Studs or bolts securing fixtures weighing in excess of 25 kg (56 pounds) shall be supported directly from the building structure.
    - b. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.
    - c. Fixtures less than 6.8 kg (15 pounds) in weight and occupying less than 3715 sq cm (two square feet) of ceiling area may, when designed for the purpose, be supported directly from the outlet box when all the following conditions are met.
      - 1) Screws attaching the fixture to the outlet box pass through round holes (not key-hole slots) in the fixture body.
      - 2) The outlet box is attached to a main ceiling runner (or cross runner) with approved hardware.
      - 3) The outlet box is supported vertically from the building structure.
    - d. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.
  5. 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.
  6. Outlet boxes for support of lighting fixtures (where permitted) shall be secured directly to the building structure with approved devices or supported vertically in a hung ceiling from the building structure with a nine gauge wire hanger, and be secured by an approved device to a main ceiling runner or cross runner to prevent any horizontal movement relative to the ceiling.
- E. Furnish and install the new lamps as specified for all lighting fixtures installed under this project, and for all existing lighting fixtures reused under this project.

- F. The electrical and ceiling trades shall coordinate to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges, etc.), to match the ceiling system being installed.
- G. Bond lighting fixtures to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- H. At completion of project, replace all defective components of the lighting fixtures at no cost to the Government.
- I. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT .

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

- A. Perform the following:
  - 1. Visual Inspection:
    - a. Verify proper operation by operating the lighting controls.
    - b. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.
  - 2. Electrical tests:
    - a. Exercise dimming components of the lighting fixtures over full range of dimming capability by operating the control devices(s) in the presence of the COR. Observe for visually detectable flicker over full dimming range, and replace defective components at no cost to the Government.
    - b. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless specifically recommended otherwise by the lamp manufacturer. Burn-in dimmed fluorescent and compact fluorescent lamps for at least 100 hours at full voltage, unless specifically recommended otherwise by the lamp manufacturer. Replace any lamps and ballasts which fail during burn-in.

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

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

---END---

**SECTION 28 05 00**  
**COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section, Common Work Results for Electronic Safety and Security (ESS), applies to all sections of Division 28.
- B. Furnish and install fully functional electronic safety and security cabling system(s), equipment and approved accessories in accordance with the specification section(s), drawing(s), and referenced publications. Capacities and ratings of cable and other items and arrangements for the specified items are shown on each system's required Bill of Materials (BOM) and verified on the approved system drawing(s). If there is a conflict between contract's specification(s) and drawings(s), the contract's specification requirements shall prevail.
- C. The Contractor shall extend existing ESS systems, installed, programmed, configured, documented, and tested. The security system shall include but not limited to: physical access control, intrusion detection, duress alarms, elevator control interface, video assessment and surveillance, video recording and storage, delayed egress, personal protection system, intercommunication system, fire alarm interface, equipment cabinetry, dedicated photo badging system and associated live camera, report printer, photo badge printer, and uninterruptible power supplies (UPS) interface. Operator training shall not be required as part of the Security Contractors scope and shall be provided by the Owner. The Security Contractor shall still be required to provide necessary maintenance and troubleshooting manuals as well as submittals as identified herein. The work shall include the procurement and installation of electrical wire and cables, the installation and testing of all system components. Inspection, testing, demonstration, and acceptance of equipment, software, materials, installation, documentation, and workmanship, shall be as specified herein. The Contractor shall provide all associated installation support, including the provision of primary electrical input power circuits.
- D. Repair Service Replacement Parts On-site service during the warranty period shall be provided as specified under "Emergency Service". The Contractor shall warranty all parts and labor for a term of one (1) year, unless dictated otherwise in this specification from the acceptance date of the system as described in Part 5 of this Specification. The Contractor shall be responsible for all equipment, software, shipping, transportation charges, and expenses associated with the service of the system for one (1) year. The Contractor shall provide 24-hour telephone support for the software program at no additional charge to the owner. Software support shall include all software updates that occur during the warranty period.
- E. Section Includes:
  - 1. Description of Work for Electronic Security Systems,
  - 2. Electronic security equipment coordination with relating Divisions,
  - 3. Submittal Requirements for Electronic Security,

4. Miscellaneous Supporting equipment and materials for Electronic Security,

5. Electronic security installation requirements.

### **1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- C. Section 08 71 00 - DOOR HARDWARE. Requirements for door installation.
- D. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.
- E. Section 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- F. Section 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Requirements for infrastructure.
- G. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for conductors and cables.
- H. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for grounding of equipment.
- I. Section 28 05 28.33 - CONDUITS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for infrastructure.
- J. Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS. Requirements for Commissioning.
- K. Section 28 13 00 - PHYSICAL ACCESS CONTROL SYSTEMS (PACS). For physical access control integration.
- L. Section 28 23 00 - VIDEO SURVEILLANCE. Requirements for security camera systems.
- M. Section 28 26 00 - ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS). Requirements for emergency and interior communications.

### **1.3 DEFINITIONS**

- A. AGC: Automatic Gain Control.
- B. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- C. BICSI: Building Industry Consulting Service International.
- D. CCD: Charge-coupled device.
- E. Central Station: A PC with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.
- F. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.
- G. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

- H. CPU: Central processing unit.
- I. Credential: Data assigned to an entity and used to identify that entity.
- J. DGP: Data Gathering Panel - component of the Physical Access Control System capable to communicate, store and process information received from readers, reader modules, input modules, output modules, and Security Management System.
- K. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.
- L. EMI: Electromagnetic interference.
- M. EMT: Electric Metallic Tubing.
- N. ESS: Electronic Security System.
- O. File Server: A PC in a network that stores the programs and data files shared by users.
- P. GFI: Ground fault interrupter.
- Q. IDC: Insulation displacement connector.
- R. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- S. I/O: Input/Output.
- T. Intrusion Zone: A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between sensors and communication link to central-station control unit.
- U. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- V. LAN: Local area network.
- W. LCD: Liquid-crystal display.
- X. LED: Light-emitting diode.
- Y. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.
- Z. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- AA. M-JPEG: Motion - Joint Photographic Experts Group.
- BB. MPEG: Moving picture experts group.
- CC. NEC: National Electric Code
- DD. NEMA: National Electrical Manufacturers Association
- EE. NFPA: National Fire Protection Association
- FF. NTSC: National Television System Committee.
- GG. NRTL: Nationally Recognized Testing Laboratory.

- HH. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- II. PACS: Physical Access Control System; A system comprised of cards, readers, door controllers, servers and software to control the physical ingress and egress of people within a given space
- JJ. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.
- KK. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).
- LL. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.
- MM. RCDD: Registered Communications Distribution Designer.
- NN. RFI: Radio-frequency interference.
- OO. RIGID: Rigid conduit is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.
- PP. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- QQ. RS-485: An TIA/EIA standard for multipoint communications.
- RR. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.
- SS. SMS: Security Management System - A SMS is software that incorporates multiple security subsystems (e.g., physical access control, intrusion detection, closed circuit television, intercom) into a single platform and graphical user interface.
- TT. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- UU. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.
- VV. UPS: Uninterruptible Power Supply
- WW. UTP: Unshielded Twisted Pair
- XX. Workstation: A PC with software that is configured for specific limited security system functions.

#### 1.4 QUALITY ASSURANCE

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



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

C. Contractor Qualification:

1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Security Management System's (PACS) manufacturer. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the PACS. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility. The facility shall be located within [60] <insert number> miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures. The COR reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.
2. The Contractor shall provide proof project superintendent with BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.
3. Cable installer must have on staff a Registered Communication Distribution Designer (RCDD) certified by Building Industry Consulting Service International. The staff member shall provide consistent oversight of the project cabling throughout design, layout, installation, termination and testing.

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

#### 1.5 GENERAL ARRANGEMENT OF CONTRACT DOCUMENTS

- A. The Contract Documents supplement to this specification indicates approximate locations of equipment. The installation and/or locations of the equipment and devices shall be governed by the intent of the design; specification and Contract Documents, with due regard to actual site conditions, recommendations, ambient factors affecting the equipment and operations in the vicinity. The Contract Documents are diagrammatic and do not reveal all offsets, bends, elbows, components, materials, and other specific elements that may be required for proper installation. If any departure from the contract documents is deemed necessary, or in the event of conflicts, the Contractor shall submit details of such departures or conflicts in writing to the owner or owner's representative for his or her comment and/or approval before initiating work.
- B. Anything called for by one of the Contract Documents and not called for by the others shall be of like effect as if required or called by all, except if a provision clearly designed to negate or alter a provision contained in one or more of the other Contract Documents shall have the intended effect. In the event of conflicts among the Contract Documents, the Contract Documents shall take precedence in the following order: the Form of Agreement; the Supplemental General Conditions; the Special Conditions; the Specifications with attachments; and the drawings.

#### 1.6 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
  1. Mark the submittals, "SUBMITTED UNDER SECTION \_\_\_\_\_".
  2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  3. Submit each section separately.
- D. The submittals shall include the following:
  1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
  2. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

- E. Submittals shall be in full compliance of the Contract Documents. All submittals shall be provided in accordance with this section. Submittals lacking the breadth or depth these requirements will be considered incomplete and rejected. Submissions are considered multidisciplinary and shall require coordination with applicable divisions to provide a complete and comprehensive submission package. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted. Additional general provisions are as follows:
1. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination drawings refer to Specification Section 01 33 10 - Design Submittal Procedures, which outline basic submittal requirements and coordination. Section 01 33 10 shall be used in conjunction with this section.
  2. The Contractor shall identify variations from requirements of Contract Documents and state product and system limitations, which may be detrimental to successful performance of the completed work or system.
  3. Each package shall be submitted at one (1) time for each review and include components from applicable disciplines (e.g., electrical work, architectural finishes, door hardware, etc.) which are required to produce an accurate and detailed depiction of the project.
  4. Manufacturer's information used for submittal shall have pages with items for approval tagged, items on pages shall be identified, and capacities and performance parameters for review shall be clearly marked through use of an arrow or highlighting. Provide space for COR and Contractor review stamps.
  5. Technical Data Drawings shall be in the latest version of AutoCAD®, drawn accurately, and in accordance with VA CAD Standards CAD Standard Application Guide, and VA BIM Guide. FREEHAND SKETCHES OR COPIED VERSIONS OF THE CONSTRUCTION DOCUMENTS WILL NOT BE ACCEPTED. The Contractor shall not reproduce Contract Documents or copy standard information as the basis of the Technical Data Drawings. If departures from the technical data drawings are subsequently deemed necessary by the Contractor, details of such departures and the reasons thereof shall be submitted in writing to the COR for approval before the initiation of work.
  6. Packaging: The Contractor shall organize the submissions according to the following packaging requirements.
    - a. Manual Content: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
      - 1) Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.

- 2) Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
- 3) The manuals shall include:
  - a) Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
  - b) A control sequence describing start-up, operation, and shutdown.
  - c) Description of the function of each principal item of equipment.
  - d) Installation and maintenance instructions.
  - e) Safety precautions.
  - f) Diagrams and illustrations.
  - g) Testing methods.
  - h) Performance data.
  - i) Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
  - j) Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- b. Submittal Organization: Organize each electronic manual into separate sections for each piece of related equipment. At a minimum, each manual shall contain a title page, table of contents, copies of Product Data supplemented by drawings and written text, and copies of each warranty, bond, certifications, and service Contract issued. Refer to Group I through V Technical Data Package Submittal requirements for required section content.
- c. Title Page: Provide a title page as the first sheet of each manual to include the following information; project name and address, subject matter covered by the manual, name and address of the Project, date of the submittal, name, address, and telephone number of the Contractor, and cross references to related systems in other operating and/or maintenance manuals.
- d. Table of Contents: After the title page, include a type written table of contents for each volume, arranged systematically according to the Project Manual format. Provide a list of each product included, identified by product name or other appropriate identifying symbols and indexed to the content of the volume. Where more than one (1) volume is required to hold data for a particular system, provide a comprehensive table of contents for all volumes in each volume of the set.

- e. General Information Section: Provide a general information section immediately following the table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the installer and maintenance Contractor. In addition, list a local source for replacement parts and equipment.
  - f. Drawings: Provide specially prepared drawings where necessary to supplement the manufacturers printed data to illustrate the relationship between components of equipment or systems, or provide control or flow diagrams. Coordinate these drawings with information contained in Project Record Drawings to assure correct illustration of the completed installation.
  - g. Manufacturer's Data: Where manufacturer's standard printed data is included in the manuals, include only those sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where more than one (1) item in tabular format is included, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation and delete references to information which is not applicable.
  - h. Where manufacturer's standard printed data is not available and the information is necessary for proper operation and maintenance of equipment or systems, or it is necessary to provide additional information to supplement the data included in the manual, prepare written text to provide the necessary information. Organize the text in a consistent format under a separate heading for different procedures. Where necessary, provide a logical sequence of instruction for each operating or maintenance procedure. Where similar or more than one product is listed on the submittal the Contractor shall differentiate by highlighting the specific product to be utilized.
  - i. Calculations: Provide a section for circuit and panel calculations.
  - j. Loading Sheets: Provide a section for DGP Loading Sheets.
  - k. Certifications: Provide section for Contractor's manufacturer certifications.
7. Contractor Review: Review submittals prior to transmittal. Determine and verify field measurements and field construction criteria. Verify manufacturer's catalog numbers and conformance of submittal with requirements of contract documents. Return non-conforming or incomplete submittals with requirements of the work and contract documents. Apply Contractor's stamp with signature certifying the review and verification of products occurred, and the field dimensions, adjacent construction, and coordination of information is in accordance with the requirements of the contract documents.
8. Resubmission: Revise and resubmit submittals as required within 15 calendar days of return of submittal. Make resubmissions under procedures specified for initial submittals. Identify all changes made since previous submittal.

9. Product Data: Within 15 calendar days after execution of the contract, the Contractor shall submit for approval a complete list of all of major products proposed for use. The data shall include name of manufacturer, trade name, model number, the associated contract document section number, paragraph number, and the referenced standards for each listed product.
- F. Group 1 Technical Data Package: Group I Technical Data Package shall be one submittal consisting of the following content and organization. Refer to VA Special Conditions Document for drawing format and content requirements. The data package shall include the following:
1. Section I - Drawings:
    - a. General - Drawings shall conform to VA CAD Standards Guide. All text associated with security details shall be 1/8" tall and meet VA text standard for AutoCAD™ drawings.
    - b. Cover Sheet - Cover sheet shall consist of Project Title and Address, Project Number, Area and Vicinity Maps.
    - c. General Information Sheets - General Information Sheets shall consist of General Notes, Abbreviations, Symbols, Wire and Cable Schedule, Project Phasing, and Sheet Index.
    - d. Floor Plans - Floor plans shall be produced from the Architectural backgrounds issued in the Construction Documents. The contractor shall receive floor plans from the prime A/E to develop these drawing sets. Security devices shall be placed on drawings in scale. All text associated with security details shall be 1/8" tall and meet VA text standard for AutoCAD™ drawings. Floor plans shall identify the following:
      - 1) Security devices by symbol,
      - 2) The associated device point number (derived from the loading sheets),
      - 3) Wire & cable types and counts
      - 4) Conduit sizing and routing
      - 5) Conduit riser systems
      - 6) Device and area detail call outs
    - e. Architectural details - Architectural details shall be produced for each device mounting type (door details for EECS and IDS, Intrusion Detection system (motion sensor, vibration, microwave Motion Sensor and Camera mounting,
    - f. Riser Diagrams - Contractor shall provide a riser diagram indicating riser architecture and distribution of the SMS throughout the facility (or area in scope).
    - g. Block Diagrams - Contractor shall provide a block diagram for the entire system architecture and interconnections with SMS subsystems. Block diagram shall identify SMS subsystem (e.g., electronic entry control, intrusion detection, closed circuit television, intercom, and other associated subsystems) integration; and data transmission and media conversion methodologies.

- h. Interconnection Diagrams - Contractor shall provide interconnection diagram for each sensor, and device component. Interconnection diagram shall identify termination locations, standard wire detail to include termination schedule. Diagram shall also identify interfaces to other systems such as elevator control, fire alarm systems, and security management systems.
- i. Security Details:
  - 1) Panel Assembly Detail - For each panel assembly, a panel assembly details shall be provided identifying individual panel component size and content.
  - 2) Panel Details - Provide security panel details identify general arrangement of the security system components, backboard size, wire through size and location, and power circuit requirements.
  - 3) Device Mounting Details - Provide mounting detailed drawing for each security device (physical access control system, intrusion detection, video surveillance and assessment, and intercom systems) for each type of wall and ceiling configuration in project. Device details shall include device, mounting detail, wiring and conduit routing.
  - 4) Details of connections to power supplies and grounding
  - 5) Details of surge protection device installation
  - 6) Sensor detection patterns - Each system sensor shall have associated detection patterns.
  - 7) Equipment Rack Detail - For each equipment rack, provide a scaled detail of the equipment rack location and rack space utilization. Use of BISCII wire management standards shall be employed to identify wire management methodology. Transitions between equipment racks shall be shown to include use vertical and horizontal latter rack system.
  - 8) Security Control Room - The contractor shall provide a layout plan for the Security Control Room. The layout plan shall identify all equipment and details associated with the installation.
  - 9) Operator Console - The contractor shall provide a layout plan for the Operator Console. The layout plan shall identify all equipment and details associated with the installation.  
Equipment room - the contractor shall provide a layout plan for the equipment room. The layout plan shall identify all equipment and details associated with the installation.
  - 10) Equipment Room - Equipment room details shall provide architectural, electrical, mechanical, plumbing, IT/Data and associated equipment and device placements both vertical and horizontally.
- j. Electrical Panel Schedule - Electrical Panel Details shall be provided for all SMS systems electrical power circuits. Panel details shall be provided identifying panel type (Standard, Emergency Power, Emergency/Uninterrupted Power Source, and Uninterrupted Power Source Only), panel location, circuit number, and circuit amperage rating.

- k. Door Schedule - A door schedule shall be developed for each door equipped with electronic security components. At a minimum, the door schedule shall be coordinated with Division 08 work and include the following information:
- 1) Item Number
  - 2) Door Number (Derived from A/E Drawings)
  - 3) Floor Plan Sheet Number
  - 4) Standard Detail Number
  - 5) Door Description (Derived from Loading Sheets)
  - 6) Data Gathering Panel Input Number
  - 7) Door Position or Monitoring Device Type & Model Number
  - 8) Lock Type, Model Number & Power Input/Draw (standby/active)
  - 9) Card Reader Type & Model Number
  - 10) Shunting Device Type & Model Number
  - 11) Sounder Type & Model Number
  - 12) Manufacturer
  - 13) Misc. devices as required
    - a) Delayed Egress Type & Model Number
    - b) Intercom
    - c) Camera
    - d) Electric Transfer Hinge
    - e) Electric Pass-through device
  - 14) Remarks column indicating special notes or door configurations
2. Camera Schedule - A camera schedule shall be developed for each camera. Contractors shall coordinate with the COR to determine camera starting numbers and naming conventions. All drawings shall identify wire and cable standardization methodology. Color coding of all wiring conductors and jackets is required and shall be communicated consistently throughout the drawings package submittal. At a minimum, the camera schedule shall include the following information:
- a. Item Number
  - b. Camera Number
  - c. Naming Conventions
  - d. Description of Camera Coverage
  - e. Camera Location
  - f. Floor Plan Sheet Number
  - g. Camera Type
  - h. Mounting Type
  - i. Standard Detail Reference
  - j. Power Input & Draw



- k. Power Panel Location
  - l. Remarks Column for Camera
3. Section II - Data Gathering Panel Documentation Package
- a. Contractor shall provide Data Gathering Panel (DGP) input and output documentation packages for review at the Shop Drawing submittal stage and also with the as-built documentation package. The documentation packages shall be provided in both printed and magnetic form at both review stages.
  - b. The Contractor shall provide loading sheet documentation package for the associated DGP, including input and output boards for all field panels associated with the project. Documentation shall be provided in current version Microsoft Excel spreadsheets following the format currently utilized by VA. A separate spreadsheet file shall be generated for each DGP and associated field panels.
  - c. The spreadsheet names shall follow a sequence that shall display the spreadsheets in numerical order according to the DGP system number. The spreadsheet shall include the prefix in the file name that uniquely identifies the project site. The spreadsheet shall detail all connected items such as card readers, alarm inputs, and relay output connections. The spreadsheet shall include an individual section (row) for each panel input, output and card reader. The spreadsheet shall automatically calculate the system numbers for card readers, inputs, and outputs based upon data entered in initialization fields.
  - d. All entries must be verified against the field devices. Copies of the floor plans shall be forwarded under separate cover.
  - e. The DGP spreadsheet shall include an entry section for the following information:
    - 1) DGP number
    - 2) First Reader Number
    - 3) First Monitor Point Number
    - 4) First Relay Number
    - 5) DGP, input or output Location
    - 6) DGP Chain Number
    - 7) DGP Cabinet Tamper Input Number
    - 8) DGP Power Fail Input Number
    - 9) Number of Monitor Points Reserved For Expansion Boards
    - 10) Number of Control Points (Relays) Reserved For Expansion Boards
  - f. The DGP, input module and output module spreadsheets shall automatically calculate the following information based upon the associated entries in the above fields:
    - 1) System Numbers for Card Readers
    - 2) System Numbers for Monitor Point Inputs
    - 3) System Numbers for Control Points (Relays)
    - 4) Next DGP or input module First Monitor Point Number

- 5) Next DGP or output module First Control Point Number
- g. The DGP spreadsheet shall provide the following information for each card reader:
- 1) DGP Reader Number
  - 2) System Reader Number
  - 3) Cable ID Number
  - 4) Description Field (Room Number)
  - 5) Description Field (Device Type i.e.: In Reader, Out Reader, etc.)
  - 6) Description Field
  - 7) DGP Input Location
  - 8) Date Test
  - 9) Date Passed
  - 10) Cable Type
  - 11) Camera Numbers (of cameras viewing the reader location)
- h. The DGP and input module spreadsheet shall provide the following information for each monitor point (alarm input).
- 1) DGP Monitor Point Input Number
  - 2) System Monitor Point Number
  - 3) Cable ID Number
  - 4) Description Field (Room Number)
  - 5) Description Field (Device Type i.e.: Door Contact, Motion Detector, etc.)
  - 6) DGP or input module Input Location
  - 7) Date Test
  - 8) Date Passed
  - 9) Cable Type
  - 10) Camera Numbers (of associated alarm event preset call-ups)
- i. The DGP and output module spreadsheet shall provide the following information for each control point (output relay). DGP Control Point (Relay) Number
- 1) System (Control Point) Number
  - 2) Cable ID Number
  - 3) Description Field (Room Number)
  - 4) Description Field (Device: Lock Control, Local Sounder, etc.)
  - 5) Description Field
  - 6) DGP or OUTPUT MODULE Output Location
  - 7) Date Test
  - 8) Date Passed Cable Type
  - 9) Camera Number (of associated alarm event preset call-ups)

- j. The DGP, input module and output module spreadsheet shall include the following information or directions in the header and footer:
    - 1) Header
      - a) DGP Input and Output Worksheet
      - b) Enter Beginning Reader, Input, and Output Starting Numbers and Sheet Will Automatically Calculate the Remaining System Numbers.
    - 2) Footer
      - a) File Name
      - b) Date Printed
      - c) Page Number
  - 4. Section IV - Manufacturers' Data: The data package shall include manufacturers' data for all materials and equipment, including sensors, local processors and console equipment provided under this specification.
  - 5. Section VI - Certifications & References: All specified manufacturer's certifications shall be included with the data package. Contractor shall provide Project references as outlined in Paragraph 1.4 "Quality Assurance".
- G. Group III Technical Data Package
- 1. Development of Test Procedures: The Contractor will prepare performance test procedures for the system testing. The test procedures shall follow the format of the VA Testing procedures and be customized to the contract requirements. The Contractor will deliver the test procedures to the COR for approval at least 60 calendar days prior to the requested test date.
- H. Group IV Technical Data Package
- 1. Performance Verification Test
    - a. Based on the successful completion of the pre-delivery test, the Contractor shall finalize the test procedures and report forms for the performance verification test (PVT) and the endurance test. The PVT shall follow the format, layout and content of the pre-delivery test. The Contractor shall deliver the PVT and endurance test procedures to the COR for approval. The Contractor may schedule the PVT after receiving written approval of the test procedures. The Contractor shall deliver the final PVT and endurance test reports within 14 calendar days from completion of the tests. Refer to Part 3 of this section for System Testing and Acceptance requirements.
  - 2. Training Documentation

- a. New Facilities and Major Renovations: Familiarization training shall be provided for new equipment or systems. Training can include site familiarization training for VA technicians and administrative personnel. Training shall include general information on new system layout including closet locations, turnover of the completed system including all documentation, including manuals, software, key systems, and full system administration rights. Lesson plans and training manuals training shall be oriented to type of training to be provided.
  - b. New Unit Control Room:
    - 1) Provide the security personnel with training in the use, operation, and maintenance of the entire control room system (Unit Control and Equipment Rooms). The training documentation must include the operation and maintenance. The first of the training sessions shall take place prior to system turnover and the second immediately after turnover. Coordinate the training sessions with the Owner. Completed classroom sessions will be witnessed and documented by the Architect/Engineer, and approved by the COR. Instruction is not to begin until the system is operational as designed.
    - 2) The training documents will cover the operation and the maintenance manuals and the control console operators' manuals and service manuals in detail, stressing all important operational and service diagnostic information necessary for the maintenance and operations personnel to efficiently use and maintain all systems.
    - 3) Provide an illustrated control console operator's manual and service manual. The operator's manual shall be written in laymen's language and printed so as to become a permanent reference document for the operators, describing all control panel switch operations, graphic symbol definitions and all indicating functions and a complete explanation of all software.
    - 4) The service manual shall be written in laymen's language and printed so as to become a permanent reference document for maintenance personnel, describing how to run internal self diagnostic software programs, troubleshoot head end hardware and field devices with a complete scenario simulation of all possible system malfunctions and the appropriate corrective measures.
    - 5) Provide a professional color DVD instructional recording of all the operational procedures described in the operator's manual. All charts used in the training session shall be clearly presented on the video. Any DVD found to be inferior in recording or material content shall be reproduced at no cost until an acceptable DVD is submitted. Provide four copies of the training DVD, one to the architect/engineer and three to the owner.
3. System Configuration and Data Entry:

- a. The contractor is responsible for providing all system configuration and data entry for the SMS and subsystems (e.g., video matrix switch, intercom, digital video recorders, network video recorders). All data entry shall be performed per VA standards & guidelines. The Contractor is responsible for participating in all meetings with the client to compile the information needed for data entry. These meetings shall be established at the beginning of the project and incorporated in to the project schedule as a milestone task. The contractor shall be responsible for all data collection, data entry, and system configuration. The contractor shall collect, enter, & program and/or configure the following components:
    - 1) Physical Access control system components,
    - 2) All intrusion detection system components,
    - 3) Video surveillance, control and recording systems,
    - 4) Intercom systems components,
    - 5) All other security subsystems shown in the contract documents.
  - b. The Contractor is responsible for compiling the card access database for the VA employees, including programming reader configurations, access shifts, schedules, exceptions, card classes and card enrollment databases.
  - c. Refer to Part 3 for system programming requirements and planning guidelines.
4. Graphics: Based on CAD as-built drawings developed for the construction project, create all map sets showing locations of all alarms and field devices. Graphical maps of all alarm points installed under this contract including perimeter and exterior alarm points shall be delivered with the system. The Contractor shall create and install all graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the COR, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 203.2 x 254 mm (8 x 10 in) of each type of graphic to be used for the completed Security system. The graphics examples shall be delivered to the COR for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires them.

- I. Group V Technical Data Package: Final copies of the manuals shall be delivered to the COR as part of the acceptance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each sub-contractor installing equipment or systems, as well as the nearest service representatives for each item of equipment for each system. The manuals shall include a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Two (2) hard-copies and one (1) soft copy on CD of each item listed below shall be delivered as a part of final systems acceptance.
1. Functional Design Manual: The functional design manual shall identify the operational requirements for the entire system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. Manufacturer developed literature may be used; however, shall be produced to match the project requirements.
  2. Equipment Manual: A manual describing all equipment furnished including:
    - a. General description and specifications; installation and checkout procedures; equipment electrical schematics and layout drawings; system schematics and layout drawings; alignment and calibration procedures; manufacturer's repair list indicating sources of supply; and interface definition.
  3. Software Manual: The software manual shall describe the functions of all software and include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
    - a. Definition of terms and functions; use of system and applications software; procedures for system initialization, start-up, and shutdown; alarm reports; reports generation, database format and data entry requirements; directory of all disk files; and description of all communications protocols including data formats, command characters, and a sample of each type of data transfer.
  4. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:
    - a. Computers and peripherals; system start-up and shutdown procedures; use of system, command, and applications software; recovery and restart procedures; graphic alarm presentation; use of report generator and generation of reports; data entry; operator commands' alarm messages, and printing formats; and system access requirements.
  5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, recommend schedules, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

6. Spare Parts & Components Data: At the conclusion of the Contractor's work, the Contractor shall submit to the COR a complete list of the manufacturer's recommended spare parts and components required to satisfactorily maintain and service the systems, as well as unit pricing for those parts and components.
7. Operation, Maintenance & Service Manuals: The Contractor shall provide two (2) complete sets of operating and maintenance manuals in the form of an instructional manual for use by the VA Security Guard Force personnel. The manuals shall be organized into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder. If multiple volumes are required, each volume shall be fully indexed and coordinated.
8. Equipment and Systems Maintenance Manual: The Contractor shall provide the following descriptive information for each piece of equipment, operating system, and electronic system:
  - a. Equipment and/or system function.
  - b. Operating characteristics.
  - c. Limiting conditions.
  - d. Performance curves.
  - e. Engineering data and test.
  - f. Complete nomenclature and number of replacement parts.
  - g. Provide operating and maintenance instructions including assembly drawings and diagrams required for maintenance and a list of items recommended to stock as spare parts.
  - h. Provide information detailing essential maintenance procedures including the following: routine operations, trouble shooting guide, disassembly, repair and re-assembly, alignment, adjusting, and checking.
  - i. Provide information on equipment and system operating procedures, including the following; start-up procedures, routine and normal operating instructions, regulation and control procedures, instructions on stopping, shut-down and emergency instructions, required sequences for electric and electronic systems, and special operating instructions.
  - j. Manufacturer equipment and systems maintenance manuals are permissible.

9. **Project Redlines:** During construction, the Contractor shall maintain an up-to-date set of construction redlines detailing current location and configuration of the project components. The redline documents shall be marked with the words 'Master Redlines' on the cover sheet and be maintained by the Contractor in the project office. The Contractor will provide access to redline documents anytime during the project for review and inspection by the COR or authorized Office of Protection Services representative. Master redlines shall be neatly maintained throughout the project and secured under lock and key in the contractor's onsite project office. Any project component or assembly that is not installed in strict accordance with the drawings shall be so noted on the drawings. Prior to producing Record Construction Documents, the contractor will submit the Master Redline document to the COR for review and approval of all changes or modifications to the documents. Each sheet shall have COR initials indicating authorization to produce "As Built" documents. Field drawings shall be used for data gathering & field changes. These changes shall be made to the master redline documents daily. Field drawings shall not be considered "master redlines".
10. **Record Specifications:** The Contractor shall maintain one (1) copy of the Project Specifications, including addenda and modifications issued, for Project Record Documents. The Contractor shall mark the Specifications to indicate the actual installation where the installation varies substantially from that indicated in the Contract Specifications and modifications issued. (Note related Project Record Drawing information where applicable). The Contractor shall pay particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later. Upon completion of the mark ups, the Contractor shall submit record Specifications to the COR. As with master redlines, Contractor shall maintain record specifications for COR review and inspection at anytime.
11. **Record Product Data:** The Contractor shall maintain one (1) copy of each Product Data submittal for Project Record Document purposes. The Data shall be marked to indicate the actual product installed where the installation varies substantially from that indicated in the Product Data submitted. Significant changes in the product delivered to the site and changes in manufacturer's instructions and recommendations for installation shall be included. Particular attention will be given to information on concealed products and installations that cannot be readily identified or recorded later. Note related Change Orders and mark up of Record Construction Documents, where applicable. Upon completion of mark up, submit a complete set of Record Product Data to the COR.
12. **Miscellaneous Records:** The Contractor shall maintain one (1) copy of miscellaneous records for Project Record Document purposes. Refer to other Specifications for miscellaneous record-keeping requirements and submittals concerning various construction activities. Before substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Categories of requirements resulting in miscellaneous records include a minimum of the following:
- a. Certificates received instead of labels on bulk products.



- b. Testing and qualification of tradesmen. ("Contractor's Qualifications")
  - c. Documented qualification of installation firms.
  - d. Load and performance testing.
  - e. Inspections and certifications.
  - f. Final inspection and correction procedures.
  - g. Project schedule
13. Record Construction Documents (Record As-Built)
- a. Upon project completion, the contractor shall submit the project master redlines to the COR prior to development of Record construction documents. The COR shall be given a minimum of a thirty (30) day review period to determine the adequacy of the master redlines. If the master redlines are found suitable by the COR, the COR will initial and date each sheet and turn redlines over to the contractor for as built development.
  - b. The Contractor shall provide the COR a complete set of "as-built" drawings and original master redlined marked "as-built" blue-line in the latest version of AutoCAD drawings unlocked on CD or DVD. The as-built drawing shall include security device number, security closet connection location, data gathering panel number, and input or output number as applicable. All corrective notations made by the Contractor shall be legible when submitted to the COR. If, in the opinion of the COR, any redlined notation is not legible, it shall be returned to the Contractor for re-submission at no extra cost to the Owner. The Contractor shall organize the Record Drawing sheets into manageable sets bound with durable paper cover sheets with suitable titles, dates, and other identifications printed on the cover. The submitted as built shall be in editable formats and the ownership of the drawings shall be fully relinquished to the owner.
  - c. Where feasible, the individual or entity that obtained record data, whether the individual or entity is the installer, sub-contractor, or similar entity, is required to prepare the mark up on Record Drawings. Accurately record the information in a comprehensive drawing technique. Record the data when possible after it has been obtained. For concealed installations, record and check the mark up before concealment. At the time of substantial completion, submit the Record Construction Documents to the COR. The Contractor shall organize into bound and labeled sets for the COR's continued usage. Provide device, conduit, and cable lengths on the conduit drawings. Exact in-field conduit placement/routings shall be shown. All conduits shall be illustrated in their entire length from termination in security closets; no arrowed conduit runs shall be shown. Pull box and junction box sizes are to be shown if larger than 100mm (4 inch).
- J. FIPS 201 Compliance Certificates
- 1. Provide Certificates for all software components and device types utilizing credential verification. Provide certificates for:
    - a. Fingerprint Capture Station

- b. Card Readers
- c. Facial Image Capturing Camera
- d. PIV Middleware
- e. Template Matcher
- f. Electromagnetically Opaque Sleeve
- g. Certificate Management
  - 1) CAK Authentication System
  - 2) PIV Authentication System
  - 3) Certificate Validator
  - 4) Cryptographic Module
- K. Approvals will be based on complete submission of manuals together with shop drawings.
- L. After approval and prior to installation, furnish the COR with one sample of each of the following:
  - 1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
  - 2. Each type of conduit and pathway coupling, bushing and termination fitting.
  - 3. Conduit hangers, clamps and supports.
  - 4. Duct sealing compound.
- M. In addition to the requirement of SUBMITTALS, the VA reserves the right to request the manufacturer to arrange for a VA representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

#### **1.7 APPLICABLE PUBLICATIONS**

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/ International Code Council (ICC):
  - 1. A117.1 Standard on Accessible and Usable Buildings and Facilities
- C. American National Standards Institute (ANSI)/ Security Industry Association (SIA):
  - 1. AC-03 Access Control: Access Control Guideline Dye Sublimation Printing Practices for PVC Access Control Cards
  - 2. CP-01-00 Control Panel Standard-Features for False Alarm Reduction
  - 3. PIR-01-00 Passive Infrared Motion Detector Standard - Features for Enhancing False Alarm Immunity
  - 4. TVAC-01 CCTV to Access Control Standard - Message Set for System Integration

- D. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):
  - 1. 330-09 Electrical Performance Standards for CCTV Cameras
  - 2. 375A-76 Electrical Performance Standards for CCTV Monitors
- E. American National Standards Institute (ANSI):
  - 1. ANSI S3.2-99 Method for measuring the Intelligibility of Speech over Communications Systems
- F. American Society for Testing and Materials (ASTM)
  - 1. B1-07 Standard Specification for Hard-Drawn Copper Wire
  - 2. B3-07 Standard Specification for Soft or Annealed Copper Wire
  - 3. B8-04 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
  - 4. C1238-97 (R03) Standard Guide for Installation of Walk-Through Metal Detectors
  - 5. D2301-04 Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- G. Architectural Barriers Act (ABA), 1968
- H. Department of Justice: American Disability Act (ADA)
  - 1. 28 CFR Part 36-2010 ADA Standards for Accessible Design
- I. Department of Veterans Affairs:
  - 1. VHA National CAD Standard Application Guide, 2006
- J. VA BIM Guide, V1.0 10
- K. Federal Communications Commission (FCC):
- L. (47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems
- M. Federal Information Processing Standards (FIPS):
  - 1. FIPS-201-1 Personal Identity Verification (PIV) of Federal Employees and Contractors
- N. Federal Specifications (Fed. Spec.):
  - 1. A-A-59544-08 Cable and Wire, Electrical (Power, Fixed Installation)
- O. Government Accountability Office (GAO):
  - 1. GAO-03-8-02 Security Responsibilities for Federally Owned and Leased Facilities
- P. Homeland Security Presidential Directive (HSPD):
  - 1. HSPD-12 Policy for a Common Identification Standard for Federal Employees and Contractors
- Q. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. 81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
  - 2. 802.3af-08 Power over Ethernet Standard

3. 802.3at-09 Power over Ethernet (PoE) Plus Standard
  4. C2-07 National Electrical Safety Code
  5. C62.41-02 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
  6. C95.1-05 Standards for Safety Levels with Respect to Human Exposure in Radio Frequency Electromagnetic Fields
- R. International Organization for Standardization (ISO):
1. 7810 Identification cards - Physical characteristics
  2. 7811 Physical Characteristics for Magnetic Stripe Cards
  3. 7816-1 Identification cards - Integrated circuit(s) cards with contacts - Part 1: Physical characteristics
  4. 7816-2 Identification cards - Integrated circuit cards - Part 2: Cards with contacts -Dimensions and location of the contacts
  5. 7816-3 Identification cards - Integrated circuit cards - Part 3: Cards with contacts - Electrical interface and transmission protocols
  6. 7816-4 Identification cards - Integrated circuit cards - Part 11: Personal verification through biometric methods
  7. 7816-10 Identification cards - Integrated circuit cards - Part 4: Organization, security and commands for interchange
  8. 14443 Identification cards - Contactless integrated circuit cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 inches distance
  9. 15693 Identification cards -- Contactless integrated circuit cards - Vicinity cards; Contactless Vicinity Cards Operating at 13.56 MHz in up to 50 inches distance
  10. 19794 Information technology - Biometric data interchange formats
- S. National Electrical Contractors Association
1. 303-2005 Installing Closed Circuit Television (CCTV) Systems
- T. National Electrical Manufacturers Association (NEMA):
1. 250-08 Enclosures for Electrical Equipment (1000 Volts Maximum)
  2. TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
  3. FB1-07 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- U. National Fire Protection Association (NFPA):
1. 70-11 National Electrical Code (NEC)
  2. 731-08 Standards for the Installation of Electric Premises Security Systems
  3. 99-2005 Health Care Facilities
- V. National Institute of Justice (NIJ)
1. 0601.02-03 Standards for Walk-Through Metal Detectors for use in Weapons Detection

2. 0602.02-03 Hand-Held Metal Detectors for Use in Concealed Weapon and Contraband Detection
- W. National Institute of Standards and Technology (NIST):
1. IR 6887 V2.1 Government Smart Card Interoperability Specification (GSC-IS)
  2. Special Pub 800-37 Guide for Applying the Risk Management Framework to Federal Information Systems
  3. Special Pub 800-63 Electronic Authentication Guideline
  4. Special Pub 800-73-3 Interfaces for Personal Identity Verification (4 Parts)
  5. Pt. 1- End Point PIV Card Application Namespace, Data Model & Representation
  6. Pt. 2- PIV Card Application Card Command Interface
  7. Pt. 3- PIV Client Application Programming Interface
  8. Pt. 4- The PIV Transitional Interfaces & Data Model Specification
  9. Special Pub 800-76-1 Biometric Data Specification for Personal Identity Verification
  10. Special Pub 800-78-2 Cryptographic Algorithms and Key Sizes for Personal Identity Verification
  11. Special Pub 800-79-1 Guidelines for the Accreditation of Personal Identity Verification Card Issuers
  12. Special Pub 800-85B-1 DRAFTPIV Data Model Test Guidelines
  13. Special Pub 800-85A-2 PIV Card Application and Middleware Interface Test Guidelines (SP 800-73-3 compliance)
  14. Special Pub 800-96 PIV Card Reader Interoperability Guidelines
  15. Special Pub 800-104A Scheme for PIV Visual Card Topography
- X. Occupational and Safety Health Administration (OSHA):
1. 29 CFR 1910.97 Nonionizing radiation
- Y. Section 508 of the Rehabilitation Act of 1973
- Z. Security Industry Association (SIA):
1. AG-01 Security CAD Symbols Standards
- AA. Underwriters Laboratories, Inc. (UL):
1. 1-05 Flexible Metal Conduit
  2. 5-04 Surface Metal Raceway and Fittings
  3. 6-07 Rigid Metal Conduit
  4. 44-05 Thermoset-Insulated Wires and Cables
  5. 50-07 Enclosures for Electrical Equipment
  6. 83-08 Thermoplastic-Insulated Wires and Cables
  7. 294-99 The Standard of Safety for Access Control System Units
  8. 305-08 Standard for Panic Hardware

9. 360-09 Liquid-Tight Flexible Steel Conduit
10. 444-08 Safety Communications Cables
11. 464-09 Audible Signal Appliances
12. 467-07 Electrical Grounding and Bonding Equipment
13. 486A-03 Wire Connectors and Soldering Lugs for Use with Copper  
Conductors
14. 486C-04 Splicing Wire Connectors
15. 486D-05 Insulated Wire Connector Systems for Underground Use or  
in Damp or Wet Locations
16. 486E-00 Equipment Wiring Terminals for Use with Aluminum and/or  
Copper Conductors
17. 493-07 Thermoplastic-Insulated Underground Feeder and Branch  
Circuit Cable
18. 514A-04 Metallic Outlet Boxes
19. 514B-04 Fittings for Cable and Conduit
20. 51-05 Schedule 40 and 80 Rigid PVC Conduit
21. 609-96 Local Burglar Alarm Units and Systems
22. 634-07 Standards for Connectors with Burglar-Alarm Systems
23. 636-01 Standard for Holdup Alarm Units and Systems
24. 639-97 Standard for Intrusion-Detection Units
25. 651-05 Schedule 40 and 80 Rigid PVC Conduit
26. 651A-07 Type EB and A Rigid PVC Conduit and HDPE Conduit
27. 752-05 Standard for Bullet-Resisting Equipment
28. 797-07 Electrical Metallic Tubing
29. 827-08 Central Station Alarm Services
30. 1037-09 Standard for Anti-theft Alarms and Devices
31. 1635-10 Digital Alarm Communicator System Units
32. 1076-95 Standards for Proprietary Burglar Alarm Units and Systems
33. 1242-06 Intermediate Metal Conduit
34. 1479-03 Fire Tests of Through-Penetration Fire Stops
35. 1981-03 Central Station Automation System
36. 2058-05 High Security Electronic Locks
37. 60950 Safety of Information Technology Equipment
38. 60950-1 Information Technology Equipment - Safety - Part 1:  
General Requirements
- BB. Uniform Federal Accessibility Standards (UFAS) 1984
- CC. United States Department of Commerce:
  1. Special Pub 500-101 Care and Handling of Computer Magnetic Storage  
Media

### **1.8 COORDINATION**

- A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed.

### **1.9 MINIMUM REQUIREMENTS**

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

### **1.10 DELIVERY, STORAGE, & HANDLING**

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
  - 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  - 2. Damaged equipment shall be, as determined by the COR, placed in first class operating condition or be returned to the source of supply for repair or replacement.
  - 3. Painted surfaces shall be protected with factory installed removable heavy craft paper, sheet vinyl or equal.
  - 4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.
- B. Central Station, Workstations, and Controllers:
  - 1. Store in temperature and humidity controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 10 to 30 deg C (50 to 85 deg F), and not more than 80 percent relative humidity, non-condensing.
  - 2. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.

3. Mark packing list with designations which have been assigned to materials and equipment for recording in the system labeling schedules generated by cable and asset management system.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

#### **1.11 PROJECT CONDITIONS**

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  1. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 2 to 50 deg C (36 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 1 enclosure.
  2. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of -18 to 50 deg C (0 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 4X enclosures.
  3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -34 to 50 deg C (-30 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 610 mm (24 in) thick. NEMA 250, Type 4X enclosures.
  4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
  5. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.
- B. Security Environment: Use vandal resistant enclosures in high-risk areas where equipment may be subject to damage.
- C. Console: All console equipment shall, unless noted otherwise, be rated for continuous operation under ambient environmental conditions of 15.6 to 29.4 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent.

#### **1.12 EQUIPMENT AND MATERIALS**

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
  1. Components of an assembled unit need not be products of the same manufacturer.



2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  3. Components shall be compatible with each other and with the total assembly for the intended service.
  4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the COR a minimum of 15 working days prior to the manufacturers making the factory tests.
  2. Four copies of certified test reports containing all test data shall be furnished to the COR prior to final inspection and not more than 90 days after completion of the tests.
  3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

### **1.13 COMPONENT ENCLOSURES**

- A. Construction of Enclosures
1. Consoles, power supply enclosures, detector control and terminal cabinets, control units, wiring gutters, and other component housings, collectively referred to as enclosures, shall be so formed and assembled as to be sturdy and rigid.
  2. Thickness of metal in-cast and sheet metal enclosures of all types shall not be less than those in Tables I and II, UL 611. Sheet steel used in fabrication of enclosures shall be not less than 14 gauge. Consoles shall be 16-gauge.
  3. Doors and covers shall be flanged. Enclosures shall not have pre-punched knockouts. Where doors are mounted on hinges with exposed pins, the hinges shall be of the tight pin type or the ends of hinge pins shall be tack welded to prevent removal. Doors having a latch edge length of less than 609.6 mm (24 in) shall be provided with a single construction core. Where the latch edge of a hinged door is more than 609.6 mm (24 in) or more in length, the door shall be provided with a three-point latching device with construction core; or alternatively with two, one located near each end.
  4. Any ventilator openings in enclosures and cabinets shall conform to the requirements of UL 611. Unless otherwise indicated, sheet metal enclosures shall be designed for wall mounting with tip holes slotted. Mounting holes shall be in positions that remain accessible when all major operating components are in place and the door is open, but shall be in accessible when the door is closed.

5. Covers of pull and junction boxes provided to facilitate initial installation of the system shall be held in place by tamper proof Torx Center post security screws. Stenciled or painted labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate the box is part of the Electronic Security System (ESS).

B. Tamper Provisions and Tamper Switches:

1. Enclosures, cabinets, housings, boxes and fittings or every product description having hinged doors or removable covers and which contain circuits, or the integrated security system and its power supplies shall be provided with cover operated, corrosion-resistant tamper switches.
2. Tamper switches shall be arranged to initiate an alarm signal that will report to the monitoring station when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. It shall take longer than 1 second to depress or defeat the tamper switch after opening or removing the cover. The enclosure and tamper switch shall function together in such a manner as to prohibit direct line of sign to any internal component before the switch activates.
3. Tamper switches shall be inaccessible until the switch is activated. Have mounting hardware concealed so the location of the switch cannot be observed from the exterior of the enclosure. Be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating. Be spring-loaded and held in the closed position by the door or cover and be wired so they break the circuit when the door cover is disturbed. Tamper circuits shall be adjustable type screw sets and shall be adjusted by the contractor to eliminate nuisance alarms associated with incorrectly mounted tamper device shall annunciate prior to the enclosure door opening (within 1/4 " tolerance. The tamper device or its components shall not be visible or accessing with common tools to bypass when the enclosure is in the secured mode.
4. The single gang junction boxes for the portrait alarming and pull boxes with less than 102 square mm will not require tamper switches.
5. All enclosures over 305 square mm shall be hinged with an enclosure lock.
6. Control Enclosures: Maintenance/Safety switches on control enclosures, which must be opened to make routing maintenance adjustments to the system and to service the power supplies, shall be push/pull-set automatic reset type.
7. Provide one (1) enclosure tamper switch for each 609 linear mm of enclosure lock side opening evenly spaced.
8. All security screws shall be Torx-Post Security Screws.
9. The contractor shall provide the owner with two (2) torx-post screwdrivers.

#### **1.14 WARRANTY**

- A. The Contractor shall, as a condition precedent to the final payment, execute a written warranty to the COR certifying all contract requirements have been completed according to the final specifications. Contract drawings and the warranty of all materials and equipment furnished under this contract are to remain in satisfactory operating condition for one (1) year from the date the Contractor received written notification of final acceptance from the COR. Demonstration and training shall be performed prior to system acceptance. All defects or damages due to faulty materials or workmanship shall be repaired or replaced without delay, to the COR's satisfaction, and at the Contractor's expense. When equipment and labor covered by the Contractor's warranty, or by a manufacturer's warranty, have been replaced or restored because of its failure during the warranty period, the warranty period for the replaced or repaired equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work. In the event any manufacturer customarily provides a warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.

#### **1.15 SINGULAR NUMBER**

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

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT AND MATERIALS**

- A. All equipment associated within the Security Control Room, Security Console and Security Equipment Room shall be UL 827, UL 1981, and UL 60950 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
- B. All equipment shall operate on a 120 volts alternating current (VAC); 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of [8] <insert hours> hours of run time in the event of a loss of primary power to the facility.
- C. The system shall be designed, installed, and programmed in a manner that will allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.
- D. All equipment and materials for the system will be compatible to ensure correct operation.

#### **2.2 EQUIPMENT ITEMS**

- A. The Security Management System shall provide full interface with all components of the security subsystem as follows:

1. Shall allow for communication between the Physical Access Control System and Database Management and all subordinate work and monitoring stations, enrollment centers for badging and biometric devices as part of the PACS, local annunciation centers, the electronic Security Management System (SMS), and all other VA redundant or backup command center or other workstations locations.
2. Shall provide automatic continuous communication with all systems that are monitored by the SMS, and shall automatically annunciate any communication failures or system alarms to the SMS operator providing identification of the system, nature of the alarm, and location of the alarm.
3. Controlling devices shall be utilized to interface the SMS with all field devices.
4. The Security control room and security console will be supported by an uninterrupted power supply (UPS) or dedicated backup generator power circuit.

B. Wires and Cables:

1. Shall meet or exceed the manufactures recommendation for power and signals.
2. Shall be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
3. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will contained in either EMT or RGS conduit.
4. All conduit, pull boxes, and junction boxes shall be marked with colored permanent tape or paint that will allow it to be distinguished from all other infrastructure conduit.
5. Conduit fills shall not exceed 50 percent unless otherwise documented.
6. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
7. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area.
8. High voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security subsystems shall be any cable or sets of cables carrying 30 VDC/VAC or higher.
9. For all equipment that is carrying digital data between the Security Control Room, Security Equipment Room, Security Console, or at a remote monitoring station, it shall not be less than 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.

## 2.3 INSTALLATION KIT

### A. General:

1. The kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer. The following sections outline the minimum required installation sub-kits to be used:
2. System Grounding:
  - a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
  - b. This includes, but is not limited to:
    - 1) Coaxial Cable Shields
    - 2) Control Cable Shields
    - 3) Data Cable Shields
    - 4) Equipment Racks
    - 5) Equipment Cabinets
    - 6) Conduits
    - 7) Cable Duct blocks
    - 8) Cable Trays
    - 9) Power Panels
    - 10) Grounding
    - 11) Connector Panels
3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
5. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.

6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this document.
8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to provide the system documentation as required by this document and explained herein.

### **PART 3 - EXECUTION**

#### **3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION**

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Equipment location shall be as close as practical to locations shown on the drawings.
- G. Inaccessible Equipment:
  1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

#### **3.2 FIRESTOPPING**

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section 07 84 00 "Firestopping."

### **3.3 DEMONSTRATION AND TRAINING**

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the COR at least 30 days prior to the planned training.
- D. Provide services of manufacturer's technical representative for <insert hours> hours to instruct VA personnel in operation and maintenance of units.

### **3.4 WORK PERFORMANCE**

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

### **3.5 SYSTEM PROGRAMMING**

- A. General Programming Requirements
  - 1. This following section shall be used by the contractor to identify the anticipated level of effort (LOE) required setup, program, and configure the Electronic Security System (ESS). The contractor shall be responsible for providing all setup, configuration, and programming to include data entry for the Security Management System (SMS) and subsystems [(e.g., video matrix switch, intercoms, digital video recorders, intrusion devices, including integration of subsystems to the SMS (e.g., camera call up, time synchronization, intercoms)]. System programming for existing or new SMS servers shall not be conducted at the project site.
- B. Level of Effort for Programming
  - 1. The Contractor shall perform and complete system programming (including all data entry) at an offsite location using the Contractor's own copy of the SMS software. The Contractor's copy of the SMS software shall be of the Owners current version. Once system programming has been completed, the Contractor shall deliver the data to the COR on data entry forms and an approved electronic medium, utilizing data from the contract documents. The completed forms shall be delivered to the COR for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires it. The Contractor shall not upload system programming until the COR has provided written approval. The Contractor is responsible for backing up the system prior to uploading new programming data. Additional programming requirements are provided as follows:

- a. Programming for Existing SMS Servers: The contractor shall perform all related system programming except for personnel data as noted. The contractor will not be responsible for uploading personnel information (e.g., ID Cards backgrounds, names, access privileges, access schedules, personnel groupings). The contractor shall anticipate a weekly coordination meeting and working alongside of COR to ensure data uploading is performed without incident of loss of function or data loss. System programming for SMS servers shall be performed by using the Contractor's own server and software. These servers shall not be connected to existing devices or systems at any time.
2. The Contractor shall identify and request from the COR, any additional data needed to provide a complete and operational system as described in the contract documents.
3. Contractor and COR coordination on programming requires a high level of coordination to ensure programming is performed in accordance with VA requirements and programming uploads do not disrupt existing systems functionality. The contractor shall anticipate a minimum a weekly coordination meeting. Contractor shall ensure data uploading is performed without incident of loss of function or data loss. The following Level of Effort Chart is provided to communicate the expected level of effort required by contractors on VA ESS projects. Calculations to determine actual levels of effort shall be confirmed by the contractor before project award.

### **Table 1 Contractor Level of Effort**

#### **3.6 TESTING AND ACCEPTANCE**

##### **A. Performance Requirements**

1. General:
  - a. The Contractor shall perform contract field, performance verification, and endurance testing and make adjustments of the completed security system when permitted. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the COR at least 60 calendar days prior to the test and after the Contractor has received written approval of the specific test procedures.
  - b. The COR shall witness all testing and system adjustments during testing. Written permission shall be obtained from the COR before proceeding with the next phase of testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the COR at the conclusion of each phase of testing and prior to COR approval of the test.
2. Test Procedures and Reports: The test procedures, compliant w/ VA standard test procedures, shall explain in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. The test reports shall be used to document results of the tests. The reports shall be delivered to the COR within seven (7) calendar days after completion of each test.



#### B. Pre-Delivery Testing

1. The purpose of the pre-delivery test is to establish that a system is suitable for installation. As such, pre-delivery test shall be a mock-up of the system as planned in the contract documents. The Contractor shall assemble the Security Test System at the Contractors local project within 50-miles of the project site, and perform tests to demonstrate the performance of the system complies with the contract requirements in accordance with the approved pre-delivery test procedures. The tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during pre-delivery testing, including results of each test procedure, shall be documented and delivered to the COR at the conclusion of pre-delivery testing and prior to COR's approval of the test. The test report shall be arranged so all commands, stimuli, and responses are correlated to allow logical interpretation. For Existing System modifications, the contractor shall provide their own server with loaded applicable software to support PDT.
2. Test Setup: The pre-delivery test setup shall include the following:
  - a. All console equipment.
    - 1) At least one of each type of data transmission media (DTM) and associated equipment to provide a fully integrated PACS.
    - 2) The number of local processors shall equal the amount required by the site design.
    - 3) Enough sensor simulators to provide alarm signal inputs to the system equal to the number of sensors required by the design. The alarm signals shall be manually or software generated.
    - 4) Contractor to prove to owner all systems are appropriately sized and configured as sized.
    - 5) Integration of VASS, intercom systems, other subsystems.
3. During the bidding process the contractor shall submit a request for information to the Owner to determine if a pre-delivery test will be required. If a pre-delivery test is not required, the contractor shall provide a written notification that the Pre-delivery Test is not required in their shop drawings submission.

#### C. Intermediate Testing

1. After completion of 30-50 percent of the installation of ESS cabinet(s) and equipment, one local and remote control stations and prior to any further work, this portion of the system must be pretested, inspected, and certified. Each item of installed equipment shall be checked to ensure appropriate FCC listing & UL certification labels are affixed, NFPA, Emergency, Safety, and JCAHCO guidelines are followed, and proper installation practices are followed. The intermediate test shall include a full operational test.

- D. The inspection and test will be conducted by a factory-certified contractor representative and witnessed by a Government Representative. The results of the inspection will be officially recorded by a designated Government Representative and maintained on file by the COR, until completion of the entire project. The results will be compared to the Acceptance Test results.
- E. Contractor's Field Testing (CFT)
1. The Contractor shall calibrate and test all equipment, verify DTM operation, place the integrated system in service, and test the integrated system. Ground rods installed by this Contractor within the base of camera poles shall be tested as specified in IEEE STD 142. The Contractor shall test all security systems and equipment, and provide written proof of a 100% operational system before a date is established for the system acceptance test. Documentation package for CFT shall include completed (fully annotated details of test details) for each device and system tested, and annotated loading sheets documenting complete testing to COR approval. CFT test documentation package shall conform to submittal requirements outlined in this Section. The Contractor's field testing procedures shall be identical to the COR's acceptance testing procedures. The Contractor shall provide the COR with a written listing of all equipment and software indicating all equipment and components have been tested and passed. The Contractor shall deliver a written report to the COR stating the installed complete system has been calibrated, tested, and is ready to begin performance verification testing; describing the results of the functional tests, diagnostics, and calibrations; and the report shall also include a copy of the approved acceptance test procedure. Performance verification testing shall not take place until written notice by contractor is received certifying that a contractors field test was successful.
- F. Performance Verification Test (PVT)
1. Test team:
    - a. After the system has been pretested and the Contractor has submitted the pretest results and certification to the COR, then the Contractor shall schedule an acceptance test to date and give the COR written, notice as described herein, prior to the date the acceptance test is expected to begin. The system shall be tested in the presence of a Government Representative, an OEM certified representative, representative of the Contractor and other approved by the COR. The system shall be tested utilizing the approved test equipment to certify proof of performance, FCC, UL and Emergency Service compliance. The test shall verify that the total system meets all the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.

2. The Contractor shall demonstrate the completed Physical Access Control System PACS complies with the contract requirements. In addition, the Contractor shall provide written certification that the system is 100% operational prior to establishing a date for starting PVT. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The PVT will be stopped and aborted as soon as 10 technical deficiencies are found requiring correction. The Contractor shall be responsible for all travel and lodging expenses incurred for out-of-town personnel required to be present for resumption of the PVT. If the acceptance test is aborted, the re-test will commence from the beginning with a retest of components previously tested and accepted.
3. The PVT, as specified, shall not begin until receipt of written certification that the Contractors Field Testing was successful. This shall include certification of successful completion of testing as specified in paragraph "Contractor's Field Testing", and upon successful completion of testing at any time when the system fails to perform as specified. Upon termination of testing by the COR or Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II.
4. Upon successful completion of the acceptance test, the Contractor shall deliver test reports and other documentation, as specified, to the COR prior to commencing the endurance test.
5. Additional Components of the PVT shall include:
  - a. System Inventory
    - 1) All Device equipment
    - 2) All Software
    - 3) All Logon and Passwords
    - 4) All Cabling System Matrices
    - 5) All Cable Testing Documents
    - 6) All System and Cabinet Keys
  - b. Inspection
    - 1) Contractor shall record an inspection punch list noting all system deficiencies. The contractor shall prepare an inspection punch list format for CORs approval.
    - 2) As a minimum the punch list shall include a listing of punch list items, punch list item location, description of item problem, date noted, date corrected, and details of how item was corrected.
6. Partial PVT - At the discretion of COR, the Performance Verification Test may be performed in part should a 100% compliant CFT be performed. In the event that a partial PVT will be performed instead of a complete PVT; the partial PVT shall be performed by testing 10% of the system. The contractor shall perform a test of each procedure on select devices or equipment.

G. Endurance Test

1. The Contractor shall demonstrate the specified probability of detection and false alarm rate requirements of the completed system. The endurance test shall be conducted in phases as specified below. The endurance test shall not be started until the COR notifies the Contractor, in writing, that the performance verification test is satisfactorily completed, training as specified has been completed, and correction of all outstanding deficiencies has been satisfactorily completed. VA shall operate the system 24 hours per day, including weekends and holidays, during Phase I and Phase III endurance testing. VA will maintain a log of all system deficiencies. The COR may terminate testing at any time the system fails to perform as specified. Upon termination of testing, the Contractor shall commence an assessment period as described for Phase II. During the last day of the test, the Contractor shall verify the appropriate operation of the system. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the COR prior to acceptance of the system.
2. Phase I (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized in writing by the COR. If the system experiences no failures, the Contractor may proceed directly to Phase III testing after receiving written permission from the COR.
3. Phase II (Assessment):
  - a. After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the COR. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed.
  - b. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the COR. The meeting shall not be scheduled earlier than five (5) business days after the COR receives the report. As part of this test review meeting, the Contractor shall demonstrate all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the COR will provide a written determine of either the restart date or require Phase I be repeated.
4. Phase III (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized in writing by the COR.
5. Phase IV (Assessment):
  - a. After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the COR. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed.

- b. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the COR. The meeting shall not be scheduled earlier than five (5) business days after receipt of the report by the COR. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by repeating appropriate portions for the performance verification test. Based on the review meeting the test should not be scheduled earlier than five (5) business days after the COR receives the report. As a part of this test review meeting, the Contractor shall demonstrate all failures have been corrected by repeating appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the COR will provide a written determine of either the restart date or require Phase III be repeated. After the conclusion of any re-testing which the COR may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.
- H. Exclusions
1. The Contractor will not be held responsible for failures in system performance resulting from the following:
    - a. An outage of the main power in excess of the capability of any backup power source provided the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the PACS performed as specified.
    - b. Failure of an Owner furnished equipment or communications link, provided the failure was not due to Contractor furnished equipment, installation, or software.
    - c. Failure of existing Owner owned equipment, provided the failure was not due to Contractor furnished equipment, installation, or software.

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- C. Section 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. Requirements for general requirements that are common to more than one section in Division 28.
- D. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 28 05 28.33 - CONDUITS AND BOXES FOR ELECTRONIC SECURITY AND SAFETY. Requirements for infrastructure.

**1.3 DEFINITIONS**

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- F. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- G. RCDD: Registered Communications Distribution Designer.
- H. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.
- I. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.
- J. UTP: Unshielded twisted pair.

**1.4 QUALITY ASSURANCE**

- A. See section 28 05 00, Paragraph 1.4.

### 1.5 SUBMITTALS

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

### 1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.
- B. American Society of Testing Material (ASTM):
1. D2301-04 Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- C. Federal Specifications (Fed. Spec.):
1. A-A-59544-08 Cable and Wire, Electrical (Power, Fixed Installation)
- D. National Fire Protection Association (NFPA):
1. 70-11 National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):

1. 44-05 Thermoset-Insulated Wires and Cables
2. 83-08 Thermoplastic-Insulated Wires and Cables
3. 467-07 Electrical Grounding and Bonding Equipment
4. 486A-03 Wire Connectors and Soldering Lugs for Use with Copper Conductors
5. 486C-04 Splicing Wire Connectors
6. 486D-05 Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
7. 486E-00 Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
8. 493-07 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
9. 514B-04 Fittings for Cable and Conduit
10. 1479-03 Fire Tests of Through-Penetration Fire Stops

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

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

#### **1.8 PROJECT CONDITIONS**

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

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL**

- A. General: All cabling locations shall be in conduit systems as outlined in Division 28 unless a waiver is granted in writing or an exception is noted on the construction drawings.
- B. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
  1. Support brackets with cable tie slots for fastening cable ties to brackets.
  2. Lacing bars, spools, J-hooks, and D-rings.
  3. Straps and other devices.



C. Cable Trays:

1. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick ].
2. Basket Cable Trays: 6 inches (150 mm) wide and 2 inches (50 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
3. Trough Cable Trays: Nominally 6 inches (150 mm) wide.
4. Ladder Cable Trays: wide, and a rung spacing of 12 inches (305 mm).
5. Channel Cable Trays: One-piece construction, nominally 4 inches (100 mm) wide. Slot spacing shall not exceed 4-1/2 inches (115 mm) o.c.

D. Conduit and Boxes: Comply with requirements in Division 28 Section "Conduits and Backboxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

**2.2 BACKBOARDS**

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

**2.3 UTP CABLE**

- A. Description: 100-ohm, 4-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.
  1. Comply with ICEA S-90-661 for mechanical properties.
  2. Comply with TIA/EIA-568-B.1 for performance specifications.
  3. Comply with TIA/EIA-568-B.2, Category 6.
  4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM or CMG .
    - b. Communications, Plenum Rated: Type CMP , complying with NFPA 262.
    - c. Communications, Riser Rated: Type CMR , complying with UL 1666.
    - d. Communications, Limited Purpose: Type CMX.
    - e. Multipurpose: Type MP or MPG .
    - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    - g. Multipurpose, Riser Rated: Type MPR , complying with UL 1666.

**2.4 UTP CABLE HARDWARE**

- A. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- B. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

## 2.5 OPTICAL FIBER CABLE

- A. Description: Multimode, 62.5/125-micrometer, 24 -fiber, tight buffer, optical fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
  2. Comply with TIA/EIA-568-B.3 for performance specifications.
  3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
  4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
    - a. General Purpose, Nonconductive: Type OFN or OFNG .
    - b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    - c. Riser Rated, Nonconductive: Type OFNR , complying with UL 1666.
    - d. General Purpose, Conductive: Type OFC or OFCG .
    - e. Plenum Rated, Conductive: Type OFCP , complying with NFPA 262.
    - f. Riser Rated, Conductive: Type OFCR , complying with UL 1666.
  5. Conductive cable shall be steel armored type.
  6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
  7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- B. Jacket:
1. Jacket Color: Orange for 62.5/125-micrometer cable.
  2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
  3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

## 2.6 OPTICAL FIBER CABLE HARDWARE

- A. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
1. Quick-connect, simplex and duplex, Type SC, ]Type ST connectors. Insertion loss shall be not more than 0.75 dB.
  2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

## 2.7 COAXIAL CABLE

- A. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- B. RG-11/U: NFPA 70, Type CATV.
1. No. 14 AWG, solid, copper-covered steel conductor.
  2. Gas-injected, foam-PE insulation.

3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
  4. Jacketed with sunlight-resistant, black PVC or PE.
  5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
- C. RG59/U: NFPA 70, Type CATVR.
1. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
  2. Gas-injected, foam-PE insulation.
  3. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
  4. Color-coded PVC jacket.
- D. RG-6/U: NFPA 70, Type CATV or CM.
1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
  2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
  3. Jacketed with black PVC or PE.
  4. Suitable for indoor installations.
- E. RG59/U: NFPA 70, Type CATV.
1. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
  2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
  3. PVC jacket.
- F. RG59/U (Plenum Rated): NFPA 70, Type CMP.
1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
  2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
  3. Copolymer jacket.
- G. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
1. CATV Cable: Type CATV.
  2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
  3. CATV Riser Rated: Type CATVR, complying with UL 1666.
  4. CATV Limited Rating: Type CATVX.

## 2.8 COAXIAL CABLE HARDWARE

- A. Coaxial-Cable Connectors: Type BNC, 75 ohms.

## **2.9 RS-232 CABLE**

- A. Standard Cable: NFPA 70, Type CM.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Polypropylene insulation.
  - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  - 4. PVC jacket.
  - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  - 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Plastic insulation.
  - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  - 4. Plastic jacket.
  - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  - 6. Flame Resistance: Comply with NFPA 262.

## **2.10 RS-485 CABLE**

- A. Standard Cable: NFPA 70, Type CM[ or CMG].
  - 1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Fluorinated ethylene propylene insulation.
  - 3. Unshielded.
  - 4. Fluorinated ethylene propylene jacket.
  - 5. Flame Resistance: NFPA 262, Flame Test.

## **2.11 LOW-VOLTAGE CONTROL CABLE**

- A. Paired Lock Cable: NFPA 70, Type CMG.
  - 1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.

4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.
  1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with NFPA 262.
- C. Paired Lock Cable: NFPA 70, Type CMG.
  1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with UL 1581.
- D. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.
  1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
  2. Fluorinated ethylene propylene insulation.
  3. Unshielded.
  4. Plastic jacket.
  5. Flame Resistance: NFPA 262, Flame Test.

#### **2.12 CONTROL-CIRCUIT CONDUCTORS**

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway [power-limited cable, concealed in building finishes] complying with UL 83.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

#### **2.13 FIRE ALARM WIRE AND CABLE**

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than size as recommended by system manufacturer.
  1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
  1. Low-Voltage Circuits: No. 16 AWG, minimum.

2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

#### **2.14 IDENTIFICATION PRODUCTS**

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

#### **2.15 SOURCE QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
- E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- F. Cable will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

#### **2.16 WIRE LUBRICATING COMPOUND**

- A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.
- B. Shall not be used on wire for isolated type electrical power systems.

#### **2.17 FIREPROOFING TAPE**

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

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION of conductors and cables**

- A. Comply with NECA 1.

- B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
  2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  3. Install 110-style IDC termination hardware unless otherwise indicated.
  4. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  9. Pulling Cable:
    - a. Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
    - b. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
    - c. Use ropes made of nonmetallic material for pulling feeders.
    - d. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COR.
    - e. Pull in multiple cables together in a single conduit.
- C. Splice cables and wires where necessary only in outlet boxes, junction boxes, or pull boxes.
1. Splices and terminations shall be mechanically and electrically secure.
  2. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.
- D. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.
- E. Unless otherwise specified in other sections install wiring and connect to equipment/devices to perform the required functions as shown and specified.
- F. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

- G. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.
- H. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.
- I. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.
- J. UTP Cable Installation:
  - 1. Comply with TIA/EIA-568-B.2.
  - 2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- K. Optical Fiber Cable Installation:
  - 1. Comply with TIA/EIA-568-B.3.
  - 2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.
- L. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than [60 inches (1525 mm)] <Insert dimension> apart.
  - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- M. Installation of Cable Routed Exposed under Raised Floors:
  - 1. Install plenum-rated cable only.
  - 2. Install cabling after the flooring system has been installed in raised floor areas.
  - 3. Coil cable [72 inches (1830 mm)] <Insert size> long shall be neatly coiled not less than [12 inches (300 mm)] <Insert size> in diameter below each feed point.
- N. Outdoor Coaxial Cable Installation:
  - 1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
  - 2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).
- O. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.



2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

### **3.2 FIRE ALARM WIRING INSTALLATION**

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Division 28 Section CONDUITS AND BACKBOXES FOR ELECTRICAL SYSTEMS."
  1. Install plenum cable in environmental air spaces, including plenum ceilings.
  2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
  1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
  2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is permitted.

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3. Signaling Line Circuits: Power-limited fire alarm cables may ] be installed in the same cable or raceway as signaling line circuits.

- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### **3.3 CONTROL CIRCUIT CONDUCTORS**

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

### **3.4 CONNECTIONS**

- A. Comply with requirements in Division 28 Section, PHYSICAL ACCESS CONTROL for connecting, terminating, and identifying wires and cables.
- B. Comply with requirements in Division 28 Section "VIDEO SURVEILLANCE" for connecting, terminating, and identifying wires and cables.
- C. Comply with requirements in Division 28 Section "ELECTRONIC PERSONAL PROTECTION SYSTEMS" for connecting, terminating, and identifying wires and cables.
- D. Comply with requirements in Division 28 Section "FIRE DETECTION AND ALARM" for connecting, terminating, and identifying wires and cables.

### **3.5 FIRESTOPPING**

- A. Comply with requirements in Division 07 Section "PENETRATION FIRESTOPPING."  
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- B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### **3.6 GROUNDING**

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 28 Section "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY."

### **3.7 IDENTIFICATION**

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.
- B. Install a permanent wire marker on each wire at each termination.
- C. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- D. Wire markers shall retain their markings after cleaning.
- E. In each handhole, install embossed brass tags to identify the system served and function.

### **3.8 FIELD QUALITY CONTROL**

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

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- 1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
  - 2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
5. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System."
- D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
  - E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
  - F. Prepare test and inspection reports.

### 3.9 EXISTING WIRING

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

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**SECTION 28 05 26**  
**GROUNDING AND BONDING FOR ELECTRONIC safety and SECURITY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the finishing, installation, connection, testing and certification of the grounding and bonding required for a fully functional Electronic Safety and Security (ESS) system.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning

**1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for low voltage power and lighting wiring.
- C. Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS. Requirements for commissioning.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- B. Shop Drawings:
  - 1. Clearly present enough information to determine compliance with drawings and specifications.
  - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COR:
  - 1. Certification that the materials and installation are in accordance with the drawings and specifications.
  - 2. Certification by the contractor that the complete installation has been properly installed and tested.

**1.4 applicable publications**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. B1-07 Standard Specification for Hard-Drawn Copper Wire
  - 2. B3-07 Standard Specification for Soft or Annealed Copper Wire

3. B8-04 Standard Specification for Concentric -Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
1. 81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
  2. C2-07 National Electrical Safety Code
- D. National Fire Protection Association (NFPA):
1. 70-11 National Electrical Code (NEC)
  2. 99-2005 Health Care Facilities
- E. Underwriters Laboratories, Inc. (UL):
1. 44-05 Thermoset-Insulated Wires and Cables
  2. 83-08 Thermoplastic-Insulated Wires and Cables
  3. 467-07 Grounding and Bonding Equipment
  4. 486A-486B-03 Wire Connectors

## **PART 2 - PRODUCTS**

### **2.1 GROUNDING AND BONDING CONDUCTORS**

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm<sup>2</sup> (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm<sup>2</sup> (4 AWG) and larger shall be permitted to be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm<sup>2</sup> (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

### **2.2 GROUND RODS**

- A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance.

### **2.3 SPLICES AND TERMINATION COMPONENTS**

- A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).2.4 ground connections
- B. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- C. Below Grade: Exothermic-welded type connectors.
- D. Above Grade:
  1. Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lockwashers.
  2. Connection to Building Steel: Exothermic-welded type connectors.

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

#### **2.4 EQUIPMENT RACK AND CABINET GROUND BARS**

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x 3/4 inch).

#### **2.5 GROUND TERMINAL BLOCKS**

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

#### **2.6 SPLICE CASE GROUND ACCESSORIES**

- A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm<sup>2</sup> (6 AWG) insulated ground wire with shield bonding connectors.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.
- B. System Grounding:
  1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
  2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- C. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

#### **3.2 INACCESSIBLE GROUNDING CONNECTIONS**

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

### **3.3 corrosion inhibitors**

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

### **3.4 CONDUCTIVE PIPING**

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

### **3.5 COMPUTER ROOM/SECURITY EQUIPMENT ROOM GROUNDING**

- A. Conduit: Ground and bond metallic conduit systems as follows:
  - 1. Ground metallic service conduit and any pipes entering or being routed within the computer room at each end using 16 mm<sup>2</sup> (6AWG) bonding jumpers.
  - 2. Bond at all intermediate metallic enclosures and across all joints using 16 mm<sup>2</sup> (6 AWG) bonding jumpers.

### **3.6 WIREWAY GROUNDING**

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

### **3.7 LIGHTNING PROTECTION SYSTEM**

- A. Bond the lightning protection system to earth ground externally to the building. Under no condition shall the electrical system's third or fourth ground electrode system, or the telecommunications system circulating ground system be connected to the lightning protection system. The Facility's structural steel may be used to connect the lightning protection system at the direction of the COR certified by an independent certified grounding contractor.

### **3.8 GROUND RESISTANCE**

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



- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.
- D. Below-grade connections shall be visually inspected by the COR prior to backfilling. The contractor shall notify the COR 24 hours before the connections are ready for inspection.

### **3.9 GROUND ROD INSTALLATION**

- A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

### **3.10 GROUNDING FOR RF/EMI CONTROL**

- A. Install bonding jumpers to bond all conduit, cable trays, sleeves and equipment for low voltage signaling and data communications circuits. Bonding jumpers shall consist of 100 mm (4 inches) wide copper strip or two 6 mm<sup>2</sup> (10 AWG) copper conductors spaced minimum 100 mm (4 inches) apart. Use 16 mm<sup>2</sup> (6 AWG) copper where exposed and subject to damage.
- B. Comply with the following when shielded cable is used for data circuits.
  - 1. Shields shall be continuous throughout each circuit.
  - 2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
  - 3. Do not connect shields from different circuits together.
  - 4. Shield shall be connected at one end only. Connect shield to signal reference at the origin of the circuit. Consult with equipment manufacturer to determine signal reference.

### **3.11 LABELING**

- A. Comply with requirements in Division 26 Section "ELECTRICAL IDENTIFICATION" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer [and at the grounding electrode conductor where exposed].
  - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

**3.12 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
  - 1. Power Distribution Units or Panel boards Serving Electronic Equipment:  
3 ohm(s).
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the finishing, installation, connection, testing certification of the conduit, fittings, and boxes to form a complete, coordinated, raceway system(s). Conduits and when approved separate UL Certified and Listed partitioned telecommunications raceways are required for a fully functional Electronic Safety and Security (ESS) system. Raceways are required for all electronic safety and security cabling unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

**1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 06 10 00 - ROUGH CARPENTRY. Requirements for mounting board for communication closets.
- C. Section 07 84 00 - FIRESTOPPING. Requirements for sealing around penetrations to maintain the integrity of fire rated construction.
- D. Section 07 92 00 - JOINT SEALANTS. Requirements for sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- E. Section 09 91 00 - PAINTING. Requirements for identification and painting of conduit and other devices.
- F. Section 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. For general electrical requirements, general arrangement of the contract documents, coordination, quality assurance, project conditions, equipment and materials, and items that is common to more than one section of Division 28.
- G. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- H. Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS. Requirements for commissioning - systems readiness checklists, and training.

**1.3 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.

- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

#### **1.4 QUALITY ASSURANCE**

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

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Furnish the following:
  - B. Shop Drawings:
    - 1. Size and location of main feeders;
    - 2. Size and location of panels and pull boxes
    - 3. Layout of required conduit penetrations through structural elements.
    - 4. The specific item proposed and its area of application shall be identified on the catalog cuts.
  - C. Certification: Prior to final inspection, deliver to the COR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.
  - D. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.
  - E. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
  - F. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
  - G. Source quality-control test reports.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - 1. TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
  - 2. FB1-07 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- C. National Fire Protection Association (NFPA):
  - 1. 70-11 National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):

1. 1-05 Flexible Metal Conduit
2. 5-04 Surface Metal Raceway and Fittings
3. 6-07 Rigid Metal Conduit
4. 50-07 Enclosures for Electrical Equipment
5. 360-09 Liquid-Tight Flexible Steel Conduit
6. 467-07 Grounding and Bonding Equipment
7. 514A-04 Metallic Outlet Boxes
8. 514B-04 Fittings for Cable and Conduit
9. 514C-02 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
10. 651-05 Schedule 40 and 80 Rigid PVC Conduit
11. 651A-07 Type EB and A Rigid PVC Conduit and HDPE Conduit
12. 797-07 Electrical Metallic Tubing
13. 1242-06 Intermediate Metal Conduit

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

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

### **2.2 CONDUIT**

- A. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
- B. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
- C. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
- D. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 volts or less.
- E. Flexible galvanized steel conduit: Shall Conform to UL 1.
- F. Liquid-tight flexible metal conduit: Shall Conform to UL 360.
- G. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

### **2.3 WIREWAYS AND RACEWAYS**

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

### **2.4 CONDUIT FITTINGS**

- A. Rigid steel and IMC conduit fittings:
  1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.

3. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
  4. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
  5. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
  6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
- B. Rigid aluminum conduit fittings:
1. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
  2. Locknuts and bushings: As specified for rigid steel and IMC conduit.
  3. Set screw fittings: Not permitted for use with aluminum conduit.
- C. Electrical metallic tubing fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  2. Only steel or malleable iron materials are acceptable.
  3. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
  4. Indent type connectors or couplings are prohibited.
  5. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- D. Flexible steel conduit fittings:
1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
  2. Clamp type, with insulated throat.
- E. Liquid-tight flexible metal conduit fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
  2. Only steel or malleable iron materials are acceptable.
  3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- F. Direct burial plastic conduit fittings:

1. Fittings shall meet the requirements of UL 514C and NEMA TC3.
2. As recommended by the conduit manufacturer.
- G. Surface metal raceway fittings: As recommended by the raceway manufacturer.
- H. Expansion and deflection couplings:
  1. Conform to UL 467 and UL 514B.
  2. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
  3. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
  4. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

## **2.5 CONDUIT SUPPORTS**

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

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

- A. UL-50 and UL-514A.
- B. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Metal Floor Boxes: Cast or sheet metal, semi-adjustable, rectangular.
- E. Sheet metal boxes: Galvanized steel, except where otherwise shown.
- F. Flush mounted wall or ceiling boxes shall be installed with raised covers so that front face of raised cover is flush with the wall. Surface mounted wall or ceiling boxes shall be installed with surface style flat or raised covers.

## **2.7 CABINETS**

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

## 2.8 WIREWAYS

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

## 2.9 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 84 00 "FIRESTOPPING."

## 2.10 SLEEVE SEALS

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

## 2.11 GROUT

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

## PART 3 - EXECUTION

### 3.1 PENETRATIONS

- A. Cutting or Holes:
  - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the COR prior to drilling through structural sections.
  - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the COR as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other electronic safety and security raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.



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

### 3.2 INSTALLATION, GENERAL

A. Install conduit as follows:

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

B. Conduit Bends:

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

C. Layout and Homeruns:

1. Install conduit with wiring, including homeruns, as shown.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COR.

D. Fire Alarm:

1. Fire alarm conduit shall be painted red (a red "top-coated" conduit from the conduit manufacturer may be used in lieu of painted conduit) in accordance with the requirements of Section 28 31 00, "FIRE DETECTION AND ALARM".

### **3.3 CONCEALED WORK INSTALLATION**

#### **A. In Concrete:**

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

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

1. Conduit for conductors above 600 volts:
  - a. Rigid steel or rigid aluminum.
  - b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
2. Conduit for conductors 600 volts and below:
  - a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (6 feet) of flexible metal conduit extending from a junction box to the fixture.
5. Tightening set screws with pliers is prohibited.

### **3.4 EXPOSED WORK INSTALLATION**

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 volts and below:

1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- F. Surface metal raceways: Use only where shown.
- G. Painting:
  1. Paint exposed conduit as specified in Section 09 91 00, "PAINTING".
  2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section 09 91 00, "PAINTING" for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (two inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

### **3.5 EXPANSION JOINTS**

- A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.
- C. Install expansion and deflection couplings where shown.

### **3.6 CONDUIT SUPPORTS, INSTALLATION**

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
  1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
  2. Existing Construction:

- a. Steel expansion anchors not less than 6 mm (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
  - b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
  - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

### **3.7 BOX INSTALLATION**

- A. Boxes for Concealed Conduits:
- 1. Flush mounted.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 600 mm (24 inch), center-to-center lateral spacing shall be maintained between boxes).
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 100 mm (4 inches) square by 55 mm (2-1/8 inches) deep, with device covers for the wall material and thickness involved.
- F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
- G. On all Branch Circuit junction box covers, identify the circuits with black marker.

### **3.8 ELECTRONIC SAFETY AND SECURITY CONDUIT**

- A. Install the electronic safety and security raceway system as shown on drawings.
- B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.

- C. All conduit ends shall be equipped with insulated bushings.
- D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.
- F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.
- G. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.
- H. All empty conduits located in communications closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.
- I. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

| Sizes of Conduit<br>Trade Size | Radius of Conduit Bends<br>mm, Inches |
|--------------------------------|---------------------------------------|
| ¾                              | 150 (6)                               |
| 1                              | 230 (9)                               |
| 1-1/4                          | 350 (14)                              |
| 1-1/2                          | 430 (17)                              |
| 2                              | 525 (21)                              |
| 2-1/2                          | 635 (25)                              |
| 3                              | 775 (31)                              |
| 3-1/2                          | 900 (36)                              |
| 4                              | 1125 (45)                             |

- J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in on the wall of communication closets where shown on drawings. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.
- K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).

**3.9 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 28 08 00 - "COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS" for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 28 08 00, "COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS" and related sections for contractor responsibilities for system commissioning.

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 28.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

**1.2 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**1.3 SUMMARY**

- A. This Section includes requirements for commissioning the Facility electronic safety and security systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

**1.4 DEFINITIONS**

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

**1.5 COMMISSIONED SYSTEMS**

- A. Commissioning of a system or systems specified in Division 28 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 28, is required in cooperation with the VA and the Commissioning Agent.
- B. The Facility exterior closure systems commissioning will include the systems listed in Section 01 19 00 General Commissioning Requirements:

## **1.6 SUBMITTALS**

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

## **PART 2 - PRODUCTS (Not Used)**

## **PART 3 - EXECUTION**

### **3.1 Construction Inspections**

- A. Commissioning of Electronic Safety and Security systems will require inspection of individual elements of the electronic safety and security systems throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 19 00 and the Commissioning plan to schedule electronic safety and security systems inspections as required to support the Commissioning Process.

### **3.2 PRE-FUNCTIONAL CHECKLISTS**

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

### **3.3 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 28 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### **3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING**

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

### **3.5 TRAINING OF VA PERSONNEL**

- A. Training of the VA operation and maintenance personnel is required in cooperation with the COR and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 19 00. The instruction shall be scheduled in coordination with the VA COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 28 Sections for additional Contractor training requirements.

----- END -----



**SECTION 28 13 00**  
**PHYSICAL ACCESS CONTROL SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the finishing, installation, connection, testing and certification of a complete and fully operating Physical Access Control System, hereinafter referred to as the PACS.
- B. This Section includes a Physical Access Control System consisting of a system server, [one or more networked workstation computers,] operating system and application software, and field-installed Controllers connected by a high-speed electronic data transmission network. The PACS shall have the following:
  - 1. Physical Access Control:
    - a. Regulating access through doors
    - b. Anti-passback
    - c. Secondary alarm annunciator
    - d. Credential cards and readers
    - e. Push-button switches
    - f. RS-232 ASCII interface
    - g. Credential creation and credential holder database and management
    - h. Monitoring of field-installed devices
    - i. Reporting
  - 2. Security:
    - a. Video and camera control.
- C. System Architecture:
  - 1. Criticality, operational requirements, and/or limiting points of failure may dictate the development of an enterprise and regional server architecture as opposed to system capacity. Provide server and workstation configurations with all necessary connectors, interfaces and accessories as shown.
- D. PACS shall provide secure and reliable identification of Federal employees and contractors by utilizing credential authentication per FIPS-201.
- E. Physical Access Control System (PACS) shall consist of:
  - 1. Head-End equipment server,
  - 2. One or more networked PC-based workstations,
  - 3. Physical Access Control System and Database Management Software,
  - 4. Credential validation software/hardware,
  - 5. Field installed controllers,
  - 6. PIV Middleware,

7. Card readers,
8. Biometric identification devices,
9. PIV PIV-I cards,
10. Supportive information system,
11. Door locks and sensors,
12. Power supplies,
13. Interfaces with:
  - a. Video Surveillance and Assessment System,
  - b. Gate, turnstile, and traffic arm controls,
  - c. Automatic door operators,
  - d. Intrusion Detection System,
  - e. Intercommunication System
  - f. Building Management System,
  - g. Elevator Controls,
- F. Head-End equipment server, workstations and controllers shall be connected by a high-speed electronic data transmission network.
- G. Information system supporting PACS , Head-End equipment server, workstations, network switches, routers and controllers shall comply with FIPS 200 requirements (Minimum Security Requirements for Federal Information and Information Systems)and NIST Special Publication 800-53 (Recommended Security Controls for Federal Information Systems).
- H. PACS system shall support:
  1. Multiple credential authentication modes,
  2. Bidirectional communication with the reader,
  3. Incident response policy implementation capability; system shall have capability to automatically change access privileges for certain user groups to high security areas in case of incident/emergency.
  4. Visitor management,
- I. All security relevant decisions shall be made on "secure side of the door". Secure side processing shall include;
  1. Challenge/response management,
  2. PKI path discovery and validation,
  3. Credential identifier processing,
  4. Authorization decisions.
- J. For locations where secure side processing is not applicable the tamper switches and certified cryptographic processing shall be provided per FIPS-140-2.
- K. System Software: Based on Lenel central-station, workstation operating system, server operating system, and application software.
- L. Software and controllers shall be capable of matching full 56 bit FASC-N plus minimum of 32 bits of public key certificate data.

M. Systems Networks:

1. A standalone system network shall interconnect all components of the system. This network shall include communications between a central station and any peer or subordinate workstations, enrollment stations, local annunciation stations, portal control stations or redundant central stations.

N. Number of points:

1. PACS shall support multiple autonomous regional servers that can connect to a master command and controller server.
2. Unlimited number of access control readers, unlimited number of inputs or outputs, unlimited number of client workstations, unlimited number of cardholders.
3. Total system solution to enable enterprise-wide, networked, multi-user access to all system resources via a wide range of options for connectivity with the customer's existing LAN and WAN.

O. Network(s) connecting PCs and Controllers shall comply with NIST Special Publication 800-53 (Recommended Security Controls for Federal Information Systems) and consist of one or more of the following:

1. Local area, IEEE 802.3 Fast Ethernet [10 BASE-T] [100 BASE-TX], star topology network based on TCP/IP.
2. Direct-connected, RS-232 cable from the COM port of the Central Station to the first Controller, then RS-485 to interconnect the remainder of the Controllers at that Location.

**1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- C. Section 08 71 00 - DOOR HARDWARE. Requirements for door installation.
- D. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.
- E. Section 26 05 21 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- F. Section 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS. Requirements for infrastructure.
- G. Section 26 56 00 - EXTERIOR LIGHTING. Requirements for perimeter lighting.
- H. Section 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. For general requirements that are common to more than one section in Division 28.
- I. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for conductors and cables.
- J. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for grounding of equipment.
- K. Section 28 05 28.33 - CONDUITS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for infrastructure.

- L. Section 28 23 00 - VIDEO SURVEILLANCE. Requirements for security camera systems.
- M. Section 28 26 00 - ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS). Requirements for emergency and interior communications.
- N. Section 28 31 00 - FIRE DETECTION AND ALARM. Requirements for integration with fire detection and alarm system.

**1.3 QUALITY ASSURANCE**

- A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- B. The Contractor shall be responsible for providing, installing, and the operation of the PACS as shown. The Contractor shall also provide certification as required.
- C. The security system will be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.
- D. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- E. Product Qualifications:
  - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  - 2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- F. Contractor Qualifications:

1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Security Management System's (PACS) manufacturer. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the PACS. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures. The COR reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.
  - a. The Contractor shall provide proof project superintendent with BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.
  - b. Cable installer must have on staff a Registered Communication Distribution Designer (RCDD) certified by Building Industry Consulting Service International. The staff member shall provide consistent oversight of the project cabling throughout design, layout, installation, termination and testing.
- G. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

#### **1.4 SUBMITTALS**

- A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- B. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, Section 02 41 00, DEMOLITION, and Section 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- C. Provide certificates of compliance with Section 1.3, Quality Assurance.

- D. Provide a complete and thorough pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.
- E. Shop drawing and as-built packages shall include, but not be limited to:
1. Index Sheet that shall:
    - a. Define each page of the design package to include facility name, building name, floor, and sheet number.
    - b. Provide a complete list of all security abbreviations and symbols.
    - c. Reference all general notes that are utilized within the design package.
    - d. Specification and scope of work pages for all individual security systems that are applicable to the design package that will:
      - 1) Outline all general and job specific work required within the design package.
      - 2) Provide a detailed device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
  2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
    - a. Include a title block as defined above.
    - b. Clearly define the drawings scale in both standard and metric measurements.
    - c. Provide device identification and location.
    - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
    - e. Identify all pull box and conduit locations, sizes, and fill capacities.
    - f. Address all general and drawing specific notes for a particular drawing sheet.
  3. A detailed riser drawing for each applicable security subsystem shall:
    - a. Indicate the sequence of operation.
    - b. Relationship of integrated components on one diagram.
    - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
    - d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
  4. A detailed system drawing for each applicable security system shall:
    - a. Clearly identify how all equipment within the system, from main panel to device, shall be laid out and connected.

- b. Provide full detail of all system components wiring from point-to-point.
  - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
  - d. Show device locations that correspond to the floor plans.
  - e. All general and drawing specific notes shall be included with the system drawings.
5. A detailed schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
- a. Device ID.
  - b. Device Location (e.g. site, building, floor, room number, location, and description).
  - c. Mounting type (e.g. flush, wall, surface, etc.).
  - d. Power supply or circuit breaker and power panel number.
  - e. In addition, for the PACS, provide the door ID, door type (e.g. wood or metal), locking mechanism (e.g. strike or electromagnetic lock) and control device (e.g. card reader or biometrics).
6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.
- G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per Section 01 00 00, GENERAL REQUIREMENTS, and Section 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- H. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.
- I. General: Submittals shall be in full compliance of the Contract Documents. All submittals shall be provided in accordance with this section. Submittals lacking the breath or depth these requirements will be considered incomplete and rejected. Submissions are considered multidisciplinary and shall require coordination with applicable divisions to provide a complete and comprehensive submission package. Additional general provisions are as follows:
1. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination drawings refer to Specification Section 01 33 10 - DESIGN SUBMITTAL PROCEDURES, which outline basic submittal requirements and coordination. Section 01 33 10 shall be used in conjunction with this section.
  2. The Contractor shall identify variations from requirements of Contract Documents and state product and system limitations, which may be detrimental to successful performance of the completed work or system.

3. Each package shall be submitted at one (1) time for each review and include components from applicable disciplines (e.g., electrical work, architectural finishes, door hardware, etc.) which are required to produce an accurate and detailed depiction of the project.
  4. Manufacturer's information used for submittal shall have pages with items for approval tagged, items on pages shall be identified, and capacities and performance parameters for review shall be clearly marked through use of an arrow or highlighting. Provide space for COR and Contractor review stamps.
  5. Technical Data Drawings shall be provided in .dwg format, drawn accurately, and in accordance with VA CAD Standards. FREEHAND SKETCHES OR COPIED VERSIONS OF THE CONSTRUCTION DOCUMENTS WILL NOT BE ACCEPTED. The Contractor shall not reproduce Contract Documents or copy standard information as the basis of the Technical Data Drawings. If departures from the technical data drawings are subsequently deemed necessary by the Contractor, details of such departures and the reasons thereof shall be submitted in writing to the COR for approval before the initiation of work.
  6. Contractor Review: Review submittals prior to transmittal. Determine and verify field measurements and field construction criteria. Verify manufacturer's catalog numbers and conformance of submittal with requirements of contract documents. Return non-conforming or incomplete submittals with requirements of the work and contract documents. Apply Contractor's stamp with signature certifying the review and verification of products occurred, and the field dimensions, adjacent construction, and coordination of information is in accordance with the requirements of the contract documents.
  7. Resubmission: Revise and resubmit submittals as required within 15 calendar days of return of submittal. Make resubmissions under procedures specified for initial submittals. Identify all changes made since previous submittal.
  8. Product Data: Within 15 calendar days after execution of the contract, the Contractor shall submit for approval a complete list of all of major products proposed for use. The data shall include name of manufacturer, trade name, model number, the associated contract document section number, paragraph number, and the referenced standards for each listed product.
- J. Group III Technical Data Package
1. Development of Test Procedures: The Contractor will prepare performance test procedures for the system testing. The test procedures shall follow the format of the VA Testing procedures and be customized to the contract requirements. The Contractor will deliver the test procedures to the COR for approval at least 60 calendar days prior to the requested test date.
- K. Group IV Technical Data Package
1. Performance Verification Test



- a. Based on the successful completion of the pre-delivery test, the Contractor shall finalize the test procedures and report forms for the performance verification test (PVT) and the endurance test. The PVT shall follow the format, layout and content of the pre-delivery test. The Contractor shall deliver the PVT and endurance test procedures to the COR for approval. The Contractor may schedule the PVT after receiving written approval of the test procedures. The Contractor shall deliver the final PVT and endurance test reports within 14 calendar days from completion of the tests. Refer to Part 3 of this section for System Testing and Acceptance requirements.
2. Training Documentation
3. System Configuration and Data Entry:
  - a. The contractor is responsible for providing all system configuration and data entry for the SMS and subsystems (e.g., video matrix switch, intercom, digital video recorders, network video recorders). All data entry shall be performed per VA standards & guidelines. The Contractor is responsible for participating in all meetings with the client to compile the information needed for data entry. These meetings shall be established at the beginning of the project and incorporated in to the project schedule as a milestone task. The contractor shall be responsible for all data collection, data entry, and system configuration. The contractor shall collect, enter, & program and/or configure the following components:
    - 1) Physical Access control system components,
    - 2) All intrusion detection system components,
    - 3) Video surveillance, control and recording systems,
    - 4) Intercom systems components,
    - 5) All other security subsystems shown in the contract documents.
  - b. The Contractor is responsible for compiling the card access database for the VA employees, including programming reader configurations, access shifts, schedules, exceptions, card classes and card enrollment databases.
  - c. Refer to Part 3 for system programming requirements and planning guidelines.

4. Graphics: Based on CAD as-built drawings developed for the construction project, create all map sets showing locations of all alarms and field devices. Graphical maps of all alarm points installed under this contract including perimeter and exterior alarm points shall be delivered with the system. The Contractor shall create and install all graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the COR, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 203.2 x 254 mm (8 x 10 in) of each type of graphic to be used for the completed Security system. The graphics examples shall be delivered to the COR for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires them.
- L. Group V Technical Data Package: Final copies of the manuals shall be delivered to the COR as part of the acceptance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each sub-contractor installing equipment or systems, as well as the nearest service representatives for each item of equipment for each system. The manuals shall include a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. [Six (6) hard-copies and one (1) soft copy on CD] of each item listed below shall be delivered as a part of final systems acceptance.
1. Functional Design Manual: The functional design manual shall identify the operational requirements for the entire system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. Manufacturer developed literature may be used; however, shall be produced to match the project requirements.
  2. Equipment Manual: A manual describing all equipment furnished including:
    - a. General description and specifications; installation and checkout procedures; equipment electrical schematics and layout drawings; system schematics and layout drawings; alignment and calibration procedures; manufacturer's repair list indicating sources of supply; and interface definition.
  3. Software Manual: The software manual shall describe the functions of all software and include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

- a. Definition of terms and functions; use of system and applications software; procedures for system initialization, start-up, and shutdown; alarm reports; reports generation, database format and data entry requirements; directory of all disk files; and description of all communications protocols including data formats, command characters, and a sample of each type of data transfer.
4. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:
  - a. Computers and peripherals; system start-up and shutdown procedures; use of system, command, and applications software; recovery and restart procedures; graphic alarm presentation; use of report generator and generation of reports; data entry; operator commands' alarm messages, and printing formats; and system access requirements.
5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, recommend schedules, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
6. Spare Parts & Components Data: At the conclusion of the Contractor's work, the Contractor shall submit to the COR a complete list of the manufacturer's recommended spare parts and components required to satisfactorily maintain and service the systems, as well as unit pricing for those parts and components.
7. Operation, Maintenance & Service Manuals: The Contractor shall provide two (2) complete sets of operating and maintenance manuals in the form of an instructional manual for use by the VA Security Guard Force personnel. The manuals shall be organized into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder. If multiple volumes are required, each volume shall be fully indexed and coordinated.
8. Equipment and Systems Maintenance Manual: The Contractor shall provide the following descriptive information for each piece of equipment, operating system, and electronic system:
  - a. Equipment and/or system function.
  - b. Operating characteristics.
  - c. Limiting conditions.
  - d. Performance curves.
  - e. Engineering data and test.
  - f. Complete nomenclature and number of replacement parts.
  - g. Provide operating and maintenance instructions including assembly drawings and diagrams required for maintenance and a list of items recommended to stock as spare parts.
  - h. Provide information detailing essential maintenance procedures including the following: routine operations, trouble shooting guide, disassembly, repair and re-assembly, alignment, adjusting, and checking.

- i. Provide information on equipment and system operating procedures, including the following; start-up procedures, routine and normal operating instructions, regulation and control procedures, instructions on stopping, shut-down and emergency instructions, required sequences for electric and electronic systems, and special operating instructions.
    - j. Manufacturer equipment and systems maintenance manuals are permissible.
9. Project Redlines: During construction, the Contractor shall maintain an up-to-date set of construction redlines detailing current location and configuration of the project components. The redline documents shall be marked with the words 'Master Redlines' on the cover sheet and be maintained by the Contractor in the project office. The Contractor will provide access to redline documents anytime during the project for review and inspection by the COR or authorized Office of Protection Services representative. Master redlines shall be neatly maintained throughout the project and secured under lock and key in the contractor's onsite project office. Any project component or assembly that is not installed in strict accordance with the drawings shall be so noted on the drawings. Prior to producing Record Construction Documents, the contractor will submit the Master Redline document to the COR for review and approval of all changes or modifications to the documents. Each sheet shall have COR initials indicating authorization to produce "As Built" documents. Field drawings shall be used for data gathering & field changes. These changes shall be made to the master redline documents daily. Field drawings shall not be considered "master redlines".
10. Record Specifications: The Contractor shall maintain one (1) copy of the Project Specifications, including addenda and modifications issued, for Project Record Documents. The Contractor shall mark the Specifications to indicate the actual installation where the installation varies substantially from that indicated in the Contract Specifications and modifications issued. (Note related Project Record Drawing information where applicable). The Contractor shall pay particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later. Upon completion of the mark ups, the Contractor shall submit record Specifications to the COR. As with master relines, Contractor shall maintain record specifications for COR review and inspection at anytime.
11. Record Product Data: The Contractor shall maintain one (1) copy of each Product Data submittal for Project Record Document purposes. The Data shall be marked to indicate the actual product installed where the installation varies substantially from that indicated in the Product Data submitted. Significant changes in the product delivered to the site and changes in manufacturer's instructions and recommendations for installation shall be included. Particular attention will be given to information on concealed products and installations that cannot be readily identified or recorded later. Note related Change Orders and mark up of Record Construction Documents, where applicable. Upon completion of mark up, submit a complete set of Record Product Data to the COR.

12. Miscellaneous Records: The Contractor shall maintain one (1) copy of miscellaneous records for Project Record Document purposes. Refer to other Specifications for miscellaneous record-keeping requirements and submittals concerning various construction activities. Before substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Categories of requirements resulting in miscellaneous records include, a minimum of the following:
  - a. Certificates received instead of labels on bulk products.
  - b. Testing and qualification of tradesmen. ("Contractor's Qualifications")
  - c. Documented qualification of installation firms.
  - d. Load and performance testing.
  - e. Inspections and certifications.
  - f. Final inspection and correction procedures.
  - g. Project schedule
13. Record Construction Documents (Record As-Built)
  - a. Upon project completion, the contractor shall submit the project master redlines to the COR prior to development of Record construction documents. The COR shall be given a minimum of a thirty (30) day review period to determine the adequacy of the master redlines. If the master redlines are found suitable by the COR, the COR will initial and date each sheet and turn redlines over to the contractor for as built development.
  - b. The Contractor shall provide the COR a complete set of "as-built" drawings and original master redlined marked "as-built" blue-line in the latest version of AutoCAD drawings unlocked on CD or DVD. The as-built drawing shall include security device number, security closet connection location, data gathering panel number, and input or output number as applicable. All corrective notations made by the Contractor shall be legible when submitted to the COR. If, in the opinion of the COR, any redlined notation is not legible, it shall be returned to the Contractor for re-submission at no extra cost to the Owner. The Contractor shall organize the Record Drawing sheets into manageable sets bound with durable paper cover sheets with suitable titles, dates, and other identifications printed on the cover. The submitted as built shall be in editable formats and the ownership of the drawings shall be fully relinquished to the owner.

c. Where feasible, the individual or entity that obtained record data, whether the individual or entity is the installer, sub-contractor, or similar entity, is required to prepare the mark up on Record Drawings. Accurately record the information in a comprehensive drawing technique. Record the data when possible after it has been obtained. For concealed installations, record and check the mark up before concealment. At the time of substantial completion, submit the Record Construction Documents to the COR. The Contractor shall organize into bound and labeled sets for the COR's continued usage. Provide device, conduit, and cable lengths on the conduit drawings. Exact in-field conduit placement/routings shall be shown. All conduits shall be illustrated in their entire length from termination in security closets; no arrowed conduit runs shall be shown. Pull box and junction box sizes are to be shown if larger than 100mm (4 inch).

M. FIPS 201 Compliance Certificates

1. Provide Certificates for all software components and device types utilizing credential verification. Provide certificates for:

- a. Card Readers
- b. Facial Image Capturing Camera
- c. PIV Middleware
- d. Template Matcher
- e. Certificate Management
  - 1) CAK Authentication System
  - 2) PIV Authentication System
  - 3) Certificate Validator
  - 4) Cryptographic Module

N. Approvals will be based on complete submission of manuals together with shop drawings.

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

**1.5 APPLICABLE PUBLICATIONS**

A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1

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

C. American National Standards Institute (ANSI)/ Security Industry Association (SIA):

1. AC-03 Access Control: Access Control Guideline Dye Sublimation Printing Practices for PVC Access Control Cards

2. TVAC-01 CCTV to Access Control Standard - Message Set for System Integration
- D. American National Standards Institute (ANSI)/ International Code Council (ICC):
  1. A117.1 Standard on Accessible and Usable Buildings and Facilities
- E. Department of Justice American Disability Act (ADA)
  1. 28 CFR Part 36 ADA Standards for Accessible Design 2010
- F. Department of Veterans Affairs (VA):
  1. PACS-R: Physical Access Control System (PACS) Requirements
  2. VA Handbook 0730 Security and Law Enforcement
- G. Government Accountability Office (GAO):
  1. GAO-03-8-02 Security Responsibilities for Federally Owned and Leased Facilities
- H. National Electrical Contractors Association
  1. 303-2005 Installing Closed Circuit Television (CCTV) Systems
- I. National Electrical Manufacturers Association (NEMA):
  1. 250-08 Enclosures for Electrical Equipment (1000 Volts Maximum)
- J. National Fire Protection Association (NFPA):
  1. 70-11 National Electrical Code
- K. Underwriters Laboratories, Inc. (UL):
  1. 294-99 The Standard of Safety for Access Control System Units
  2. 305-08 Standard for Panic Hardware
  3. 639-97 Standard for Intrusion-Detection Units
  4. 752-05 Standard for Bullet-Resisting Equipment
  5. 827-08 Central Station Alarm Services
  6. 1076-95 Standards for Proprietary Burglar Alarm Units and Systems
  7. 1981-03 Central Station Automation System
  8. 2058-05 High Security Electronic Locks
- L. Homeland Security Presidential Directive (HSPD):
  1. HSPD-12 Policy for a Common Identification Standard for Federal Employees and Contractors
- M. Federal Communications Commission (FCC):
  1. (47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems
- N. Federal Information Processing Standards (FIPS):
  1. FIPS-201-1 Personal Identity Verification (PIV) of Federal Employees and Contractors
- O. National Institute of Standards and Technology (NIST):

1. IR 6887 V2.1 Government Smart Card Interoperability Specification (GSC-IS)
  2. Special Pub 800-63 Electronic Authentication Guideline
  3. Special Pub 800-96 PIV Card Reader Interoperability Guidelines
  4. Special Pub 800-73-3 Interfaces for Personal Identity Verification (4 Parts)
  5. Pt. 1- End Point PIV Card Application Namespace, Data Model & Representation
  6. Pt. 2- PIV Card Application Card Command Interface
  7. Pt. 3- PIV Client Application Programming Interface
  8. Pt. 4- The PIV Transitional Interfaces & Data Model Specification
  9. Special Pub 800-76-1 Biometric Data Specification for Personal Identity Verification
  10. Special Pub 800-78-2 Cryptographic Algorithms and Key Sizes for Personal Identity Verification
  11. Special Pub 800-79-1 Guidelines for the Accreditation of Personal Identity Verification Card Issuers
  12. Special Pub 800-85B-1 DRAFTPIV Data Model Test Guidelines
  13. Special Pub 800-85A-2 PIV Card Application and Middleware Interface Test Guidelines (SP 800-73-3 compliance)
  14. Special Pub 800-96 PIV Card Reader Interoperability Guidelines
  15. Special Pub 800-37 Guide for Applying the Risk Management Framework to Federal Information Systems
  16. Special Pub 800-96 PIV Card Reader Interoperability Guidelines
  17. Special Pub 800-96 PIV Card Reader Interoperability Guidelines
  18. Special Pub 800-104A Scheme for PIV Visual Card Topography
  19. Special Pub 800-116 Recommendation for the Use of PIV Credentials in Physical Access Control Systems (PACS)
- P. Institute of Electrical and Electronics Engineers (IEEE):
1. C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
- Q. International Organization for Standardization (ISO):
1. 7810 Identification cards - Physical characteristics
  2. 7811 Physical Characteristics for Magnetic Stripe Cards
  3. 7816-1 Identification cards - Integrated circuit(s) cards with contacts - Part 1: Physical characteristics
  4. 7816-2 Identification cards - Integrated circuit cards - Part 2: Cards with contacts -Dimensions and location of the contacts
  5. 7816-3 Identification cards - Integrated circuit cards - Part 3: Cards with contacts - Electrical interface and transmission protocols
  6. 7816-4 Identification cards - Integrated circuit cards - Part 11: Personal verification through biometric methods



7. 7816-10 Identification cards - Integrated circuit cards - Part 4: Organization, security and commands for interchange
  8. 14443 Identification cards - Contactless integrated circuit cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 inches distance
  9. 15693 Identification cards -- Contactless integrated circuit cards - Vicinity cards; Contactless Vicinity Cards Operating at 13.56 MHz in up to 50 inches distance
  10. 19794 Information technology - Biometric data interchange formats
- R. Uniform Federal Accessibility Standards (UFAS) 1984
- S. ADA Standards for Accessible Design 2010
- T. Section 508 of the Rehabilitation Act of 1973

#### 1.6 DEFINITIONS

- A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- B. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.
- C. Access Control List: A list of (identifier, permissions) pairs associated with a resource or an asset. As an expression of security policy, a person may perform an operation on a resource or asset if and only if the person's identifier is present in the access control list (explicitly or implicitly), and the permissions in the (identifier, permissions) pair include the permission to perform the requested operation.
- D. Access Control: A function or a system that restricts access to authorized persons only.
- E. API Application Programming Interface
- F. Assurance Level (or E-Authentication Assurance Level): A measure of trust or confidence in an authentication mechanism defined in OMB Memorandum M-04-04 and NIST Special Publication (SP) 800-63, in terms of four levels: [M-04-04]
1. Level 1: LITTLE OR NO confidence
  2. Level 2: SOME confidence
  3. Level 3: HIGH confidence
  4. Level 4: VERY HIGH confidence
- G. Authentication: A process that establishes the origin of information, or determines an entity's identity. In this publication, authentication often means the performance of a PIV authentication mechanism.
- H. Authenticator: A memory, possession, or quality of a person that can serve as proof of identity, when presented to a verifier of the appropriate kind. For example, passwords, cryptographic keys, and fingerprints are authenticators.
- I. Authorization: A process that associates permission to access a resource or asset with a person and the person's identifier(s).

- J. BIO or BIO-A: A FIPS 201 authentication mechanism that is implemented by using a Fingerprint data object sent from the PIV Card to the PACS. Note that the short-hand "BIO (-A)" is used throughout the document to represent both BIO and BIO-A authentication mechanisms.
- K. Biometric: An authenticator produced from measurable qualities of a living person.
- L. CAC EP - CAC End Point with end point PIV applet
- M. CAC NG - CAC Next Generation with transitional PIV applet
- N. Card Authentication Key (CAK): A PIV authentication mechanism (or the PIV Card key of the same name) that is implemented by an asymmetric or symmetric key challenge/response protocol. The CAK is an optional mechanism defined in NIST SP 800-73. [SP800-73] NIST strongly recommends that every PIV Card contain an asymmetric CAK and corresponding certificate, and that agencies use the asymmetric CAK protocol, rather than a symmetric CAK protocol, whenever the CAK authentication mechanism is used with PACS.
- O. CCTV: Closed-circuit television.
- P. Central Station: A PC with software designated as the main controlling PC of the PACS. Where this term is presented with initial capital letters, this definition applies.
- Q. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.
- R. CPU: Central processing unit.
- S. Credential: Data assigned to an entity and used to identify that entity.
- T. File Server: A PC in a network that stores the programs and data files shared by users.
- U. FIPS Federal Information Processing Standards
- V. FRAC - First Responder Authentication Credential
- W. HSPD Homeland Security Presidential Directive
- X. I/O: Input/Output.
- Y. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- Z. IEC International Electrotechnical Commission
- AA. ISO International Organization for Standardization
- BB. KB Kilobyte
- CC. kbit/s Kilobits / second
- DD. LAN: Local area network.
- EE. LED: Light-emitting diode.
- FF. Legacy CAC - Contact only Common Access Card with v1 and v2 applets

- GG. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.
- HH. NIST: National Institute of Standards and Technology
- II. PACS: Physical Access Control System
- JJ. PC/SC: Personal Computer / Smart Card
- KK. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.
- LL. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).
- MM. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.
- NN. PIV: Personal Identification Verification
- OO. PIV-I - PIV Interoperable credential
- PP. PPS: Protocol and Parameters Selection
- QQ. RF: Radio frequency.
- RR. ROM: Read-only memory. ROM data are maintained through losses of power.
- SS. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- TT. RS-485: An TIA/EIA standard for multipoint communications.
- UU. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- VV. TPDU: Transport Protocol Data Unit
- WW. TWIC - Transportation Worker Identification Credential
- XX. UPS: Uninterruptible power supply.
- YY. Vcc: Voltage at the Common Collector
- ZZ. WAN: Wide area network.
- AAA. WAV: The digital audio format used in Microsoft Windows.
- BBB. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- CCC. Windows: Operating system by Microsoft Corporation.
- DDD. Workstation: A PC with software that is configured for specific limited security system functions.

#### 1.7 COORDINATION

- A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1

- B. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- D. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed.

**1.8 MAINTENANCE & SERVICE**

- A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- B. General Requirements
  - 1. The Contractor shall provide all services required and equipment necessary to maintain the entire integrated electronic security system in an operational state as specified for a period of one (1) year after formal written acceptance of the system. The Contractor shall provide all necessary material required for performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. See also General Project Requirements.
- C. Description of Work
  - 1. The adjustment and repair of the security system includes all software updates, panel firmware, and the following new items computers equipment, communications transmission equipment and data transmission media (DTM), local processors, security system sensors, physical access control equipment, facility interface, signal transmission equipment, and video equipment.
- D. Personnel
  - 1. Service personnel shall be certified in the maintenance and repair of the selected type of equipment and qualified to accomplish all work promptly and satisfactorily. The COR shall be advised in writing of the name of the designated service representative, and of any change in personnel. The COR shall be provided copies of system manufacturer certification for the designated service representative.
- E. Schedule of Work
  - 1. The work shall be performed during regular working hours, Monday through Friday, excluding federal holidays. These inspections shall include:

- a. The Contractor shall perform two (2) minor inspections at six (6) month intervals or more if required by the manufacturer, and two (2) major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
  - 1) Minor Inspections shall include visual checks and operational tests of all console equipment, peripheral equipment, local processors, sensors, electrical and mechanical controls, and adjustments on printers.
  - 2) Major Inspections shall include all work described for Minor Inspections and the following: clean all system equipment and local processors including interior and exterior surfaces; perform diagnostics on all equipment; operational tests of the CPU, switcher, peripheral equipment, recording devices, monitors, picture quality from each camera; check, walk test, and calibrate each sensor; run all system software diagnostics and correct all problems; and resolve any previous outstanding problems.

F. Emergency Service

1. The owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. The Owner shall have sole authority for determining catastrophic and non-catastrophic system failures within parameters stated in General Project Requirements.
  - a. For catastrophic system failures, the Contractor shall provide same day four (4) hour service response with a defect correction time not to exceed eight (8) hours from [notification][arrival on site]. Catastrophic system failures are defined as any system failure that the Owner determines will place the facility(s) at increased risk.
  - b. For non-catastrophic failures, the Contractor within eight (8) hours with a defect correction time not to exceed 24 hours from notification.

G. Operation

1. Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable portions of the performance verification test.

H. Records & Logs

1. The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

I. Work Request

1. The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall deliver a record of the work performed within five (5) working days after the work was completed.

J. System Modifications

1. The Contractor shall make any recommendations for system modification in writing to the COR. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the COR. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and other documentation affected.

K. Software

1. The Contractor shall provide all software updates when approved by the Owner from the manufacturer during the installation and 12-month warranty period and verify operation of the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the operations and maintenance manuals and software documentation. There shall be at least one (1) scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software. All software changes shall be recorded in a log maintained in the unit control room. An electronic copy of the software update shall be maintained within the log. At a minimum, the contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "SOFTWARE CHANGE LOG".

**1.9 EQUIPMENT AND MATERIALS**

- A. Refer to 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY, Part 1
- B. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- C. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- D. 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.
- E. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- F. When Factory Testing Is Specified:
  1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the COR a minimum of 15 working days prior to the manufacturers making the factory tests.
  2. Four copies of certified test reports containing all test data shall be furnished to the COR prior to final inspection and not more than 90 days after completion of the tests.
  3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

**1.10 WARRANTY OF CONSTRUCTION.**

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

**1.11 GENERAL REQUIREMENTS**

- A. For general requirements that are common to more than one section in Division 28 refer to Section 28 05 00, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.
- B. General requirements applicable to this section include:
  1. General Arrangement Of Contract Documents,
  2. Delivery, Handling and Storage,
  3. Project Conditions,
  4. Electrical Power,
  5. Lightning, Power Surge Suppression, and Grounding,
  6. Electronic Components,
  7. Substitute Materials and Equipment, and
  8. Like Items.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. All equipment and materials for the system will be compatible to ensure correct operation as outlined in FIPS 201, March 2006 and HSPD-12.
- B. The security system characteristics listed in this section will serve as a guide in selection of equipment and materials for the PACS. If updated or more suitable versions are available then the Contracting Officer will approve the acceptance of prior to an installation.
- C. PACS equipment shall meet or exceed all requirements listed below.
- D. A PACS shall be comprised of, but not limited to, the following components:

1. Physical Access Control System
2. Application Software
3. System Database
4. Surge and Tamper Protection
5. Standard Workstation Hardware
6. Communications Workstation
7. Controllers (Data Gathering Panel)
8. Secondary Alarm Annunciator
9. Keypads
10. Card Readers
11. Credential Cards
12. Biometric Identity Verification Equipment
13. Enrolment Center (To be provided in accordance with the VA PIV enrollment and issuance system.)
14. System Sensors and Related Equipment
15. Push Button Switches
16. Interfaces
17. Door and Gate Hardware interface
18. RS-232 ASCII Interface
19. Floor Select Elevator Control
20. After-Hours HVAC Control
21. Real Time Guard Tour
22. Video and Camera Control
23. Cables
24. Transformers

## **2.2 CONTROLLERS**

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the Central Station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this Article, manufacturers may use multipurpose Controllers.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
- D. Entry-Control Controller:
  1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personal identity verification devices, door strikes, magnetic latches, gate and door operators, and exit push-buttons.



- a. Operate as a stand-alone portal Controller using the downloaded database during periods of communication loss between the Controller and the field-device network.
  - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
    - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
    - 2) Privileges shall include, but not be limited to, time of day control, day of week control, group control, and visitor escort control.
  - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
2. Inputs:
- a. Data from entry-control devices; use this input to change modes between access and secure.
  - b. Database downloads and updates from the Central Station that include enrollment and privilege information.
3. Outputs:
- a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
  - b. Grant or deny entry by sending control signals to portal-control devices [and mask intrusion alarm annunciation from sensors stimulated by authorized entries].
  - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the Central Station.
  - d. Door Prop Alarm: If a portal is held open for longer than 20 seconds, alarm sounds.
4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communications with Central Station, or when data transmission is degraded and generating continuous checksum errors, the Controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
- a. Store up to 1000 transactions during periods of communication loss between the Controller and access-control devices for subsequent upload to the Central Station on restoration of communication.
6. Controller Power: NFPA 70, Class II power supply transformer, with 12- or 24-V ac secondary, backup battery and charger.

- a. Backup Battery: Premium, valve-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full 1-year warranty and a pro rata 19-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
- b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
- c. Backup Power Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.
- d. Power Monitoring: Provide manual dynamic battery load test, initiated and monitored at the control center; with automatic disconnection of the Controller when battery voltage drops below Controller limits. Report by using local Controller-mounted LEDs and by communicating status to Central Station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
  - 1) Trouble Alarm: Normal power off load assumed by battery.
  - 2) Trouble Alarm: Low battery.
  - 3) Alarm: Power off.

### **2.3 CARD READERS**

- A. Power: Card reader shall be powered from its associated Controller, including its standby power source.
- B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the Controller. Response time shall be 800ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
- C. Enclosure: Suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:
  1. Indoors, controlled environment.
  2. Indoors, uncontrolled environment.
  3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.
- D. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power on/off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- E. Shall be utilized for controlling the locking hardware on a door and allows for reporting back to the main control panel with the time/date the door was accessed, the name of the person accessing the point of entry, and its location.

- F. Will be fully programmable and addressable, locally and remotely, and hardwired to the system.
- G. Shall be individually home run to the main panel.
- H. Shall be installed in a manner that they comply with:
  - 1. The Uniform Federal Accessibility Standards (UFAS)
  - 2. The Americans with Disabilities Act (ADA)
  - 3. The ADA Standards for Accessible Design
- I. Shall support a variety of card readers that must encompass a wide functional range. The PACS may combine any of the card readers described below for installations requiring multiple types of card reader capability (i.e., card only, card and/or PIN, card and/or biometrics, card and/or pin and/or biometrics, supervised inputs, etc.). These card readers shall be available in the approved technology to meet FIPS 201, and is ISO 14443 A or B, ISO/IEC 7816 compliant. The reader output can be Wiegand, RS-22, 485 or TCP/IP.
- J. Shall be housed in an aluminum bezel with a wide lead-in for easy card entry.
- K. Shall contain read head electronics, and a sender to encode digital door control signals.
- L. LED's shall be utilized to indicate card reader status and access status.
- M. Shall be able to support a user defined downloadable off-line mode of operation (e.g. locked, unlocked), which will go in effect during loss of communication with the main control panel.
- N. Shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two audible tones or beeps shall indicate access granted and three tones or beeps shall indicate access denied. All keypad buttons shall provide tactile audible feedback.
- O. Shall have a minimum of two programmable inputs and two programmable outputs.
- P. All card readers that utilize keypad controls along with a reader and shall meet the following specifications:
  - 1. Entry control keypads shall use a unique combination of alphanumeric and other symbols as an identifier. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII code ordinal sequence. Communications protocol shall be compatible with the local processor.
- Q. Shall include a Light Emitting Diode (LED) or other type of visual indicator display and provide visual or visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected. The design of the keypad display or keypad enclosure shall limit the maximum horizontal and vertical viewing angles of the keypad. The maximum horizontal viewing angle shall be plus and minus five (5) degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle shall be plus and minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.
  - 1. Shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.

2. Shall be powered from the source as designed and shall not dissipate more than 150 Watts.
3. Shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
4. Shall provide a means for users to indicate a duress situation by entering a special code.

R. PIV Contact Card Reader

1. Application Protocol Data Unit (APDU) Support: At a minimum, the contact interface shall support all card commands for contact based access specified in Section 7, End-point PIV Card Application Card Command Interface of SP 800-73-1, Interfaces for Personal Identity Verification.
2. Buffer Size: The reader must contain a buffer large enough to receive the maximum size frame permitted by International Organization for Standardization International Electrotechnical Commission (ISO/IEC) 7816-3:1997, Section 9.4.
3. Programming Voltage: PIV Readers shall not generate a Programming Voltage.
4. Support for Operating Class: PIV Readers shall support cards with Class A Vccs as defined in ISO/IEC 7816-3:1997 and ISO/IEC 7816-3:1997/Amd 1:2002.
5. Retrieval Time: Retrieval time<sup>1</sup> for 12.5 kilobytes (KB) of data through the contact interface of the reader shall not exceed 2.0 seconds.
6. Transmission Protocol: The PIV Reader shall support both the character-based T=0 protocol and block-based T=1 protocol as defined in ISO/IEC 7816-3:1997.
7. Support for PPS Procedure: The reader shall support Protocol and Parameters Selection (PPS) procedure by having the ability to read character TA1 of the Answer to Reset (ATR) sent by the card as defined in ISO/IEC 7816-3:1997.

S. Contactless Smart Cards and Readers

1. Smart card readers shall read credential cards whose characteristics of size and technology meet those defined by ISO/IEC 7816, 14443, 15693.
2. The readers shall have "flash" download capability to accommodate card format changes.
3. The card reader shall have the capability of reading the card data and transmitting the data to the main monitoring panel.
4. The card reader shall be contactless and meet or exceed the following technical characteristics:
  - a. Data Output Formats: FIPS 201 low outputs the FASC-N in an assortment of Wiegand bit formats from 40 - 200 bits. FIPS 201 medium outputs a combination FASC-N and HMAC in an assortment of Wiegand bit formats from 32 - 232 bits. All Wiegand formats or the upgradeability from Low to Medium Levels can be field configured with the use of a command card.
  - b. FIPS 201 readers shall be able to read, but not be limited to, DESfire and iCLASS cards.

- c. Reader range shall comply with ISO standards 7816, 14443, and 15693, and also take into consideration conditions, are at a minimum 1" to 2" (2.5 - 5 cm).
- d. APDU Support: At a minimum, the contactless interface shall support all card commands for contactless based access specified in Section 7, End-point PIV Card Application Card Command Interface of SP 800-73-1, Interfaces for Personal Identity Verification.
- e. Buffer Size: The reader shall contain a buffer large enough to receive the maximum size frame permitted by ISO/IEC 7816-3, Section 9.4.
- f. ISO 14443 Support: The PIV Reader shall support parts (1 through 4) of ISO/IEC 14443 as amended in the References of this publication.
- g. Type A and B Communication Signal Interfaces: The contactless interface of the reader shall support both the Type A and Type B communication signal interfaces as defined in ISO/IEC 14443-2:2001.
- h. Type A and B Initialization and Anti-Collision The contactless interface of the reader shall support both Type A and Type B initialization and anti-collision methods as defined in ISO/IEC 14443-3:2001.
- i. Type A and B Transmission Protocols: The contactless interface of the reader shall support both Type A and Type B transmission protocols as defined in ISO/IEC 14443-4:2001.
- j. Retrieval Time: Retrieval time for 4 KB of data through the contactless interface of the reader shall not exceed 2.0 seconds.
- k. Transmission Speeds: The contactless interface of the reader shall support bit rates of fc/128 (~106 kbits/s), fc/64(~212 kbits/s), and configurable to allow activation/deactivation.
- l. Readability Range: The reader shall not be able to read PIV card more than 10cm(4inch) from the reader

#### 2.4 CREDENTIAL CARDS

- A. Personal Identity Verification (PIV) credential cards shall comply to Federal Information Processing Standards Publication (FIPS) 201.
- B. Visual Card Topography shall be compliant with NIST 800-104.
- C. PIV logical credentials shall contain multiple data elements for the purpose of verifying the cardholder's identity at graduated assurance levels. These mandatory data elements shall collectively comprise the data model for PIV logical credentials, and include the following:
  - 1. CHUID
  - 2. PIN
  - 3. PIV authentication data (one asymmetric key pair and corresponding certificate)
  - 4. + Two biometric fingerprints.
- D. The credential card (PIV) shall be an ISO 14443 type smart card with contactless interface that operates at 13.56 MHZ.
- E. The credential card (PIV) shall be an ISO 7816 type smart card.

## 2.5 PORTAL CONTROL DEVICES

- A. Shall be used to assist the PACS.
- B. Such devices shall:
  - 1. Provide a means of monitoring the doors status.
  - 2. Allow for exiting a space via either a push button, request to exit, or panic/crash bar.
  - 3. Provide a means of override to the PACS via a keypad or key bypass.
  - 4. Assist door operations utilizing automatic openers and closures.
  - 5. Provide a secondary means of access to a space via a keypad.
- C. Shall be connected to and monitored by the main PACS panel.
- D. Shall be installed in a manner that they comply with:
  - 1. The Uniform Federal Accessibility Standards (UFAS)
  - 2. The Americans with Disabilities Act (ADA)
  - 3. The ADA Standards for Accessible Design
- E. Shall provide a secondary means of physical access control within a secure area.
- F. Push-Button Switches:
  - 1. Shall be momentary contact, back lighted push buttons, and stainless steel switch enclosures for each push button as shown. Buttons are to be utilized for secondary means of releasing a locking mechanism.
    - a. In an area where a push button is being utilized for remote access of the locking device then no more than two (2) buttons shall operate one door from within one secure space. Buttons will not be wired in series with one other.
    - b. In an area where locally stationed guards control entry to multiple secure points via remote switches. An interface board shall be designed and constructed for only the amount of buttons it shall house. These buttons shall be flush mounted and clearly labeled for ease of use. All buttons shall be connected to the PACS and SMS system for monitoring purposes.
    - c. Shall have double-break silver contacts that will make 720 VA at 60 amperes and break 720 VA at 10 amperes.
- G. Entry Control Devices:
  - 1. Shall be hardwired to the PACS main control panel and operated by either a card reader or a biometric device via a relay on the main control panel.
  - 2. Shall be fail-safe in the event of power failure to the PACS system.
  - 3. Shall operate at 24 VCD, with the exception of turnstiles and be powered by a separate power supply dedicated to the door control system. Each power supply shall be rated to operate a minimum of two doors simultaneously without error to the system or overload the power supply unit.
  - 4. Shall have a diode or metal-oxide varistor (MOV) to protect the controller and power supply from reverse current surges or back-check.

- 5. Electric Strikes/Bolts: Shall be:
  - a. Made of heavy-duty construction and tamper resistant design.
  - b. Tested to over one million cycles.
  - c. Rated for a minimum of 1000 lbs. holding strength.
  - d. Utilize an actuating solenoid for the strike/bolt. The solenoid shall move from fully open to fully closed position and back in not more than 500 milliseconds and be rated for continuous duty.
  - e. Utilize a signal switch that will indicate to the system if the strike/bolt is not engaged or is unlocked when it should be secured.
  - f. Flush mounted within the door frame.
- 6. Electric Mortise Locks: Shall be installed within the door and an electric transfer hinge shall be utilized to allow the wires to be transferred from the door frame to the lock. If utilized with a double door then the lock shall be installed inside the active leaf. Electric Mortise Locks shall:
  - a. Have integrated Request to Exit switch for doors receiving physical access control devices.
  - b. Provide integration of the Electric Mortise Locks with the PACS for:
    - 1) Lock Power
    - 2) Request to Exit switch.
- 7. Electromagnetic Locks:
  - a. These locks shall be without mechanical linkage utilizing no moving parts, and securing the door to its frame solely on electromagnetic force.
  - b. Shall be comprised of two pieces, the mag-lock and the door plate. The electromagnetic locks shall be surface mounted to the door frame and the door plate shall be surface mounted to the door.
  - c. Ensure a diode is installed in line with the DC voltage supplying power to the unit in order to prevent back-check on the system when the electromagnetic lock is powered.
  - d. Shall utilize a magnetic bonding sensor (MBS) to monitor the door status and report that status to the SMS.
  - e. Electromagnetic locks shall meet the following minimum technical characteristics:

|                   |               |                   |
|-------------------|---------------|-------------------|
| Operating Voltage |               | 24 VDC            |
| Current Draw      |               | .5A               |
| Holding Force     | Swing Doors   | 675 kg (1500 lbs) |
|                   | Sliding Doors | 225 kg (500 lbs)  |

## 2.6 INTERFACES

### A. CCTV System Interface

1. An RS232 Ethernet interface associated driver, and controller shall be provided for connection of the SMS Central Computer to the CCTV Alarm interface and switcher. The interface shall provide alarm data to the CCTV Alarm interface for automatic camera call-up. If required the Security Contractor shall be responsible for programming the command strings into the SMS Server.

B. Intercom System Interface

1. The CCTV call-up from intercom stations shall be through the intercom unit via RS232 Ethernet communications interface to the SMS system, then through the matrix switcher.

a. Application Software

- 1) Provides the interface between the Alarm Annunciation System and Operator; all sensors, local processors and data links, drive displays, report alarms, and report generation.
- 2) Software is categorized as System Software and Application Software. System Software must consist of software to support set-up, operation, hard drive back-ups and maintenance processor. Application Software must consist of software to provide the completion of Physical Access Control System.

C. Power Supplies:

1. Shall be UL rated and able to adequately power (enter number) entry control devices on a continuous base without failure.
2. Shall meet the following minimum technical characteristics:

a. PACS System Enclosure Power Supply

|                   |   |
|-------------------|---|
| INPUT POWER       | 110 VAC 60 HZ (enter amperage)A                         |
| OUTPUT VOLTAGE    | 12 VDC Nominal (13.8 VDC)<br><br>Filtered and Regulated |
| BATTERY           | Dependant on Output Voltage shall provide up to 7 Ah    |
| OUTPUT CURRENT    | 5 [amp max.] [@ 13.8] VDC                               |
| PRIMARY FUSE SIZE | sized by manufacturer (non-removable)                   |
| BATTERY FUSE SIZE | sized by manufacturer, 3AG                              |
| CHARGING CIRCUIT  | Built-in standard                                       |

b. Door Hardware Power Supply

|                   |   |
|-------------------|---|
| INPUT POWER       | 110 VAC 60 HZ (enter amperage)A                         |
| OUTPUT VOLTAGE    | 24 VDC Nominal (27.6 VDC)<br><br>Filtered and Regulated |
| BATTERY           | Dependant on Output Voltage shall provide up to 40 Ah   |
| OUTPUT CURRENT    | 6 [amp max.] [@ 27.6] VDC<br>Total of (8) fused outputs |
| PRIMARY FUSE SIZE | sized by manufacturer                                   |



|                   |                            |
|-------------------|----------------------------|
|                   | (non-removable)            |
| BATTERY FUSE SIZE | sized by manufacturer, 3AG |
| CHARGING CIRCUIT  | Built-in standard          |

**2.7 WIRES AND CABLES**

- A. Refer to section 28 05 13 "CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY".
- B. RS-485 communications require 2 twisted pairs, with a distance limitation of 4000 feet (1220 m).
- C. Plenum-Type, Multiconductor, Access Control Cable: 12 twisted shield pair conductors, No. 18 AWG, stranded tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
  - 1. NFPA 70, Type CMP.
  - 2. Flame Resistance: NFPA 262 Flame Test.
- D. LAN (Ethernet) Cabling: Comply with Division 28 Section "Conductors and Cables for Electronic Safety and Security."

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. The Contractor shall install all system components and appurtenances in accordance with the manufacturers' instructions, ANSI C2, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.
- B. Consult the manufacturers' installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

**3.2 CURRENT SITE CONDITIONS**

- A. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions which will affect performance of the system to the Owner in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Owner.

### 3.3 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.4 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."
- C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
  - 1. Record setup data for control station and workstations.
  - 2. For each Location, record setup of Controller features and access requirements.
  - 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
  - 4. Set up groups, linking, and list inputs and outputs for each Controller.
  - 5. Assign action message names and compose messages.
  - 6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
  - 7. Prepare and install alarm graphic maps.
  - 8. Develop user-defined fields.
  - 9. Develop screen layout formats.
  - 10. Propose setups for guard tours and key control.
  - 11. Discuss badge layout options; design badges.
  - 12. Complete system diagnostics and operation verification.
  - 13. Prepare a specific plan for system testing, startup, and demonstration.
  - 14. Develop acceptance test concept and, on approval, develop specifics of the test.
  - 15. Develop cable and asset management system details; input data from construction documents. Include system schematics and Technical Drawings.
- D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

### 3.5 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Contracting."
- B. Install cables and wiring according to requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security."
- C. All access control cabling shall be installed in 3/4" minimum conduit. Where 3/4" conduit is not feasible, contractor shall receive written approval from VAMC COR to provide 1/2" or smaller. Access control cabling shall be routed in conduit to nearest cable tray and is permitted to be run in cable tray to access control panel.
- D. Verify access controlled door requirements and exact cabling requirements with security system and door hardware vendor prior to rough-in. Contractor shall provide a single, plenum-rated cable designed for access control system from the access control panel to the door location and route the cabling to individual devices as required.
- E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5E rating of components and that ensure Category 5E performance of completed and linked signal paths, end to end.
- F. Install cables without damaging conductors, shield, or jacket.
- G. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- H. Install end-of-line resistors at the field device location and not at the Controller or panel location.

### 3.6 CABLE APPLICATION

- A. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. RS-232 Cabling: Install at a maximum distance of 50 feet (15 m).
- D. RS-485 Cabling: Install at a maximum distance of 4000 feet (1220 m).
- E. Card Readers and Keypads:
  1. Install number of conductor pairs recommended by manufacturer for the functions specified.
  2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet (75 m), and install No. 20 AWG wire if maximum distance is 500 feet (150 m).
  3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
  4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

- F. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed 250 feet (75 m).
- G. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of 25 feet (8 m).

### 3.7 GROUNDING

- A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Signal Ground:
  - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
  - 2. Bus: Mount on wall of main equipment room with standoff insulators.

### 3.8 INSTALLATION

- A. System installation shall be in accordance with UL 294, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.
- B. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a operable system.
- C. The PACS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a network.
- D. For integration purposes, the PACS shall be integrated where appropriate with the following associated security subsystems:
  - 1. IDS:
    - a. Be able monitor door control sensors.
  - 2. EPPS:
    - a. Be programmed to go into an alarm state when an emergency call box or duress alarm/panic device is activated, and notify the Physical Access Control System and Database Management of an alarm event.
    - b. For additional PACS requirements as they relate to the EPPS, refer to Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM.
- E. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.
- F. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.

- G. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system. The Contractor shall not take any corrective action without written permission from the Government.
- H. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.
- I. Existing Equipment:
1. The Contractor shall connect to and utilize existing door equipment, control signal transmission lines, and devices as outlined in the design package. Door equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.
  2. The Contractor shall perform a field survey, including testing and inspection of all existing door equipment and signal lines intended to be incorporated into the PACS, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
  3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
  4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or improper installation of equipment.
  5. The Contracting Officer shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.

- J. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.
- K. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.
- L. Control Panels:
1. Connect power and signal lines to the controller.
  2. Program the panel as outlined by the design and per the manufacturer's programming guidelines.
- M. Card Readers:
1. Connect all signal inputs and outputs as shown and specified.
  2. Terminate input signals as required.
  3. Program and address the reader as per the design package.
  4. Readers shall be surface or flushed mounted and all appropriate hardware shall be provided to ensure the unit is installed in an enclosed conduit system.
- N. Portal Control Devices:
1. Install all signal input and output cables as well as all power cables.
  2. Devices shall be surface or flush mounted as per the design package.
  3. Program all devices and ensure they are working.
- O. Door Status Indicators:
1. Install all signal input and output cables as well as all power cables.
  2. RTE's shall be surface mounted and angled in a manner that they cannot be compromised from the non-secure side of a windowed door, or allow for easy release of the locking device from a distance no greater than 6 feet from the base of the door.
  3. Door position sensors shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).
- P. Entry Control Devices:
1. Install all signal input and power cables.
  2. Strikes and bolts shall be mounted within the door frame.
  3. Mortise locks shall be mounted within the door and an electric transfer hinge shall be utilized to transfer the wire from within the door frame to the mortise lock inside the door.
  4. Electromagnetic locks shall be installed with the mag-lock mounted to the door frame and the metal plate mounted to the door.

Q. System Start-Up:

1. The Contractor shall not apply power to the PACS until the following items have been completed:
  - a. PACS equipment items and have been set up in accordance with manufacturer's instructions.
  - b. A visual inspection of the PACS has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
  - c. System wiring has been tested and verified as correctly connected as indicated.
  - d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
  - e. Power supplies to be connected to the PACS have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.
3. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum of 7 days prior notice.

R. Supplemental Contractor Quality Control:

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed PACS; and are approved by the Contracting Officer.
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

**3.9 SYSTEM SOFTWARE**

- A. Install, configure, and test software and databases for the complete and proper operation of systems involved. Provide group of software licenses for all card reader/camera licenses for this project plus 10% spare capacity for future expansion. Contractor shall be responsible for the final quantity of required licenses.

**3.10 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect , test, and adjust. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

### **3.11 PROTECTION**

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured, with an activated burglar alarm and access-control system reporting to a Central Station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

### **3.12 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.
- C. Develop separate training modules for the following:
  1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  3. Security personnel.
  4. Hardware maintenance personnel.
  5. Corporate management.
- D. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----



**SECTION 28 23 00**  
**VIDEO SURVEILLANCE**

**PART 1 - GENERAL**

**1.1 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 a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
- B. Video surveillance system shall be integrated with existing Lenel monitoring and control system specified in Section 28 13 00 "Access Control," which specifies systems integration.

**1.3 DEFINITIONS**

- A. AGC: Automatic gain control.
- B. BNC: Bayonet Neill-Concelman - type of connector.
- C. CCD: Charge-coupled device.
- D. FTP: File transfer protocol.
- E. IP: Internet protocol.
- F. LAN: Local area network.
- G. MPEG: Moving picture experts group.
- H. NTSC: National Television System Committee.
- I. PC: Personal computer.
- J. PTZ: Pan-tilt-zoom.
- K. RAID: Redundant array of independent disks.
- L. TCP: Transmission control protocol - connects hosts on the Internet.
- M. UPS: Uninterruptible power supply.
- N. WAN: Wide area network.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.

2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
3. UPS: Sizing calculations.
4. Wiring Diagrams: For power, signal, and control wiring.
- C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.
- C. Provide manufacturer security system product cut-sheets.
- D. Provide floor plans, site plans, and enlarged plans to include:
  1. Define the drawings scale in standard measurements.
  2. Provide device identification and location.
  3. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
  4. Identify all pull box and conduit locations, sizes, and fill capacities.
  5. Address all general and drawing specific notes for a particular drawing sheet.
  6. Provide corresponding device identification schedule identifying the following:
    - a. Device ID.
    - b. Device Location (e.g. site, building, floor, room number, location, and description).
    - c. Mounting type (e.g. flush, wall, surface, etc.).
    - d. Power supply or circuit breaker and power panel number.
    - e. In addition, for the VASS Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.
- E. A system drawing for each applicable security system shall:
  1. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
  2. Provide full detail of all system components wiring from point-to-point.
  3. Identify wire types utilized for connection, interconnection with associate security subsystems.
  4. Show device locations that correspond to the floor plans.

5. All general and drawing specific notes shall be included with the system drawings.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. Include the following:
  1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.
  2. Provide an updated "as-built" version of riser and floor plans as specified in "Informational Submittals" section above.

#### **1.7 QUALITY ASSURANCE**

- 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. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

#### **1.8 COORDINATION**

- A. Coordinate arrangement, mounting, and support of video surveillance equipment:
  1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  3. To allow right of way for piping and conduit installed at required slope.
  4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for video surveillance items that are behind finished surfaces or otherwise concealed.

#### **1.9 WARRANTY**

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

**PART 2 - PRODUCTS**

**2.1 SYSTEM REQUIREMENTS**

- A. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
- C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

**2.2 STANDARD CAMERAS**

- A. General Requirements: Applies to all camera types unless otherwise noted.
  - 1. Shall be powered over Ethernet.
  - 2. Shall be rated for continuous operation under the environmental conditions listed in Part 1, Project Conditions.
  - 3. Each function and activity shall be addressed within the system by a unique user defined name, with minimum of twenty (20) characters. The use of codes or mnemonics identifying the VASS action shall not be accepted.
  - 4. Shall come with built-in video motion detection that shall automatically monitor and process information from each camera. The camera motion detection shall detect motion within the camera's field of view and provide automatic visual, remote alarms as a result of detected motion.
  - 5. Will be fitted with AI/DC lenses to ensure the image quality under different light conditions.
  - 6. Appropriate signage shall be designed, provided, and posted that notifies people that an area is under camera surveillance.
  - 7. Varifocal lens type.
- B. Type 1 - Standard Fixed Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, IP camera and receiver/driver.

| <u><b>CAMERA</b></u> |  |
|----------------------|--|
| Image Sensor         | Progressive scan RGB CMOS 1/2.8"   |
| Lens                 | Varifocal, Remote focus and zoom, auto Iris control, IR corrected, Megapixel resolution<br>2.8-10 mm: 92°-33° view, F1.6 |
| Minimum Illumination | Color: 0.3 lux, F1.6, B/W: 0.06 lux, F1.6  |
| Shutter time         | 1/33500 s to 2 s   |

|                                  |  |
|----------------------------------|--|
| Camera angle adjustment          | Pan ±180°, Tilt 90°, Rotation ±95°   |
| <b><u>VIDEO</u></b>              |  |
| Compression                      | H.264 Main and Baseline Profile (MPEG-4 Part 10/AVC) Motion JPEG   |
| Video Resolutions                | 1280x960 (approx. 1.3 MP) to 160x90  |
| Frame rate                       | 30 fps   |
| Video streaming                  | Multiple individually configurable streams in H.264 and MOTion JPEG, Controllable frame rate and bandwidth, VBR/CBR H.264  |
| Image settings                   | Compression, Color, Brightness, Sharpness, Contrast, White balance, Exposure control, Exposure zones, Backlight compensation, Fine tuning of behavior at different light levels, WDR - Dynamic Contrast, Text and image overlay, Privacy mask, Mirroring of images |
| <b><u>SYSTEM INTEGRATION</u></b> |  |
| Intelligent video                | Video motion detection, Active tampering alarm   |
| <b><u>GENERAL</u></b>            |  |
| Casing                           | IK08 impact-resistant, dust resistant  |
| Power                            | Power over Ethernet IEEE 802.3af/at Type 1 Class 2, max. 4.8W, typical 3.5W  |
| Light Attenuation                | smoked bubble, f/1.5 light loss; clear bubble, zero light loss   |

1. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
  2. With AGC, manually selectable on or off.
  3. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 0.9-100000 lux at F1.7.
  4. Manually selectable modes for backlight compensation or normal lighting.
  5. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
  6. Motion Detector: Built-in digital.
- C. Type 2 - Mini Fixed Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, IP camera and receiver/driver.

|        |  |
|--------|--|
| CAMERA |  |
|--------|--|

|                         |  |
|-------------------------|--|
| Image Sensor            | Progressive scan RGB CMOS 1/2.8"   |
| Lens                    | Varifocal, Remote focus and zoom, auto Iris control, IR corrected, Megapixel resolution<br>2.8-10 mm: 92°-33° view, F1.6   |
| Minimum Illumination    | Color: 0.3 lux, F1.6, B/W: 0.06 lux, F1.6  |
| Shutter time            | 1/33500 s to 2 s   |
| Camera angle adjustment | Pan ±180°, Tilt 90°, Rotation ±95°   |
| VIDEO                   |  |
| Compression             | H.264 Main and Baseline Profile (MPEG-4 Part 10/AVC) Motion JPEG   |
| Video Resolutions       | 1280x960 (approx. 1.3 MP) to 160x90  |
| Frame rate              | 30 fps   |
| Video streaming         | Multiple individually configurable streams in H.264 and MOTION JPEG, Controllable frame rate and bandwidth, VBR/CBR H.264  |
| Image settings          | Compression, Color, Brightness, Sharpness, Contrast, White balance, Exposure control, Exposure zones, Backlight compensation, Fine tuning of behavior at different light levels, WDR - Dynamic Contrast, Text and image overlay, Privacy mask, Mirroring of images |
| SYSTEM INTEGRATION      |  |
| Intelligent video       | Video motion detection, Active tampering alarm   |
| GENERAL                 |  |
| Casing                  | IK08 impact-resistant, dust resistant  |
| Power                   | Power over Ethernet IEEE 802.3af/at Type 1 Class 2, max. 4.8W, typical 3.5W  |
| Light Attenuation       | smoked bubble, f/1.5 light loss; clear bubble, zero light loss   |

### 2.3 POWER SUPPLIES

- A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera and lens.

1. Enclosure: NEMA 250, Type 1.

#### **2.4 CAMERA-SUPPORTING EQUIPMENT**

- A. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.
  1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
  2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
  3. Speed: 12 degrees per second in both horizontal and vertical planes.
  4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
  5. Built-in encoders or potentiometers for position feedback.
  6. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.
- B. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

#### **2.5 NETWORK VIDEO RECORDERS**

- A. External storage or internal 250-1, 500-GB hard disk drive.
  1. Video and audio recording over TCP/IP network.
  2. Video recording of MPEG-2 and MPEG-4 streams.
  3. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
  4. Duplex Operation: Simultaneous recording and playback.
  5. Continuous and alarm-based recording.
  6. Full-Featured Search Capabilities: Search based on camera, time, or date.
  7. Automatic data replenishment to ensure recording even if network is down.
  8. Digital certification by watermarking.
  9. Internal RAID storage or non-RAID storage of up to 1500 GB.
  10. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
  11. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.
  12. Integrated Web server FTP server functionality.

#### **2.6 IP VIDEO SYSTEMS**

- A. Description:
  1. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
  2. System shall have seamless integration of all video surveillance and control functions.

3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
4. System design shall include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
5. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
6. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
7. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
8. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 WIRING**

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- B. Wiring Method: Install cables in raceways unless otherwise indicated.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- E. For LAN connection and fiber-optic and copper communication wiring, comply with Section 27 10 00 "Control Communication and Signal Wiring" and Section 27 15 00 "Communications Structured Cabling."



- F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

### **3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION**

- A. Cameras are to be connected to nearest Lenel switch as indicated on drawings. Provide new switch when indicated on drawing or when 24 or more cameras are to be provided under project.
- B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
- D. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
- E. Avoid ground loops by making ground connections only at the control station.

### **3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
  - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
  - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
    - a. Prepare equipment list described in "Informational Submittals" Article.
    - b. Verify operation of auto-iris lenses.
    - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.

- d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
  - e. Set and name all preset positions; consult Owner's personnel.
  - f. Connect and verify responses to alarms.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- E. Video surveillance system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

**3.5 CLEANING**

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

**END OF SECTION 28 23 00**

**SECTION 28 26 00**  
**Electronic Personal Protection system**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide and install complete Duress-Panic Alarms, Emergency Phones/ Call-Boxes, and Intercom Systems, data transmission wiring and a control station with its associated equipment, hereafter referred to as EPPS System.
- B. EPPS shall be integrated with monitoring and control system specified in Division 28 Section PHYSICAL ACCESS CONTROL SYSTEM that specifies systems integration.

**1.2 Related Work**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- C. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.
- D. Section 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- E. Section 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS. Requirements for infrastructure.
- F. Section 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. Requirements for general requirements that are common to more than one section in Division 28.
- G. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for conductors and cables.
- H. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for grounding of equipment.
- I. Section 28 05 28.33 - CONDUITS AND BACK BOXES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for infrastructure.
- J. Section 28 13 00 - PHYSICAL ACCESS CONTROL SYSTEMS (PACS). Requirements for physical access control integration.

**1.3 QUALITY ASSURANCE**

- A. The Contractor shall be responsible for providing, installing, and the operation of the EPPS System as shown. The Contractor shall also provide certification as required.
- B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.
- D. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- E. Product Qualification:
1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- F. Contractor Qualification:
1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Security Management System's (PACS) manufacturer. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the PACS. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures. The COR reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.
  2. The Contractor shall provide proof project superintendent with BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.

3. Cable installer must have on staff a Registered Communication Distribution Designer (RCDD) certified by Building Industry Consulting Service International. The staff member shall provide consistent oversight of the project cabling throughout design, layout, installation, termination and testing.

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

#### 1.4 SUBMITALS

A. Submit below items in accordance with Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY and Master Specification Sections 01 33 23, SHOP DRAWING, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.

B. Provide certificates of compliance with Section 1.3, Quality Assurance.

C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.

D. Shop drawings and as-built packages shall include, but not be limited to:

1. Index Sheet that shall:

a. Define each page of the design package to include facility name, building name, floor, and sheet number.

b. Provide a list of all security abbreviations and symbols.

c. Reference all general notes that are utilized within the design package.

d. Specification and scope of work pages for all security systems that are applicable to the design package that will:

1) Outline all general and job specific work required within the design package.

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

2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:

a. Include a title block as defined above.

b. Define the drawings scale in both standard and metric measurements.

c. Provide device identification and location.

d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).

e. Identify all pull box and conduit locations, sizes, and fill capacities.

f. Address all general and drawing specific notes for a particular drawing sheet.

3. A riser drawing for each applicable security subsystem shall:
  - a. Indicate the sequence of operation.
  - b. Relationship of integrated components on one diagram.
  - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
  - d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A system drawing for each applicable security system shall:
  - a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
  - b. Provide full detail of all system components wiring from point-to-point.
  - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
  - d. Show device locations that correspond to the floor plans.
  - e. All general and drawing specific notes shall be included with the system drawings.
5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
  - a. Device ID.
  - b. Device Location (e.g. site, building, floor, room number, location, and description).
  - c. Mounting type (e.g. flush, wall, surface, etc.).
  - d. Power supply or circuit breaker and power panel number.
6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
  1. 35 percent
  2. 65 percent
  3. 90 percent
  4. 100 percent
- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

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

#### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI):
1. ANSI S3.2-09 Method for measuring the Intelligibility of Speech over Communications Systems
- C. Department of Justice American Disability Act (ADA)
1. 28 CFR Part 36 2010 ADA Standards for Accessible Design
- D. Federal Communications Commission (FCC):
1. (47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems
- E. National Fire Protection Association (NFPA):
1. 70-11 National Electrical Code
- F. National Electrical Manufactures Association (NEMA)
1. 250-08 Enclosures for Electrical Equipment (1000 Volts Maximum)
- G. Underwriters Laboratories, Inc. (UL):
1. 305-08 Standard for Panic Hardware
  2. 444-08 Safety Communications Cables
  3. 636-01 Standard for Holdup Alarm Units and Systems
- H. Uniform Federal Accessibility Standards (UFAS), 1984

#### 1.6 COORDINATION

- A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  3. To allow right of way for piping and conduit installed at required slope.
  4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed.

## 1.7 MAINTENANCE & SERVICE

### A. General Requirements

1. The Contractor shall provide all services required and equipment necessary to maintain the entire integrated electronic security system in an operational state as specified for a period of one (1) year after formal written acceptance of the system. The Contractor shall provide all necessary material required for performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. See also General Project Requirements.

### B. Description of Work

1. The adjustment and repair of the security system includes all software updates, panel firmware, and the following new items computers equipment, communications transmission equipment and data transmission media (DTM), local processors, security system sensors, facility interface, and signal transmission equipment.

### C. Personnel

1. Service personnel shall be certified in the maintenance and repair of the selected type of equipment and qualified to accomplish all work promptly and satisfactorily. The COR shall be advised in writing of the name of the designated service representative, and of any change in personnel. The COR shall be provided copies of system manufacturer certification for the designated service representative.

### D. Schedule of Work

1. The work shall be performed during regular working ours, Monday through Friday, excluding federal holidays. These inspections shall include:
  - a. The Contractor shall perform two (2) minor inspections at six (6) month intervals or more if required by the manufacturer, and two (2) major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
    - 1) Minor Inspections shall include visual checks and operational tests of all console equipment, peripheral equipment, local processors, sensors, electrical and mechanical controls, and adjustments on printers.
    - 2) Major Inspections shall include all work described for Minor Inspections and the following: clean all system equipment and local processors including interior and exterior surfaces; perform diagnostics on all equipment; operational tests of the CPU, switcher, peripheral equipment, check and calibrate each sensor; run all system software diagnostics and correct all problems; and resolve any previous outstanding problems.

### E. Emergency Service

1. The owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. The Owner shall have sole authority for determining catastrophic and non-catastrophic system failures within parameters stated in General Project Requirements.



- a. For catastrophic system failures, the Contractor shall provide same day four (4) hour service response with a defect correction time not to exceed eight (8) hours from [notification] [arrival on site]. Catastrophic system failures are defined as any system failure that the Owner determines will place the facility(s) at increased risk.
- b. For non-catastrophic failures, the Contractor within eight (8) hours with a defect correction time not to exceed 24 hours from notification.

F. Operation

1. Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable portions of the performance verification test.

G. Records & Logs

1. The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

H. Work Request

1. The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall deliver a record of the work performed within five (5) working days after the work was completed.

I. System Modifications

1. The Contractor shall make any recommendations for system modification in writing to the COR. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the COR. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and other documentation affected.

J. Software

1. The Contractor shall provide all software updates when approved by the Owner from the manufacturer during the installation and 12-month warranty period and verify operation of the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the operations and maintenance manuals and software documentation. There shall be at least one (1) scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software. All software changes shall be recorded in a log maintained in the unit control room. An electronic copy of the software update shall be maintained within the log. At a minimum, the contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "SOFTWARE CHANGE LOG".

**1.8 WARRANTY OF CONSTRUCTION.**

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

**1.9 GENERAL REQUIREMENTS**

- A. For general requirements that are common to more than one section in Division 28 refer to Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- B. General requirements applicable to this section include:
  1. Performance Requirements,
  2. Delivery, Handling and Storage,
  3. Project Conditions,
  4. Equipment and Materials,
  5. Electrical Power,
  6. Lightning, Power Surge Suppression, and Grounding,
  7. Electronic Components,
  8. Substitute Materials and Equipment, and
  9. Like Items.

**PART 2 - PRODUCTS**

**2.1 EQUIPMENT AND MATERIALS**

- A. General:
  1. All equipment shall be rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.

2. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 hertz (Hz) or 60 Hz Alternating Current (AC) power system unless documented otherwise in subsequent sections listed within this spec. All equipment shall have a battery back-up source of power that will provide 12 hours (hrs.) of run time in the event of a loss of primary power to the security systems until a backup generator comes on-line.
3. The EPPS systems shall be designed, installed, and programmed in a manner that will allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.
4. All EPPS components located in designated "HAZARDOUS ENVIRONMENT" areas where fire or explosion could occur due to the presence of natural gases or vapors, flammable liquids, combustible residue, or ignitable fibers or debris, shall be rated Class II, Division I, Group F, and installed in accordance with National Fire Protection Association (NFPA) 70, National Electrical Code Chapter 5.
5. The Contractor shall provide the Contracting Officer Representative with written verification, that the type of wire/cable being provided is recommended and approved by the OEM. Cabling shall meet the interconnecting wiring requirements of NFPA 70, National Electrical Code. The Contractor is responsible for providing the correct protection cable duct and/or conduit and wiring.
6. When interfacing with other communications or security subsystems the Contractor shall utilize interfacing methods that are approved by the Contracting Officer Representative. At a minimum, an acceptable interfacing method requires not only a physical and mechanical connection; but also a matching of signal, voltage, and processing levels with regard to signal quality and impedance. The interface point must adhere to all standards described herein.
7. Systems shall be scaleable, not vendor specific, and allow expansion as required.
8. Wireless systems shall use ultrasonic, infrared and radio frequency waves to link distributed transmitters and receivers. Specific characteristics of particular facility will determine best application. Contractor is responsible for determining best system using prediction program to determine where readable signals can be obtained and identify "dead spots".
9. All hardwired alarms, switches, and junction boxes shall be protected from tampering and include line supervision.
10. The installation and placement of intercom units and emergency-call boxes in strategic locations shall also require that signage be posted near these devices. The signage, in accordance with Section 10 14 00, SIGNAGE shall communicate the location of the device and its unique identification number, and brief instruction on how to access/use the device. The signage may appear on the device, on a pole or wall near the device location and shall be printed in a manner that is easily read during daylight and hours of darkness.

## **2.2 EQUIPMENT ITEMS**

- A. All systems shall be designed to provide continuous electrical supervision of the complete and entire system.

- B. Noise filters and surge protectors shall be provided for all intercommunications equipment to ensure protection from primary AC power surges and to ensure noise interference is not induced into low voltage data circuits.
- C. All alarm and initiating and signaling circuits shall be supervised for open circuits, short circuits, and system grounds. Main and Uninterrupted Power Supply (UPS) power circuits shall be supervised for any change in operating conditions (e.g. low battery, primary to back up battery, and UPS online). When an open, short or ground occurs in any system circuit, an audible and visual fault alarm signal shall be initiated at the master control station and all remote locations.
- D. Control Unit: Shall consist of the components to constantly monitor and verify alarm activation; identify zone of activation and location of activation.
- E. The intercom and emergency call-box systems shall be provided with normally acceptable speech intelligibility, defined as a score of at least 70% in accordance with ANSI S3.2
- F. Duress-Panic Alarms:
  - 1. Housing shall be a rugged corrosion-resistant housing of stainless steel or Acrylonitrile Butadiene Styrene (ABS) molded plastic or similar material that is weather and dust proof.
  - 2. Actuating device shall include a minimum of a plunger button whose head is recessed from the face/front edge of the housing and be designed to avoid accidental activation using switch guard or multiple buttons (i.e., requires pressing two (2) buttons simultaneously)
  - 3. Wireless stationary devices will meet the same specifications as Personal Duress/Panic Alarms.
  - 4. Alarm switch/button shall lock-in upon activation until manually reset with key or manufacture provided device.
  - 5. The switch shall be a positive-acting, double-pole, and double-throw switch.
  - 6. Duress/Panic alarms shall meet UL 305 Standard for Panic Alarms. To reduce the possibility of false alarms and ensure installation functionality UL 636 Standard for Holdup Alarms standards shall be met.
  - 7. Alarms used for concealed application requires silent alarm notification to a monitoring station. They shall annunciate at the Physical Access Control System and Database Management, monitored by a central station or direct connect to local police, depending on local ordinance requirements.
  - 8. Shall be capable of being mounted for hand or foot use in a manner that is unable to be viewed by the public. Larger systems use a computer that intercepts and processes alarms and displays them on a monitor. The central computer can make an announcement over facility hand held radios, pagers or telephones, or at the Physical Access Control System and Database Management so that the other security personnel can be immediately notified. These systems shall be hardwired.
  - 9. Components:
    - a. Transmitter

- b. Locator subsystem
  - c. Receiver
  - d. Software
10. Wiring will be four (4) conductor #18 American Wire Gauge (AWG).
11. Duress-Panic Alarm Technical Characteristics:

|                     |  |
|---------------------|--|
| Temperature Range   | 0° to 110°F (-17.8°C to 43.3°C)          |
| Nominal Voltage     | 12 V DC @ 6 mA                           |
| Current             | Max 8 mA                                 |
| Operational Voltage | 7 V DC to 15 V DC                        |
| Operational life    | Rated for 0,000 activations              |
| Battery Activations | 500                                      |
| Actuator            | Dual button plunger with activation lock |
| LED                 | Bi-color - on and activated              |

|                     |  |
|---------------------|--|
| Temperature Range   | 0° to 110°F (-17.8°C to 43.3°C)  |
| Nominal Voltage     | 12 V DC @ 6 mA   |
| Current             | Max 8 mA   |
| Operational Voltage | 7 V DC to 15 V DC  |
| Battery Life        | Regular battery 60 hour duration or Nickel-Metal Hydride (NiMH) rechargeable 12 hrs. 20 hr. per charge |
| Battery Lifespan    | 500 activations  |
| Actuator            | Plunger with activation lock   |
| LED                 | Bi-color - on and activated  |
| Passive Activation  | Adjustable<br>Prone position 1-15 minutes  |

|              |  |
|--------------|--|
| Construction | Minimum 11 gauge stainless steel<br>Impact resistant polycarbonate window for lights   |
| Mounting     | Wall, pole or kiosk  |
| Power        | 120 VAC: 44 Watts Maximum or<br>24 VDC: 18 Watts Maximum   |
| Lighting     | Strobe: 1.5 million candlepower<br>70 flashes per minute.<br>Blue Light: 7 watt high efficiency 10,000 hour compact fluescent.<br>Faceplate Light: Ultra bright LEDs<br>100,000 hour lifetime. |

|              |  |
|--------------|--|
| Construction | 12 gauge (2.8mm) #4 brushed stainless steel face plate |
|--------------|--|

|                       |  |
|-----------------------|--|
| Operating Temperature | -4°F to +149°F (-20°C to +65°C)  |
| Communication         | 2-way hands-free communication   |
| Digital Capacity      | Up to 18 digits, including pauses, for each of two (2) phone numbers                         |
| Dialing Speed         | Minimum 10 tones per second  |
| Power Source          | Phone line powered (requires 20mA at 24 v off-hook)  |
| Connection            | Parallel tip and ring connected to RJ11 connector for quick installation                     |
| Memory                | Erasable Programmable Read-only Memory (EPROM)   |
| Circuit Protection    | Lightening suppressed and full wave polarity guarded   |
| Programming           | Non-volatile EEPROM programming can be done from any telephone.<br>No battery back-up needed |
| Wiring Requirements   | 1 twisted-shielded pair (gauge depends on distance)  |
| Camera                | Option for pin-hole color camera or Integration with existing CCTV                           |
| LED                   | Call confirmation  |
| Activation            | Sound or 1.5 in. minimum piezoelectric button  |
| Labeling              | "Push for Help" or "Emergency"   |

|                        |                          |
|------------------------|--------------------------|
| STROBE                 |                          |
| Input Voltage          | 10.5 - 28 VDC or VAC     |
| Input Current          | Average 1 amp            |
| Input Current          | Peak 3 amp               |
| Intensity              | 1,000,000 candlepower    |
| Control Circuit Output | 2 mA max                 |
| Flash Rate             | 60 - 75 times per minute |
| BEACON                 |                          |
| Input Voltage          | 10.5 - 28 VAC or VDC     |
| Input Current          | @24.0 : 427 MA           |

|                       |  |
|-----------------------|--|
| Construction          | 12 gauge (2.8mm) #4 brushed stainless steel face plate                   |
| Operating Temperature | -4°F to +149°F (-20°C to +65°C)  |
| Communication         | 2-way hands-free communication   |
| Digital Capacity      | Up to 18 digits, including pauses, for each of two (2) phone numbers     |
| Dialing Speed         | Minimum 10 tones per second  |
| Power Source          | Phone line powered or PBX  |
| Connection            | Parallel tip and ring connected to RJ11 connector for quick installation |
| Memory                | EPROM  |
| Circuit Protection    | Lightening suppressed and full wave polarity guarded                     |
| Programming           | Non-volatile EEPROM programming can be                                   |

|                     |  |
|---------------------|--|
|                     | done from any telephone.<br>No battery back-up needed              |
| Wiring Requirements | 1 twisted-shielded pair (gauge depends on distance)                |
| Camera              | Option for pin-hole color camera or Integration with existing CCTV |
| LED                 | Call confirmation  |
| Activation          | 1.5 in. (38.1mm) minimum piezoelectric button                      |
| Labeling            | "Information" or "Help"  |

### 2.3 INSTALLATION KIT

- A. General: A kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, barrier strips, wiring blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, etc., required to accomplish a neat and secure installation. Unfinished or unlabeled wire connections will not be allowed. Contractor shall turn over to the COR all unused and partially opened installation kit boxes, coaxial cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, and physical installation hardware. This is an acceptable alternate to the individual spare equipment requirement as long as the minimum spare items are provided in this count. The following installation sub-kits are required as a minimum:
  - B. System Grounding:
    - 1. The grounding kit shall include all cable in accordance with UL 444 Communications Cables, and installation hardware required. All grounding will be according to the NEC.
    - 2. This includes, but is not limited to:
      - a. Coaxial Cable Shields
      - b. Control Cable Shields
      - c. Data Cable Shields
      - d. Conduits
      - e. Cable Duct
      - f. Cable Trays
      - g. Power Panels
      - h. Connector Panels
  - C. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
  - D. Wire And Cable: The wire and cable kit shall include all connectors and terminals, barrier straps, wiring blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.

- E. Equipment Interface: The equipment interface kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface Systems and Subsystems according to the OEM requirements and this specification.
- F. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this specification.
- G. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. System installation shall be installed in accordance with NFPA 731 Standards for the Installation of Electric Premises Security Systems and appropriate installation manual for each type of subsystem designed, engineered, and installed.
- B. The location and type of duress, intercom, or call-box to be installed will be in accordance with physical security requirements unique to each VA facility.
- C. For EPPS systems (i.e. use current panic/duress and emergency call boxes) that can operate through existing VA facility telephone system lines, software programming and hardware, refer to Section 27 51 23, INTERCOMMUNICATIONS AND PROGRAM SYSTEMS to integrate additional EPPS equipment.
- D. Concealed duress/panic devices shall be mounted in such a way that their location is only known by the person having knowledge of the activating device location. No wiring shall be exposed to identify the location of the activation device.
- E. Floor mounted duress alarms shall be attached to millwork on floor. When mounted under millwork, wiring shall be routed in millwork to conduit system via flexible conduit.
- F. Hard-wired switches shall be wired to individual alarm points within the Advanced Processing Controller (apC).
- G. Wall and post mounted stations shall be mounted to meet UFAS/ADA requirements and use tamper proof bolts and screws. Testing will be finished before installation of fasteners.
- H. Cleaning: Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacture instructions.
- I. Provisions shall be made for systems in high-noise areas or areas with electrical interference environments.
- J. Adjustment/Alignment/Synchronization: Contractor shall prepare for system activation by following manufacturer's recommended procedures for adjustment, alignment, or programming. Prepare each component in accordance with appropriate provisions of the component's installation, operations, and maintenance instructions.



### 3.2 WIRELINE DATA TRANSMISSION

- A. Installation: The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable data transmission system.
- B. Identification and Labeling: The Contractor shall supply permanent identification labels for each cable at each end that will appear on the as-built drawings. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified by type or signal being carried and termination points. The labels shall be printed on letter size label sheets that are self laminated vinyl that can be printed from a computer data base or spread sheet. The labels shall be E-Z code WES12112 or equivalent.
- C. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.
- D. Transient Voltage Surge Suppressors (TVSS): The Contractor shall mount TVSS within 3 m (118 in) of equipment to be protected inside terminal cabinets or suitable NEMA 1 enclosures. Terminate off-premise conductors on input side of device. Connect the output side of the device to the equipment to be protected. Connect ground lug to a low impedance earth ground (less than 10 ohms) via Number 12 AWG insulated, stranded copper conductor.
- E. Contractor's Field Test: The Contractor shall verify the complete operation of the data transmission system during the Contractor's Field Testing. Field test shall include a bit error rate test. The Contractor shall perform the test by sending a minimum of 1,000,000 bits of data on each DTM circuit and measuring the bit error rate. The bit error rate shall not be greater than one (1) bit out of each 100,000 bits sent for each dial-up DTM circuit, and one (1) bit out of 1,000,000 bits sent for each leased or private DTM circuit. The Contractor shall submit a report containing results of the field test.
- F. Acceptance Test and Endurance Test: The wire line data transmission system shall be tested as a part of the completed IDS and EECS during the Acceptance test and Endurance Test as specified.
- G. Identification and Labeling: The Contractor shall supply identification tags or labels for each cable. Cable shall be labeled at both end points and at intermediate hand holes, manholes, and junction boxes. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

### 3.3 WIRING

- A. Wiring Method: Install cables in raceways [except in accessible indoor ceiling spaces, in attics,] [in hollow gypsum-board partitions,] and as otherwise indicated. Conceal raceways and wiring except in unfinished spaces.
- B. Wiring Method: Install cables concealed in accessible ceilings, walls, and floors where possible.

- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

### **3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.
- B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
- C. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
- D. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- E. Remove and replace malfunctioning items and retest as specified above.
- F. Record test results for each piece of equipment.
- G. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

### **3.5 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions and to optimize performance of the installed equipment. Tasks shall include, but are not limited to, the following:
  - 1. Check cable connections.
  - 2. Check proper operation of detectors.
  - 3. Recommend changes to walk trough detectors, X-ray machines, and associated equipment to improve Owner' utilization of security access detection system.
  - 4. Provide a written report of adjustments and recommendations.

### **3.6 CLEANING**

- A. Clean installed items using methods and materials recommended in writing by manufacturer.

**3.7 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain electronic personal protection system (EPSS) equipment.
  - 1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
  - 2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
  - 3. Review equipment list and data in maintenance manuals.
  - 4. Conduct a minimum of [four] <Insert number> hours' training.

**3.8 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.9 TESTS AND TRAINING**

- A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS and Section 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.

-----END-----

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section of the specifications includes the furnishing, installation, and connection of the fire alarm equipment to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control units, fire safety control devices, annunciators, power supplies, and wiring as shown on the drawings and specified.
- B. Fire alarm systems shall comply with requirements of NFPA 72 unless variations to NFPA 72 are specifically identified within these contract documents by the following notation: "variation". The design, system layout, document submittal preparation, and supervision of installation and testing shall be provided by a technician that is certified NICET level III or a registered fire protection engineer. The NICET certified technician shall be on site for the supervision and testing of the system. Factory engineers from the equipment manufacturer, thoroughly familiar and knowledgeable with all equipment utilized, shall provide additional technical support at the site as required by the Contracting Officer Representative or his authorized representative. Installers shall have a minimum of two years experience installing fire alarm systems.
- C. Fire alarm signals:
  - 1. Building 1, 1A, 1B shall have an automatic digitized voice fire alarm signal with emergency manual voice override to notify occupants to evacuate. The digitized voice message shall identify the area of the building (smoke zone) from which the alarm was initiated.
  - 2. Buildings shall have a general evacuation fire alarm signal in accordance with ASA S3.41 to notify all occupants in the respective building to evacuate.
- D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the main fire alarm system control unit located in the Security Dispatch Fire and Command Center. .
- E. The main fire alarm control unit shall automatically transmit alarm signals to a listed central station using a digital alarm communicator transmitter in accordance with NFPA 72.

**1.2 SCOPE**

- A. The existing hospital fire alarm system is a Notifier 3030 system. All new fire alarm devices shall be Notifier and shall connect to the existing Notifier 3030 system. The contractor shall provide all necessary components to expand the existing system.
- B. All existing fire alarm equipment, wiring, devices and sub-systems that are not shown to be reused shall be removed. All existing fire alarm conduit not reused shall be removed.

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- C. A fully addressable fire alarm system shall be designed and installed in accordance with the specifications and drawings. Device location and wiring runs shown on the drawings are for reference only unless specifically dimensioned. Actual locations shall be in accordance with NFPA 72 and this specification.
  - D. Existing fire alarm bells, chimes, door holders, 120VAC duct smoke detectors, valve tamper switches and waterflow/pressure switches may be reused only as specifically indicated on the drawings and provided the equipment:
    - 1. Meets this specification section
    - 2. Is UL listed or FM approved
    - 3. Is compatible with new equipment being installed
    - 4. Is verified as operable through contractor testing and inspection
    - 5. Is warranted as new by the contractor.
  - E. Existing 120 VAC duct smoke detectors, waterflow/pressure switches, and valve tamper switches reused by the Contractor shall be equipped with an addressable interface device compatible with the new equipment being installed.
  - F. Existing reused equipment shall be covered as new equipment under the Warranty specified herein.
  - G. Basic Performance:
    - 1. Alarm and trouble signals from each building fire alarm control panel shall be digitally encoded by UL listed electronic devices onto a multiplexed communication system.
    - 2. Response time between alarm initiation (contact closure) and recording at the main fire alarm control unit (appearance on alphanumeric read out) shall not exceed five (5) seconds.
    - 3. The signaling line circuits (SLC) between building fire alarm control units shall be wired Style 7 in accordance with NFPA 72. Isolation shall be provided so that no more than one building can be lost due to a short circuit fault.
    - 4. Initiating device circuits (IDC) shall be wired Style C in accordance with NFPA 72.
    - 5. Signaling line circuits (SLC) within buildings shall be wired Style 4 in accordance with NFPA 72. Individual signaling line circuits shall be limited to covering 22,500 square feet of floor space or 3 floors whichever is less.
    - 6. Notification appliance circuits (NAC) shall be wired Style Y in accordance with NFPA 72.

### 1.3 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS: Restoration of existing surfaces.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Procedures for submittals.
- C. Section 07 84 00, FIRESTOPPING: Fire proofing wall penetrations.
- D. Section 08 71 00, DOOR HARDWARE: Combination Closer-Holder.

- E. Section 09 91 00, PAINTING: Painting for equipment and existing surfaces.
- F. Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS: Sprinkler systems.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements for items which are common to other Division 26 sections.
- H. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and boxes for cables/wiring.
- I. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW: Cables/wiring.

#### 1.4 SUBMITTALS

- A. General: Submit electronic copy in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Drawings:
  - 1. Prepare electronic drawings using AutoCAD and include all contractors information. Layering shall be by VA criteria as provided by the Contracting Officer's Representative (COR). Bid drawing files on AutoCAD will be provided to the Contractor at the pre-construction meeting. The contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by VA.
  - 2. Floor plans: Provide locations of all devices (with device number at each addressable device corresponding to control unit programming), appliances, panels, equipment, junction/terminal cabinets/boxes, risers, electrical power connections, individual circuits and raceway routing, system zoning; number, size, and type of raceways and conductors in each raceway; conduit fill calculations with cross section area percent fill for each type and size of conductor and raceway. Only those devices connected and incorporated into the final system shall be on these floor plans. Do not show any removed devices on the floor plans. Show all interfaces for all fire safety functions.
  - 3. Riser diagrams: Provide, for the entire system, the number, size and type of riser raceways and conductors in each riser raceway and number of each type device per floor and zone. Show door holder interface, elevator control interface, HVAC shutdown interface, fire extinguishing system interface, and all other fire safety interfaces. Show wiring Styles on the riser diagram for all circuits. Provide diagrams both on a per building and campus wide basis.
  - 4. Detailed wiring diagrams: Provide for control panels, modules, power supplies, electrical power connections, auxiliary relays and annunciators showing termination identifications, size and type conductors, circuit boards, LED lamps, indicators, adjustable controls, switches, ribbon connectors, wiring harnesses, terminal strips and connectors, spare zones/circuits. Diagrams shall be drawn to a scale sufficient to show spatial relationships between components, enclosures and equipment configuration.

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5. Two weeks prior to final inspection, the Contractor shall deliver to the COR one (1) set of reproducible, as-built drawings, two blue-line copies and one (1) set of the as-built drawing computer CAD files. As-built drawings (floor plans) shall show all new and existing conduit used for the fire alarm system.

C. Manuals:

1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets for all items used in the system, power requirements, device wiring diagrams, dimensions, and information for ordering replacement parts.
  - a. Wiring diagrams shall have their terminals identified to facilitate installation, operation, expansion and maintenance.
  - b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
  - c. Include complete listing of all software used and installation and operation instructions including the input/output matrix chart.
  - d. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate, inspect, test and maintain the equipment and system. Provide all manufacturer's installation limitations including but not limited to circuit length limitations.
  - e. Complete listing of all digitized voice messages.
  - f. Provide standby battery calculations under normal operating and alarm modes. Battery calculations shall include the magnets for holding the doors open for one minute.
  - g. Include information indicating who will provide emergency service and perform post contract maintenance.
  - h. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
  - i. A computerized preventive maintenance schedule for all equipment. The schedule shall be provided on disk in a computer format acceptable to the VAMC and shall describe the protocol for preventive maintenance of all equipment. The schedule shall include the required times for systematic examination, adjustment and cleaning of all equipment. A print out of the schedule shall also be provided in the manual. Provide the disk in a pocket within the manual.
  - j. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
  - k. A print out for all devices proposed on each signaling line circuit with spare capacity indicated.
2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manual to the COR.
  - a. The manual shall be updated to include any information necessitated by the maintenance and operating manual approval.

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- b. Complete "As installed" wiring and schematic diagrams shall be included that shows all items of equipment and their interconnecting wiring. Show all final terminal identifications.
  - c. Complete listing of all programming information, including all control events per device including an updated input/output matrix.
  - d. Certificate of Installation as required by NFPA 72 for each building. The certificate shall identify any variations from the National Fire Alarm Code.
  - e. Certificate from equipment manufacturer assuring compliance with all manufacturers installation requirements and satisfactory system operation.
- D. Certifications:
- 1. Together with the shop drawing submittal, submit the technician's NICET level III fire alarm certification as well as certification from the control unit manufacturer that the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include in the certification the names and addresses of the proposed supervisor of installation and the proposed performer of contract maintenance. Also include the name and title of the manufacturer's representative who makes the certification.
  - 2. Together with the shop drawing submittal, submit a certification from either the control unit manufacturer or the manufacturer of each component (e.g., smoke detector) that the components being furnished are compatible with the control unit.
  - 3. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer that the wiring and connection diagrams meet this specification, UL and NFPA 72 requirements.

**1.5 WARRANTY**

- A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the COR.

**1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by the basic designation only.
- B. National Fire Protection Association (NFPA):
  - 1. 70-2005 National Electrical Code (NEC).
  - 2. 72-2002 National Fire Alarm Code.
  - 3. 90A-2002 Installation of Air Conditioning and Ventilating Systems.
  - 4. 101-2003 Life Safety Code
- C. Underwriters Laboratories, Inc. (UL):
  - 1. 2000-2000.....Fire Protection Equipment Directory
- D. Factory Mutual Research Corp (FM): Approval Guide, 2005 Edition



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- E. American National Standards Institute (ANSI):
    - 1. S3.41-1996 Audible Emergency Evacuation Signal
  - F. International Code Council, International Building Code (IBC) 2003 Edition

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT AND MATERIALS, GENERAL**

- A. Existing equipment may be reused only where indicated on the drawings.
- B. Except as indicated in paragraph A above.

### **2.2 CONDUIT, BOXES, AND WIRE**

- A. Conduit shall be in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and as follows:
  - 1. All new and reused conduit shall be installed in accordance with NFPA 70.
  - 2. Conduit fill shall not exceed 40 percent of interior cross sectional area.
  - 3. All new conduit shall be 19 mm (3/4 inch) minimum.
- B. Wire:
  - 1. All existing wiring shall be removed and new wiring installed in a conduit or raceway.
  - 2. Wiring shall be in accordance with NEC article 760, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and as recommended by the manufacturer of the fire alarm system. All wires shall be color coded. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and 14 AWG for notification device circuits.
  - 3. Addressable circuits and wiring used for the multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer in writing.
  - 4. Any fire alarm system wiring that extends outside of a building shall have additional power surge protection to protect equipment from physical damage and false signals due to lightning, voltage and current induced transients. Protection devices shall be shown on the submittal drawings and shall be UL listed or in accordance with written manufacturer's requirements.
  - 5. All wire or cable used in underground conduits including those in concrete shall be listed for wet locations.
- C. Terminal Boxes, Junction Boxes, and Cabinets:
  - 1. Shall be galvanized steel in accordance with UL requirements.
  - 2. All new and reused boxes shall be sized and installed in accordance with NFPA 70.
  - 3. New and existing 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 19 mm (3/4 inch) high.

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4. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
  5. Terminal boxes and cabinets shall have identified pressure type terminal strips and shall be located at the base of each riser. Terminal strips shall be labeled as specified or as approved by the COR.

### **2.3 FIRE ALARM CONTROL UNIT**

#### **A. General:**

1. Each building shall be provided with a fire alarm control unit (Notifier 3030) and shall operate as a supervised zoned fire alarm system.
2. Each power source shall be supervised from the other source for loss of power.
3. All circuits shall be monitored for integrity.
4. Visually and audibly annunciate any trouble condition including, but not limited to main power failure, grounds and system wiring derangement.
5. Transmit digital alarm information to the main fire alarm control unit.

#### **B. Enclosure:**

1. The control unit shall be housed in a cabinet suitable for both recessed and surface mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. Cabinet shall contain all necessary relays, terminals, lamps, and legend plates to provide control for the system.

#### **C. Operator terminal at main control unit:**

1. Operator terminal shall consist of the central processing unit, display screen, keyboard and printer.
2. Display screen shall have a minimum 15-inch diagonal non-glare screen capable of displaying 24 lines of 80 characters each.
3. Keyboard shall consist of 60 alpha numeric and 12 user/functional control keys.
4. Printer shall be the automatic type, printing the date, time and location for all alarm, supervisory, and trouble conditions.

#### **D. Power Supply:**

1. The control unit shall derive its normal power from a 120 volt, 60 Hz dedicated supply connected to the emergency power system. Standby power shall be provided by a 24 volt DC battery as hereinafter specified. The normal power shall be transformed, rectified, coordinated, and interfaced with the standby battery and charger.
2. The door holder power shall be arranged so that momentary or sustained loss of main operating power shall not cause the release of any door.
3. Power supply for smoke detectors shall be taken from the fire alarm control unit.
4. Provide protectors to protect the fire alarm equipment from damage due to lightning or voltage and current transients.

5. Provide new separate and direct ground lines to the outside to protect the equipment from unwanted grounds.
- E. Circuit Supervision: Each alarm initiating device circuit, signaling line circuit, and notification appliance circuit, shall be supervised against the occurrence of a break or ground fault condition in the field wiring. These conditions shall cause a trouble signal to sound in the control unit until manually silenced by an off switch.
- F. Supervisory Devices: All sprinkler system valves, standpipe control valves, post indicator valves (PIV), and main gate valves shall be supervised for off-normal position. Closing a valve shall sound a supervisory signal at the control unit until silenced by an off switch. The specific location of all closed valves shall be identified at the control unit. Valve operation shall not cause an alarm signal. Low air pressure switches and duct detectors shall be monitored as supervisory signals. The power supply to the elevator shunt trip breaker shall be monitored by the fire alarm system as a supervisory signal.
- G. Trouble signals:
1. Arrange the trouble signals for automatic reset (non-latching).
  2. System trouble switch off and on lamps shall be visible through the control unit door.
- H. Function Switches: Provide the following switches in addition to any other switches required for the system:
1. Remote Alarm Transmission By-pass Switch: Shall prevent transmission of all signals to the main fire alarm control unit when in the "off" position. A system trouble signal shall be energized when switch is in the off position.
  2. Alarm Off Switch: Shall disconnect power to alarm notification circuits on the local building alarm system. A system trouble signal shall be activated when switch is in the off position.
  3. Trouble Silence Switch: Shall silence the trouble signal whenever the trouble silence switch is operated. This switch shall not reset the trouble signal.
  4. Reset Switch: Shall reset the system after an alarm, provided the initiating device has been reset. The system shall lock in alarm until reset.
  5. Lamp Test Switch: A test switch or other approved convenient means shall be provided to test the indicator lamps.
  6. Drill Switch: Shall activate all notification devices without tripping the remote alarm transmitter. This switch is required only for general evacuation systems specified herein.
  7. Door Holder By-Pass Switch: Shall prevent doors from releasing during fire alarm tests. A system trouble alarm shall be energized when switch is in the abnormal position.
  8. Elevator recall By-Pass Switch: Shall prevent the elevators from recalling upon operation of any of the devices installed to perform that function. A system trouble alarm shall be energized when the switch is in the abnormal position.

9. HVAC/Smoke Damper By-Pass: Provide a means to disable HVAC fans from shutting down and/or smoke dampers from closing upon operation of an initiating device designed to interconnect with these devices.

I. Remote Transmissions:

1. Provide capability and equipment for transmission of alarm, supervisory and trouble signals to the main fire alarm control unit.
2. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

J. Remote Control Capability: Each building fire alarm control unit shall be installed and programmed so that each must be reset locally after an alarm, before the main fire alarm control unit can be reset. After the local building fire alarm control unit has been reset, then the all system acknowledge, reset, silence or disabling functions can be operated by the main fire alarm control unit

K. System Expansion: Design the control units and enclosures so that the system can be expanded in the future (to include the addition of twenty percent more alarm initiating, alarm notification and door holder circuits) without disruption or replacement of the existing control unit and secondary power supply.

## 2.4 ANNUNCIATION

A. Annunciator, Alphanumeric Type (System):

1. Shall be a supervised, LCD display containing a minimum of two lines of 40 characters for alarm annunciation in clear English text.
2. Message shall identify building number, floor, zone, etc on the first line and device description and status (pull station, smoke detector, waterflow alarm or trouble condition) on the second line.
3. The initial alarm received shall be indicated as such.
4. A selector switch shall be provided for viewing subsequent alarm messages.
5. The display shall be UL listed for fire alarm application.
6. Annunciators shall display information for all buildings connected to the system. Local building annunciators, for general evacuation system buildings, shall be permitted when shown on the drawings and approved by the COR.

## 2.5 VOICE COMMUNICATION SYSTEM (VCS)

A. General:

1. An emergency voice communication system shall be installed throughout the project area
2. Upon receipt of an alarm signal from the building fire alarm system, the VCS shall automatically transmit a pre-recorded fire alarm message in the project area.
3. A digitized voice module shall be used to store each prerecorded message.
4. The VCS shall be arranged as a dual channel system capable of transmitting two different messages simultaneously.

5. The VCS shall supervise all speaker circuits, control equipment, remote audio control equipment, and amplifiers.

B. Speaker Circuit Control Unit:

1. The speaker circuit control unit shall include switches to manually activate or deactivate speaker circuits grouped by floor in the system.
2. Speaker circuit control switches shall provide on, off, and automatic positions and indications.
3. The speaker circuit control unit shall include visual indication of active or trouble status for each group of speaker circuits in the system.
4. A trouble indication shall be provided if a speaker circuit group is disabled.
5. A lamp test switch shall be provided to test all indicator lamps.
6. A single "all call" switch shall be provided to activate all speaker circuit groups simultaneously.
7. A push-to-talk microphone shall be provided for manual voice messages.
8. A voice message disconnect switch shall be provided to disconnect automatic digitized voice messages from the system. The system shall be arranged to allow manual voice messages and indicate a system trouble condition when activated.

C. Speaker Circuit Arrangement:

1. Speaker circuits shall be arranged such that there is one speaker circuit per smoke zone.
2. Audio amplifiers and control equipment shall be electrically supervised for normal and abnormal conditions.
3. Speaker circuits shall be either 25 VRMS or 70.7 VRMS with a minimum of 50% spare power available.
4. Speaker circuits and control equipment shall be arranged such that loss of any one speaker circuit will not cause the loss of any other speaker circuit in the system.

D. Digitized Voice Module (DVM):

1. The Digitized Voice Module shall provide prerecorded digitized evacuation and instructional messages. The messages shall be professionally recorded and approved by the COR prior to programming.
2. The DVM shall be configured to automatically output to the desired circuits following a 10-second slow whoop alert tone.
3. Prerecorded magnetic taped messages and tape players are not permitted.
4. The digitized message capacity shall be no less than 15 second in length.
5. The digitized message shall be transmitted three times.
6. The DVM shall be supervised for operational status.
7. Failure of the DVM shall result in the transmission of a constant alarm tone.
8. The DVM memory shall have a minimum 50% spare capacity after those messages identified in this section are recorded. Multiple DVM's may be used to obtain the required capacity.

E. Audio Amplifiers:

1. Audio Amplifiers shall provide a minimum of 50 Watts at either 25 or 70.7 VRMS output voltage levels.
2. Amplifiers shall be continuously supervised for operational status.
3. Amplifiers shall be configured for either single or dual channel application.
4. Each audio output circuit connection shall be configurable for Style X.
5. A minimum of 50% spare output capacity shall be available for each amplifier.

F. Tone Generator(s):

1. Tone Generator(s) shall be capable of providing a distinctive three-pulse temporal pattern fire alarm signal as well as a slow whoop.
2. Tone Generator(s) shall be continuously supervised for operational status.

## 2.6 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 one-half watt tap. Speakers shall provide a minimum sound output of 80 dBA at ten feet with the one-half watt tap.
2. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
3. 100 mm (4 inches) or 200 mm (8 inches) cone type speakers ceiling mounted with white colored baffles in areas with suspended ceilings and wall mounted in areas without ceilings.

B. Strobes:

1. Xenon flash tube type minimum 15 candela in toilet rooms and 75 candela in all other areas with a flash rate of 1 HZ. Strobes shall be synchronized where required by the National Fire Alarm Code (NFPA 72).
2. Backplate shall be red with 13 mm (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. Each strobe circuit shall have a minimum of twenty (20) percent spare capacity.
4. Strobes may be combined with the audible notification appliances specified herein.

## 2.7 ALARM INITIATING DEVICES

A. Manual Fire Alarm Stations:

1. Shall be non-breakglass, address reporting type.
2. Station front shall be constructed of a durable material such as cast or extruded metal or high impact plastic. Stations shall be semi-flush type.

3. Stations shall be of single action pull down type with suitable operating instructions provided on front in raised or depressed letters, and clearly labeled "FIRE".
4. Operating handles shall be constructed of a durable material. On operation, the lever shall lock in alarm position and remain so until reset. A key shall be required to gain front access for resetting, or conducting tests and drills.
5. Unless otherwise specified, all exposed parts shall be red in color and have a smooth, hard, durable finish.
6. Stations identified as key operated only shall have a single standardized lock and key separate from the control equipment.

B. Smoke Detectors:

1. Smoke detectors shall be UL listed for use with the fire alarm control unit being furnished.
2. Smoke detectors shall be addressable type complying with applicable UL Standards for system type detectors. Smoke detectors shall be installed in accordance with the manufacturer's recommendations and NFPA 72.
3. Detectors shall have an indication lamp to denote an alarm condition. Provide remote indicator lamps and identification plates where detectors are concealed from view. Locate the remote indicator lamps and identification plates flush mounted on walls so they can be observed from a normal standing position.
4. All spot type and duct type detectors installed shall be of the photoelectric type.
5. Photoelectric detectors shall be factory calibrated and readily field adjustable. The sensitivity of any photoelectric detector shall be factory set at 3.0 plus or minus 0.25 percent obscuration per foot.
6. Detectors shall provide a visual trouble indication if they drift out of sensitivity range or fail internal diagnostics. Detectors shall also provide visual indication of sensitivity level upon testing. Detectors, along with the fire alarm control units shall be UL listed for testing the sensitivity of the detectors.

C. Heat Detectors:

1. Heat detectors shall be of the addressable restorable rate compensated fixed-temperature spot type.
2. Detectors shall have a minimum smooth ceiling rating of 2500 square feet.
3. Ordinary temperature (135 degrees F) heat detectors shall be utilized in elevator shafts and elevator mechanical rooms. Intermediate temperature rated (200 degrees F) heat detectors shall be utilized in all other areas.
4. Provide a remote indicator lamp, key test station and identification nameplate (e.g. "Heat Detector - Elevator SE-3) for each elevator group. Locate key test station in plain view on elevator machine room wall.

D. Water Flow and Pressure Switches:

1. Wet pipe water flow switches and dry pipe alarm pressure switches for sprinkler systems shall be connected to the fire alarm system by way of an address reporting interface device.

2. All new water flow switches shall be of a single manufacturer and series and non-accumulative retard type. See Section 21 12 00, FIRE-SUPPRESSION STANDPIPES and Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS for new switches added. Connect all switches shown on the approved shop drawings.
3. All new switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Timing shall be recorded and documented during testing.

## 2.8 SUPERVISORY DEVICES

### A. Duct Smoke Detectors:

1. Duct smoke detectors shall be provided and connected by way of an address reporting interface device. Detectors shall be provided with an approved duct housing mounted exterior to the duct, and shall have perforated sampling tubes extending across the full width of the duct (wall to wall). Detector placement shall be such that there is uniform airflow in the cross section of the duct.
2. Interlocking with fans shall be provided in accordance with NFPA 90A and as specified hereinafter under Part 3.2, "TYPICAL OPERATION".
3. Provide remote indicator lamps, key test stations and identification nameplates (e.g. "DUCT SMOKE DETECTOR AHU-X") for all duct detectors. Locate key test stations in plain view on walls or ceilings so that they can be observed and operated from a normal standing position.

### B. Sprinkler and Standpipe System Supervisory Switches:

1. Each sprinkler system water supply control valve, riser valve or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valve shall be equipped with a supervisory switch.
3. Valve supervisory switches shall be connected to the fire alarm system by way of address reporting interface device. See Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS for new switches to be added. Connect tamper switches for all control valves shown on the approved shop drawings.
4. The mechanism shall be contained in a weatherproof die-cast aluminum housing that shall provide a 19 mm (3/4 inch) tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The entire installed assembly shall be tamper-proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting.
6. Where dry-pipe sprinkler systems are installed, high and low air pressure switches shall be provided and monitored by way of an address reporting interface devices.
7. Fire pump running, power failure and phase reversal supervisory alarms shall be provided and monitored by way of address reporting interface devices for the fire pump located[ **indicate location.** ]



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**2.9 ADDRESS REPORTING INTERFACE DEVICE**

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

**2.10 SMOKE BARRIER DOOR CONTROL**

- A. Electromagnetic Door Holders:
  - 1. New Door Holders shall be standard wall mounted electromagnetic type. In locations where doors do not come in contact with the wall when in the full open position, an extension post shall be added to the door bracket.
  - 2. Operation shall be by 24 volt DC supplied from a battery located at the fire alarm control unit. Door holders shall be coordinated as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring and fire alarm system for operation as specified.
- B. A maximum of twelve door holders shall be provided for each circuit. Door holders shall be wired to allow releasing doors by smoke zone.
- C. Door holder control circuits shall be electrically supervised.
- D. Smoke detectors shall not be incorporated as an integral part of door holders.
- E. Where combination holder-closer units are required to match existing, these devices are furnished and installed as per Section 08 71 00, DOOR HARDWARE. Connection and wiring shall be as herein specified.

**2.11 UTILITY LOCKS AND KEYS:**

- A. All key operated test switches, control units, annunciator panels and lockable cabinets shall be provided with a single standardized utility lock and key.
- B. Key-operated manual fire alarm stations shall have a single standardized lock and key separate from the control equipment.
- C. All keys shall be delivered to the COR.

**2.12 SPARE AND REPLACEMENT PARTS**

- A. Provide spare and replacement parts as follows:
  - 1. Manual pull stations - 2
  - 2.
  - 3.
  - 4. Fire alarm strobes - 2

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5. Fire alarm bells - 2
  6. Fire alarm speakers - 2
  7. Smoke detectors - 5
  8. Duct smoke detectors with all appurtenances - 1
  9. Monitor modules - 2
  10. Control modules - 2
  11. Fire alarm SLC cable (same as installed) - 152 m (500 feet)
- B. Spare and replacement parts shall be in original packaging and submitted to the COR.
- C. Provide to the VA, all hardware, software, programming tools, license and documentation necessary to permanently modify the fire alarm system on site. The minimum level of modification includes addition and deletion of devices, circuits, zones and changes to system description, system operation, and digitized evacuation and instructional messages.

**2.13 INSTRUCTION CHART:**

**PART 3 - EXECUTION**

**3.1 INSTALLATION:**

- A. Installation shall be in accordance with NFPA 70, 72, 90A, and 101 as shown on the drawings, and as recommended by the major equipment manufacturer. Fire alarm wiring shall be installed in conduit. All conduit and wire shall be installed in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and all penetrations of smoke and fire barriers shall be protected as required by Section 07 84 00, FIRESTOPPING.
- B. All new conduits, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. All existing accessible fire alarm conduit not reused shall be removed.
- C. All new or reused exposed conduit shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas.
- D. Existing devices that are reused shall be properly mounted and installed. Where devices are installed on existing shallow backboxes, extension rings of the same material, color and texture of the new fire alarm devices shall be used. Mounting surfaces shall be cut and patched in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Restoration, and be re-painted in accordance with Section 09 91 00, PAINTING as necessary to match existing.
- E. All fire detection and alarm system devices, control units and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Exact locations to be approved by the COR.
- F. Speakers shall be ceiling mounted and fully recessed in areas with suspended ceilings. Speakers shall be wall mounted and recessed in finished areas without suspended ceilings. Speakers may be surface mounted in unfinished areas.

- G. Strobes shall be flush wall mounted 2,000 mm (80 inches) above the floor or 150 mm (6 inches) below ceiling, whichever is lower. Locate and mount to maintain a minimum 900 mm (36 inches) clearance from side obstructions.
- H. Manual pull stations shall be installed not less than 1050 mm (42 inches) or more than 1200 mm (48 inches) from finished floor to bottom of device and within 1500 mm (60 inches) of a stairway or an exit door.
- I. Where possible, locate water flow and pressure switches a minimum of 300 mm (12 inches) from a fitting that changes the direction of the flow and a minimum of 900 mm (36 inches) from a valve.
- J. Mount valve tamper switches so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
- K. Connect flow and tamper switches installed under Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS.
- L. Connect combination closer-holders installed under Section 08 71 00, DOOR HARDWARE.

### 3.2 TYPICAL OPERATION

- A. Activation of any manual pull station, water flow or pressure switch, heat detector, kitchen hood suppression system, gaseous suppression system, or smoke detector shall cause the following operations to occur:
  - 1. Operate the emergency voice communication system in the main Building . For sprinkler protected buildings, flash strobes continuously only in the zone of alarm. For buildings without sprinkler protection throughout, flash strobes continuously only on the floor of alarm.
  - 2. Continuously sound a temporal pattern general alarm and flash all strobes in the building in alarm until reset at the local fire alarm control unit in the main Building .
  - 3. Release only the magnetic door holders in the smoke zone on the floor from which alarm was initiated after the alert signal.
  - 4. Transmit a separate alarm signal, via the main fire alarm control unit to the fire department.
  - 5. Unlock the electrically locked exit doors within the zone of alarm.
- B. Heat detectors in elevator machine rooms shall, in addition to the above functions, disconnect all power to all elevators served by that machine room after a time delay. The time delay shall be programmed within the fire alarm system programming and be equal to the time it takes for the car to travel from the highest to the lowest level, plus 10 seconds.
- C. Smoke detectors in the primary elevator lobbies of Buildings indicate the buildings where there is Phase I elevator recall shall, in addition to the above functions, return all elevators in the bank to the secondary floor.
- D. Smoke detectors in the remaining elevator lobbies, elevator machine room, or top of hoistway shall, in addition to the above functions, return all elevators in the bank to the primary floor.

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- E. Operation of a smoke detector at a corridor door used for automatic closing shall also release only the magnetic door holders in that smoke zone  
Operation of a smoke detector at a shutter used for automatic closing shall also release only the shutters in that smoke zone .
  - F. Operation of duct smoke detectors shall cause a system supervisory condition and shut down the ventilation system and close the associated smoke dampers as appropriate.
  - G. Operation of any sprinkler or standpipe system valve supervisory switch, high/low air pressure switch, or fire pump alarm switch shall cause a system supervisory condition.

### **3.3 TESTS**

- A. Provide the service of a NICET level III, competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the COR.
- B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the COR. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm systems meets all contract requirements. After the system has passed the initial test and been approved by the COR, the contractor may request a final inspection.
  - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
  - 2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
  - 3. Run water through all flow switches. Check time delay on water flow switches. Submit a report listing all water flow switch operations and their retard time in seconds.
  - 4. Open each alarm initiating and notification circuit to see if trouble signal actuates.
  - 5. Ground each alarm initiation and notification circuit and verify response of trouble signals.

### **3.4 FINAL INSPECTION AND ACCEPTANCE**

- A. Prior to final acceptance a minimum 30 day "burn-in" period shall be provided. The purpose shall be to allow equipment to stabilize and potential installation and software problems and equipment malfunctions to be identified and corrected. During this diagnostic period, all system operations and malfunctions shall be recorded. Final acceptance will be made upon successful completion of the "burn-in" period and where the last 14 days is without a system or equipment malfunction.
- B. At the final inspection a factory trained representative of the manufacturer of the major equipment shall repeat the tests in Article 3.3 TESTS and those required by NFPA 72. In addition the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of a VA representative.

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**3.5 INSTRUCTION**

- A. The manufacturer's authorized representative shall provide instruction and training to the VA as follows:
  - 1. Six one-hour sessions to engineering staff, security police and central attendant personnel for simple operation of the system. Two sessions at the start of installation, two sessions at the completion of installation and two sessions 3 months after the completion of installation.
  - 2. Four two-hour sessions to engineering staff for detailed operation of the system. Two sessions at the completion of installation and two sessions 3 months after the completion of installation.
  - 3. Three eight-hour sessions to electrical technicians for maintaining, programming, modifying, and repairing the system at the completion of installation and one eight-hour refresher session 3 months after the completion of installation.
- B. The Contractor and/or the Systems Manufacturer's representative shall provide a typewritten "Sequence of Operation" including a trouble shooting guide of the entire system for submittal to the VA. The sequence of operation will be shown for each input in the system in a matrix format and provided in a loose leaf binder. When reading the sequence of operation, the reader will be able to quickly and easily determine what output will occur upon activation of any input in the system. The INPUT/OUTPUT matrix format shall be as shown in Appendix A to NFPA 72.
- C. Furnish the services of a competent instructor for instructing personnel in the programming requirements necessary for system expansion. Such programming shall include addition or deletion of devices, zones, indicating circuits and printer/display text.

**PART 4 - SCHEDULES**

**4.1 SMOKE ZONE DESCRIPTIONS:**

- A. "Smoke Zone 1-5" (First Floor)
- B. "Smoke Zone 1-6" (First Floor)
- C. "Smoke Zone 1-7" (First Floor)
- D. "Smoke Zone 2-9" (Second Floor)
- E. New First Floor Smoke Zone (Name to be determined)

**4.2 DIGITIZED VOICE MESSAGES:**

- A. Digitized voice messages shall be provided for each smoke zone of the main Building. . The messages shall be arranged with a 3 second alert tone, a "Code Red" message and a description of the fire alarm area (building number, floor, level and smoke zone). A sample of such a message is as follows:

Alert Tone

Code Red

Building One, Basement Floor, South Wing

Code Red

Bid Issue  
June 17, 2016

VAMC WADE PARK  
Enhance/Consolidate Mental Health Services  
Project No. 541-16-104

\  
Building One, Basement Floor, South Wing  
Code Red  
Building One, Basement Floor, South Wing

**4.3 LOCATION OF VOICE MESSAGES:**

- A. Upon receipt of an alarm signal from the building fire alarm system, the voice communication system shall automatically transmit a 3 second tone alert and a pre-recorded fire alarm message throughout the main building.

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**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   |
| 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<br>(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<br>Bonding Busbar (SBB))    |
| TIP  | Telecommunications Infrastructure Plant   |
| TMGB | Telecommunications Main Grounding Busbar (also<br>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<br>PCS)                    |
| UPS  | Uninterruptible Power Supply  |
| USC  | United States Code  |
| UTP  | Unshielded Balanced Twisted Pair (refer to TP and                               |

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

B. Definitions:

1. Access Floor: Pathway system of removable floor panels supported on adjustable pedestals to allow cable placement in area below.
2. BNC Connector (BNC): United States Military Standard MIL-C-39012/21 bayonet-type coaxial connector with quick twist mating/unmating, and two lugs preventing accidental disconnection from pulling forces on cable.
3. Bond: Permanent joining of metallic parts to form an electrically conductive path to ensure electrical continuity and capacity to safely conduct any currents likely to be imposed to earth ground.
4. Bundled Microducts: All forms of jacketed microducts.
5. Conduit: Includes all raceway types specified.
6. Conveniently Accessible: Capable of being reached without use of ladders, or without climbing or crawling under or over obstacles such as, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

7. 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.
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 mm<sup>2</sup> [1/0 AWG]) stranded copper wire, that connect to Grounding Electrode System and route to telecommunications main grounding busbar (TMGB) and circulate to interconnect various TGBs and other locations shown on drawings.
  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 15                      Restrictions of use for Part 15 listed RF Equipment in Safety of Life Emergency Functions and Equipment Locations
  - Part 47                      Chapter A, Paragraphs 6.1-6.23, Access to Telecommunications Service, Telecommunications Equipment and Customer Premises Equipment
  - Part 58                      Television Broadcast Service
  - Part 73                      Radio and Television Broadcast Rules
  - Part 90                      Rules and Regulations, Appendix C
  - Form 854                      Antenna Structure Registration
  - Chapter XXIII              National Telecommunications and Information Administration (NTIA, P/O Commerce, Chapter XXIII) the 'Red Book'- Chapters 7, 8 & 9 compliments CFR, Title 47, FCC Part 15, RF Restriction of Use and Compliance in "Safety of Life" Functions & Locations
2. US Department of Agriculture, (Title 7, USC, Chapter 55, Sections 2201, 2202 & 2203:RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction:
  - RUS Bull 1751F-630      Design of Aerial Cable Plants
  - RUS Bull 1751F-640      Design of Buried Cable Plant, Physical Considerations
  - RUS Bull 1751F-643      Underground Plant Design
  - RUS Bull 1751F-815      Electrical Protection of Outside Plants,
  - RUS Bull 1753F-201      Acceptance Tests of Telecommunications Plants (PC-4)
  - RUS Bull 1753F-401      Splicing Copper and Fiber Optic Cables (PC-2)
  - RUS Bull 345-50            Trunk Carrier Systems (PE-60)



- RUS Bull 345-65            Shield Bonding Connectors (PE-65)  
RUS Bull 345-72            Filled Splice Closures (PE-74)  
RUS Bull 345-83            Gas Tube Surge Arrestors (PE-80)
3. US Department of Commerce/National Institute of Standards  
Technology, (NIST):
- FIPS PUB 1-1                Telecommunications Information Exchange  
FIPS PUB 100/1              Interface between Data Terminal Equipment (DTE)  
Circuit Terminating Equipment for operation  
with Packet Switched Networks, or Between Two  
DTEs, by Dedicated Circuit  
FIPS PUB 140/2              Telecommunications Information Security  
Algorithms  
FIPS PUB 143                General Purpose 37 Position Interface between  
DTE and Data Circuit Terminating Equipment  
FIPS 160/2                  Electronic Data Interchange (EDI),  
FIPS 175                    Federal Building Standard for  
Telecommunications Pathway and Spaces  
FIPS 191                    Guideline for the Analysis of Local Area  
Network Security  
FIPS 197                    Advanced Encryption Standard (AES)  
FIPS 199                    Standards for Security Categorization of  
Federal Information and Information Systems
4. US Department of Defense, (DoD):
- MIL-STD-188-110            Interoperability and Performance Standards for  
Data Modems  
MIL-STD-188-114            Electrical Characteristics of Digital Interface  
Circuits  
MIL-STD-188-115            Communications Timing and Synchronizations  
Subsystems  
MIL-C-28883                Advanced Narrowband Digital Voice Terminals  
MIL-C-39012/21             Connectors, Receptacle, Electrical, Coaxial,  
Radio Frequency, (Series BNC (Uncabled), Socket  
Contact, Jam Nut Mounted, Class 2)
5. US Department of Health and Human Services:  
The Health Insurance Portability and Accountability Act of 1996  
(HIPAA) Privacy, Security and Breach Notification Rules
6. US Department of Justice:

- 2010 Americans with Disabilities Act Standards for Accessible Design (ADAAD).
7. US Department of Labor, (DoL) - Public Law 426-62 - CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards):
- Subpart 7                      Approved NRTLs; obtain a copy at  
[http://www.osha.gov/dts/otpca/nrtl/faq\\_nrtl.htm](http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.htm)  
1)
- Subpart 35                      Compliance with NFPA 101, Life Safety Code
- Subpart 36                      Design and Construction Requirements for Exit  
Routes
- Subpart 268                      Telecommunications
- Subpart 305                      Wiring Methods, Components, and Equipment for  
General Use
- Subpart 508                      Americans with Disabilities Act Accessibility  
Guidelines; technical requirement for  
accessibility to buildings and facilities by  
individuals with disabilities
8. US Department of Transportation, (DoT):
- a. Public Law 85-625, CFR, Title 49, Part 1, Subpart C - Federal  
Aviation Administration (FAA):AC 110/460-ID & AC 707 / 460-2E -  
Advisory Circulars Standards for Construction of Antenna Towers,  
and 7450 and 7460-2 - Antenna Construction Registration Forms.
9. US Department of Veterans Affairs (VA): Office of Telecommunications  
(OI&T), MP-6, PART VIII, TELECOMMUNICATIONS, CHAPTER 5, AUDIO, RADIO  
AND TELEVISION (and COMSEC) COMMUNICATIONS SYSTEMS: Spectrum  
Management and COMSEC Service (SMCS), AHJ for:
- a. CoG, "Continuance of Government" communications guidelines and  
compliance.
- b. COMSEC, "VA wide coordination and control of security classified  
communication assets."
- c. COOP, "Continuance of Operations" emergency communications  
guidelines and compliance.
- d. FAA, FCC, and US Department of Commerce National  
Telecommunications and Information Administration, "VA wide RF  
Co-ordination, Compliance and Licensing."

- e. Handbook 6100 - Telecommunications: Cyber and Information Security Office of Cyber and Information Security, and Handbook 6500 - Information Security Program.
  - f. Low Voltage Special Communications Systems "Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance and Life Safety Certifications for CFM and VA Facility Low Voltage Special Communications Projects (except Fire Alarm, Telephone and Data Systems)."
  - g. SATCOM, "Satellite Communications" guidelines and compliance, and Security and Law Enforcement Systems - "Coordinates the Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance, DEA and Public Safety Certification(s) for CFM and VA Facility Security Low Voltage Special Communications and Physical Security Projects.
  - h. VHA's National Center for Patient Safety - Veterans Health Administration (VHA) Warning System, Failure of Medical Alarm Systems using Paging Technology to Notify Clinical Staff, July 2004.
  - i. VA's CEOSH, concurrence with warning identified in VA Directive 7700.
  - j. Wireless and Handheld Devices, "Guidelines and Compliance,"
  - k. Office of Security and Law Enforcement: VA Directive 0730 and Health Special Presidential Directive (HSPD)-12.
- C. NRTL Standards: Refer to <https://www.osha.gov/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

|                                 |  |
|---------------------------------|--|
| 65-2010                         | Wired Cabinets   |
| 83-2008                         | Thermoplastic-Insulated Wires and Cables   |
| 96-2005                         | Lightning Protection Components  |
| 96A-2007                        | Installation Requirements for Lightning<br>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<br>with Aluminum and/or Copper Conductors  |
| 493-2007                        | Thermoplastic-Insulated Underground Feeder and<br>Branch Circuit Cable   |
| 497/497A/497B/497C<br>497D/497E | Protectors for Paired Conductors/Communications<br>Circuits/Data Communications and Fire Alarm<br>Circuits/coaxial circuits/voltage<br>protections/Antenna Lead In |
| 510-2005                        | Polyvinyl Chloride, Polyethylene and Rubber<br>Insulating Tape   |
| 514A-2013                       | Metallic Outlet Boxes  |
| 514B-2012                       | Fittings for Cable and Conduit   |
| 514C-1996                       | Nonmetallic Outlet Boxes, Flush-Device Boxes<br>and Covers   |
| 651-2011                        | Schedule 40 and 80 Rigid PVC Conduit   |
| 651A-2011                       | Type EB and A Rigid PVC Conduit and HDPE<br>Conduit  |
| 797-2007                        | Electrical Metallic Tubing   |
| 884-2011                        | Underfloor Raceways and Fittings   |
| 1069-2007                       | Hospital Signaling and Nurse Call Equipment  |
| 1242-2006                       | Intermediate Metal Conduit   |
| 1449-2006                       | Standard for Transient Voltage Surge<br>Suppressors  |
| 1479-2003                       | Fire Tests of Through-Penetration Fire Stops   |

|                    |  |
|--------------------|--|
| 1480-2003          | Speaker Standards for Fire Alarm, Emergency, Commercial and Professional use   |
| 1666-2007          | Standard for Wire/Cable Vertical (Riser) Tray Flame Tests  |
| 1685-2007          | Vertical Tray Fire Protection and Smoke Release Test for Electrical and Fiber Optic Cables                           |
| 1861-2012          | Communication Circuit Accessories  |
| 1863-2013          | Standard for Safety, communications Circuits Accessories   |
| 1865-2007          | Standard for Safety for Vertical-Tray Fire Protection and Smoke-Release Test for Electrical and Optical-Fiber Cables |
| 2024-2011          | Standard for Optical Fiber Raceways  |
| 2024-2014          | Standard for Cable Routing Assemblies and Communications Raceways  |
| 2196-2001          | Standard for Test of Fire Resistive Cable  |
| 60950-1 ed. 2-2014 | Information Technology Equipment Safety  |

D. Industry Standards:

1. Advanced Television Systems Committee (ATSC):
  - A/53 Part 1: 2013 ATSC Digital Television Standard, Part 1, Digital Television System
  - A/53 Part 2: 2011 ATSC Digital Television Standard, Part 2, RF/Transmission System Characteristics
  - A/53 Part 3: 2013 ATSC Digital Television Standard, Part 3, Service Multiplex and Transport System Characteristics
  - A/53 Part 4: 2009 ATSC Digital Television Standard, Part 4, MPEG-2 Video System Characteristics
  - A/53 Part 5: 2014 ATSC Digital Television Standard, Part 5, AC-3 Audio System Characteristics
  - A/53 Part 6: 2014 ATSC digital Television Standard, Part 6, Enhanced AC-3 Audio System Characteristics
2. American Institute of Architects (AIA): 2006 Guidelines for Design & Construction of Health Care Facilities.
3. American Society of Mechanical Engineers (ASME):
  - A17.1 (2013) Safety Code for Elevators and Escalators  
Includes Requirements for Elevators,

- Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices
- 17.3 (2011) Safety Code for Existing Elevators and Escalators
- 17.4 (2009) Guide for Emergency Personnel
- 17.5 (2011) Elevator and Escalator Electrical Equipment
4. American Society for Testing and Materials (ASTM):
- B1 (2001) Standard Specification for Hard-Drawn Copper Wire
- B8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- D1557 (2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)
- D2301 (2004) Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- B258-02 (2008) Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors
- D709-01(2007) Standard Specification for Laminated Thermosetting Materials
- D4566 (2008) Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable
5. American Telephone and Telegraph Corporation (AT&T) - Obtain following AT&T Publications at <https://ebiznet.sbc.com/SBCNEBS/>):
- ATT-TP-76200 (2013) Network Equipment and Power Grounding, Environmental, and Physical Design Requirements
- ATT-TP-76300(2012) Merged AT&T Affiliate Companies Installation Requirements
- ATT-TP-76305 (2013) Common Systems Cable and Wire Installation and Removal Requirements - Cable Racks and Raceways
- ATT-TP-76306 (2009) Electrostatic Discharge Control

- ATT-TP-76400 (2012) Detail Engineering Requirements
  - ATT-TP-76402 (2013) AT&T Raised Access Floor Engineering and Installation Requirements
  - ATT-TP-76405 (2011) Technical Requirements for Supplemental Cooling Systems in Network Equipment Environments
  - ATT-TP-76416 (2011) Grounding and Bonding Requirements for Network Facilities
  - ATT-TP-76440 (2005) Ethernet Specification
  - ATT-TP-76450 (2013) Common Systems Equipment Interconnection Standards for AT&T Network Equipment Spaces
  - ATT-TP-76461 (2008) Fiber Optic Cleaning
  - ATT-TP-76900 (2010) AT&T Installation Testing Requirement
  - ATT-TP-76911 (1999) AT&T LEC Technical Publication Notice
6. British Standards Institution (BSI):
- BS EN 50109-2 Hand Crimping Tools - Tools for The Crimp Termination of Electric Cables and Wires for Low Frequency and Radio Frequency Applications - All Parts & Sections. October 1997
7. Building Industry Consulting Service International(BICSI):
- ANSI/BICSI 002-2011 Data Center Design and Implementation Best Practices
  - ANSI/BICSI 004-2012 Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
  - ANSI/NECA/BICSI 568-2006 Standard for Installing Commercial Building Telecommunications Cabling
  - NECA/BICSI 607-2011 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
  - ANSI/BICSI 005-2013 Electronic Safety and Security (ESS) System Design and Implementation Best Practices
8. Electronic Components Assemblies and Materials Association,(ECA).
- ECA EIA/RS-270 (1973)Tools, Crimping, Solderless Wiring Devices - Recommended Procedures for User Certification
  - EIA/ECA 310-E (2005) Cabinets, and Associated Equipment

9. Facility Guidelines Institute: 2010 Guidelines for Design and Construction of Health Care Facilities.
10. Insulated Cable Engineers Association (ICEA):
- ANSI/ICEA  
S-80-576-2002 Category 1 & 2 Individually Unshielded Twisted-Pair Indoor Cables for Use in Communications Wiring Systems
- ANSI/ICEA  
S-84-608-2010 Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor, S-87-640(2011) Optical Fiber Outside Plant Communications Cable
- ANSI/ICEA  
S-90-661-2012 Category 3, 5, & 5e Individually Unshielded Twisted-Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems
- S-98-688 (2012) Broadband Twisted Pair Cable Aircore, Polyolefin Insulated, Copper Conductors
- S-99-689 (2012) Broadband Twisted Pair Cable Filled, Polyolefin Insulated, Copper Conductors
- ICEA S-102-700 (2004) Category 6 Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for use in Communications Wiring Systems Technical Requirements
11. Institute of Electrical and Electronics Engineers (IEEE):
- ISSN 0739-5175 March-April 2008 Engineering in Medicine and Biology Magazine, IEEE (Volume: 27, Issue:2) Medical Grade-Mission Critical-Wireless Networks
- IEEE C2-2012 National Electrical Safety Code (NESC)  
C62.41.2-2002/  
Cor 1-2012 IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits 4)



- C62.45-2002 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
- 81-2012 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
- 100-1992 IEEE the New IEEE Standards Dictionary of Electrical and Electronics Terms
- 602-2007 IEEE Recommended Practice for Electric Systems in Health Care Facilities
- 1100-2005 IEEE Recommended Practice for Powering and Grounding Electronic Equipment
12. International Code Council:  
AC193 (2014) Mechanical Anchors in Concrete Elements
13. International Organization for Standardization (ISO):  
ISO/TR 21730 (2007) Use of Mobile Wireless Communication and Computing Technology in Healthcare Facilities - Recommendations for Electromagnetic Compatibility (Management of Unintentional Electromagnetic Interference) with Medical Devices
14. National Electrical Manufacturers Association (NEMA):  
NEMA 250 (2008) Enclosures for Electrical Equipment (1,000V Maximum)  
ANSI C62.61 (1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits  
ANSI/NEMA FB 1 (2012) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable  
ANSI/NEMA OS 1 (2009) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports  
NEMA SB 19 (R2007) NEMA Installation Guide for Nurse Call Systems  
TC 3 (2004) Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing  
NEMA VE 2 (2006) Cable Tray Installation Guidelines
15. National Fire Protection Association (NFPA):  
70E-2015 Standard for Electrical Safety in the Workplace

- 70-2014 National Electrical Code (NEC)
- 72-2013 National Fire Alarm Code
- 75-2013 Standard for the Fire Protection of Information Technological Equipment
- 76-2012 Recommended Practice for the Fire Protection of Telecommunications Facilities
- 77-2014 Recommended Practice on Static Electricity
- 90A-2015 Standard for the Installation of Air Conditioning and Ventilating Systems
- 99-2015 Health Care Facilities Code
- 101-2015 Life Safety Code
- 241 Safeguarding construction, alternation and Demolition Operations
- 255-2006 Standard Method of Test of Surface Burning Characteristics of Building Materials
- 262 - 2011 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
- 780-2014 Standard for the Installation of Lightning Protection Systems
- 1221-2013 Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
- 5000-2015 Building Construction and Safety Code
- 16. Society for Protective Coatings (SSPC):  
SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning
- 17. Society of Cable Telecommunications Engineers (SCTE):  
ANSI/SCTE 15 2006 Specification for Trunk, Feeder and Distribution Coaxial Cable
- 18. Telecommunications Industry Association (TIA):  
TIA-120 Series Telecommunications Land Mobile communications (APCO/Project 25) (January 2014)  
TIA TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems (2004)

|                    |  |
|--------------------|--|
| TIA-155            | Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T (2010)   |
| TIA TSB-162-A      | Telecommunications Cabling Guidelines for Wireless Access Points (2013)  |
| TIA-222-G          | Structural Standard for Antenna Supporting Structures and Antennas (2014)  |
| TIA/EIA-423-B      | Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits (2012)   |
| TIA-455-C          | General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components (August 2014) |
| TIA-455-53-A       | FOTP-53 Attenuation by Substitution Measurements for Multimode Graded-Index Optical Fibers in Fiber Assemblies (Long Length) (September 2001)  |
| TIA-455-61-A       | FOTP-61 Measurement of Fiber of Cable Attenuation Using an OTDR (July 2003)  |
| TIA-472D000-B      | Fiber Optic Communications Cable for Outside Plant Use (July 2007)   |
| ANSI/TIA-492-B     | 62.5- $\mu$ Core Diameter/125- $\mu$ m Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers (November 2009)  |
| ANSI/TIA-492AAAB-A | 50- $\mu$ m Core Diameter/125- $\mu$ m Cladding Diameter Class IA Graded-Index Multimode Optically Optimized American Standard Fibers (November 2009)                                  |
| TIA-492CAAA        | Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers (September 2002)  |
| TIA-492E000        | Sectional Specification for Class IVd Nonzero-Dispersion Single-Mode Optical Fibers for the 1,550 nm Window (September 2002)   |

TIA-526-7-B Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant - OFSTP-7 (December 2008)

TIA-526.14-A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant - SFSTP-14 (August 1998)

TIA-568 Revision/Edition: C Commercial Building Telecommunications Cabling Standard Set: (TIA-568-C.0-2 Generic Telecommunications Cabling for Customer Premises (2012), TIA-568-C.1-1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements (2012), TIA-568-C.2 Commercial Building Telecommunications Cabling Standard-Part 2: Balanced Twisted Pair Cabling Components (2009), TIA-568-C.3-1 Optical Fiber Cabling Components Standard, (2011) AND TIA-568-C.4 Broadband Coaxial Cabling and Components Standard (2011) with addendums and erratas

TIA-569 Revision/Edition C Telecommunications Pathways and Spaces (March 2013)

TIA-574 Position Non-Synchronous Interface between Data Terminal equipment and Data Circuit Terminating Equipment Employing Serial Binary Interchange (May 2003)

TIA/EIA-590-A Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant (July 2001)

TIA-598-D Optical Fiber Cable Color Coding (January 2005)

TIA-604-10-B Fiber Optic Connector Intermateability Standard (August 2008)

ANSI/TIA-606-B Administration Standard for Telecommunications Infrastructure (2012)

TIA-607-B Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises (January 2013)

|                |   |
|----------------|---|
| TIA-613        | High Speed Serial Interface for Data Terminal Equipment and Data Circuit Terminal Equipment (September 2005)                    |
| ANSI/TIA-758-B | Customer-owned Outside Plant Telecommunications Infrastructure Standard (April 2012)  |
| ANSI/TIA-854   | A Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling (2001) |
| ANSI/TIA-862-A | Building Automation Systems Cabling Standard (April 2011)   |
| TIA-942-A      | Telecommunications Infrastructure Standard for Data Centers (March 2014)  |
| TIA-1152       | Requirements for Field Testing Instruments and Measurements for Balanced Twisted Pair Cabling (September 2009)                  |
| TIA-1179       | Healthcare Facility Telecommunications Infrastructure Standard (July 2010)  |

#### **1.4 SINGULAR NUMBER**

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

#### **1.5 RELATED WORK**

- A. Specification Order of Precedence: FAR Clause 52.236-21, VAAR Clause 852.236-71.
1. Field Cutting and Patching: Section 09 91 00, PAINTING.
  2. Additional submittal requirements: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
  3. Availability and source of references and standards specified in applicable publications: Section 01 42 19, REFERENCE STANDARDS.
  4. Requirements for non-hazardous building construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
  5. General requirements and procedures to comply with various federal mandates and U.S. Department of Veterans Affairs (VA) policies for sustainable design: Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.

6. 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.
7. Sealant and caulking materials and their application: Section 07 92 00, JOINT SEALANTS.
8. General electrical requirements that are common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
9. 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).
10. 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.
11. Conduit and boxes: Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
12. Wiring devices: Section 26 27 26, WIRING DEVICES.
13. General requirements common to more than one section in Division 28: Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
14. Conductors and cables for electronic safety and security systems: Section 28 05 13, CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY.
15. Low impedance path to ground for electronic safety and security system ground fault currents: Section 28 05 26, GROUNDING AND BONDING FOR SECURITY SYSTEMS.
16. Conduits and partitioned telecommunications raceways for Electronic Safety and Security systems: Section 28 05 28.33, CONDUITS AND BACK BOXES FOR ELECTRONIC SAFETY AND SECURITY.
17. Physical Access Control System field-installed controllers connected by data transmission network: Section 28 13 00, PHYSICAL ACCESS DETECTION.
18. Video surveillance system cameras, data transmission wiring, and control stations with associated equipment: Section 28 23 00, VIDEO SURVEILLANCE EQUIPMENT AND SYSTEMS.

19. Duress-panic alarms, emergency phones or call boxes, intercom systems, data transmission wiring and associated equipment: Section 28 26 00, ELECTRONIC PERSONAL PROTECTION EQUIPMENT AND SYSTEMS.
20. 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.
  3. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work.
  4. 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. Submittals are required for all equipment anchors and supports. Include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or conduit. 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. Fiber optic insertion loss power meter with light source.
    - c. Optical time domain reflectometer (OTDR).
    - d. Volt-Ohm meter.
    - e. Digital camera.
    - f. Bit Error Test Set (BERT).
    - g. Signal level meter.



3. Supply only test equipment with a calibration tag from Government-accepted calibration service dated not more than 12 months prior to test.

G. Provide sustainable design submittals.

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

#### **1.8 CLOSEOUT SUBMITTALS**

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

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

B. Record Wiring Diagrams:

1. Red Line Drawings: Keep one E size 91.44 cm x 121.92 cm (36 inches x 48 inches) set of floor plans, on site during work hours, showing installation progress marked and backbone cable labels noted. Make these drawings available for examination during construction meetings or field inspections.
2. General Drawing Specifications: Detail and elevation drawings to be D size 61 cm x 91.44 cm (24 inches x 36 inches) with a minimum scale of 0.635 cm = 30.48 cm (1/4 inch = 12 inches). ER, TR and other enlarged detail floor plan drawings to be D size 61 cm x 91.44 cm (24" x 36") with a minimum scale of 0.635 cm = 30.48 cm (1/4 inch = 12 inches). Building composite floor plan drawings to be D size 61 cm x 91.44 cm (24 inches x 36 inches) with a minimum scale of 3.175 mm = 30.48 cm (1/8 inch = 1' 0 inch).
3. Building Composite Floor Plans: Provide building floor plans showing work area outlet locations and configuration, types of jacks, distance for each cable, and cable routing locations.
4. Floor plans to include:
  - a. Final room numbers and actual backbone cabling and pathway locations and labeling.
  - b. Inputs and outputs of equipment identified according to labels installed on cables and equipment
  - c. Device locations with labels.
  - d. Conduit.

- e. Head-end equipment.
  - f. Wiring diagram.
  - g. Labeling and administration documentation.
5. Submit Record Wiring Diagrams within five business days after final cable testing.
  6. Deliver Record Wiring Diagrams as CAD files in .dwg or .rvt formats as determined by COR.
  7. Deliver four complete sets of electronic record wiring diagrams to COR on portable storage drive.

#### **1.9 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.

#### **1.10 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.

### **1.11 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.

### **1.12 WARRANTY**

## **PART 2 - COMPLY WITH FAR CLAUSE 52.246-21.PRODUCTS**

### **2.1 PERFORMANCE AND DESIGN CRITERIA**

- A. Provide communications spaces and pathways conforming to TIA 569, at a minimum.
- B. 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.
- B. Nameplates furnished by manufacturer as standard catalog items, unless other method of identification is indicated.

### **2.3 WIRE LUBRICATING COMPOUND**

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

### **2.4 FIREPROOFING**

- 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.
- F. Firestopping cable penetration pathway: Provide 4"SQ fire rated pathways each consisting of an enclosed heavy gauge galvanized steel pathway containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL classified and tested to the requirements of ASTM E814.

## **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 and cable trays 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. Provide firestopping cable pathways per PART 2 in the following locations:
    - a. Telecommunication rooms (new and existing)
    - b. Corridor walls (when quantity exceeds 20 cables)
    - c. Floors

3. Make sleeves that penetrate outside walls, basement slabs, footings, and beams waterproof.
  4. 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.
  5. Install sleeves through floors watertight and extend minimum 50.8 mm (2 inches) above floor surface.
  6. Match and set sleeves flush with adjoining floor, ceiling, and wall finishes where raceways passing through openings are exposed in finished rooms.
  7. Annular space between conduit and sleeve must be minimum 6 mm (1/4 inch).
  8. Do not provide sleeves for slabs-on-grade, unless specified or indicated otherwise.
  9. Comply with requirements for firestopping, for sleeves through rated fire walls and smoke partitions.
  10. Do not support piping risers or conduit on sleeves.
  11. Identify unused sleeves and slots for future installation.
  12. 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. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that would void warranty.

### **3.2 INSTALLATION - GENERAL**

- A. Coordinate systems, equipment, and materials installation with other building components.
- B. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
- C. Conform to VAAR 852.236.91 arrangements indicated, recognizing that work may be shown in diagrammatic form or have been impracticable to detail all items because of variances in manufacturers' methods of achieving specified results.
- D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed in both exposed and un-exposed spaces.
- E. Install equipment according to manufacturers' written instructions.
- F. Install wiring and cabling between equipment and related devices.
- G. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect

equipment for ease of disconnecting, with minimum interference of adjacent other installations.

- H. Provide access panel or doors where units are concealed behind finished surfaces.
- I. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for wiring, cabling, and equipment installations.
- J. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom and access for service and maintenance as possible.
- K. Install systems, materials, and equipment giving priority to systems required to be installed at a specified slope.
- L. Avoid interference with structure and with work or other trades, preserving adequate headroom and clearing doors and passageways to satisfaction of COR and code requirements.
- M. Install equipment and cabling to distribute equipment loads on building structural members provided for equipment support under other sections; install and support roof-mounted equipment on structural steel or roof curbs as appropriate.
- N. Provide supplementary or miscellaneous items, appurtenances, devices and materials for a complete installation.

### **3.3 EQUIPMENT IDENTIFICATION**

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Secure identification signs with screws.

### **3.4 CUTTING AND PATCHING**

- A. Perform cutting and patching according to contract general requirements and as follows:
  - 1. Remove and replace defective work.
  - 2. Remove and replace non-conforming work.
- B. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
- C. Protect adjacent installations during cutting and patching operations.
- D. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Patch finished surfaces and building components using new materials specified for original installation and experienced installers.



### 3.5 FIELD QUALITY CONTROL

- A. Provide work according to VAAR 852.236.91 and FAR clause 52.236-5.
- B. Provide minimum clearances and work required for compliance with NFPA 70, National Electrical Code (NEC), and manufacturers' instructions; comply with additional requirements indicated for access and clearances.
- C. Verify all field conditions and dimensions that affect selection and provision of materials and equipment, and provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment.
  - 1. Protect facility, equipment, and wiring from damage.
- D. Submit written notice that:
  - 1. Project has been inspected for compliance with documents.
  - 2. Work has been completed in accordance with documents.
- E. Non-Conforming Work: Conduct project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing and demonstrations after verification of system operation and completeness by Contractor.
- F. 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.

### 3.6 CLEANING

- A. Remove debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from project site and clean work area, prior to final inspection and acceptance of work.
- B. Put building and premises in neat and clean condition.
- C. Remove debris on a daily basis.
- D. Remove unused material, during progress of work.
- E. Perform cleaning and washing required to provide acceptable appearance and operation of equipment to satisfaction of COR.
- F. Clean exterior surface of all equipment, including concrete residue, dirt, and paint residue, after completion of project.
- G. Perform final cleaning prior to project acceptance by COR.
- H. Remove paint splatters and other spots, dirt, and debris; touch up scratches and mars of finish to match original finish.
- I. Clean devices internally using methods and materials recommended by manufacturer.
- J. Tighten wiring connectors, terminals, bus joints, and mountings, to include lugs, screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. In absence of published connection or terminal torque values, comply with torque values specified in UL 486A-486B.

### 3.7 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.

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**SECTION 27 05 26**  
**GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section identifies common and general grounding and bonding requirements of communication installations and applies to all sections of Divisions 27 and 28.

**1.2 RELATED WORK**

- A. Low voltage wiring: Section 27 10 00, CONTROL, COMMUNICATION AND SIGNAL WIRING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Provide plan indicating location of system grounding electrode connections and routing of aboveground and underground grounding electrode conductors.
- C. Closeout Submittals: In addition to Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS provide the following:
1. Certified test reports of ground resistance.
  2. Certifications: Two weeks prior to final inspection, submit following to COR:
    - a. Certification materials and installation is in accordance with construction documents.
    - b. Certification complete installation has been installed and tested.

**PART 2 - PRODUCTS**

**2.1 COMPONENTS**

- A. Grounding and Bonding Conductors:
1. Provide UL 83 insulated stranded copper equipment grounding conductors, with the exception of solid copper conductors for sizes 6 mm<sup>2</sup> (10 AWG) and smaller. Identify all grounding conductors with continuous green insulation color, except identify wire sizes 25 mm<sup>2</sup> (4 AWG) and larger per NEC.
  2. Provide ASTM B8 bare stranded copper bonding conductors, with the exception of ASTM B1 solid bare copper for wire sizes 6 mm<sup>2</sup> (10 AWG) and smaller.

- B. Ground Terminal Blocks: Provide screw lug-type terminal blocks at equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted.
  - 1. Electroplated tin aluminum extrusion.
  - 2. Accept conductors ranging from #14 AWG through 2/0.
  - 3. Hold conductors in place by two stainless steel set screws.
  - 4. Two 6 mm (1/4 inch) holes spaced on 15.8 mm (5/8 inch) centers to allow secure two-bolt attachment.
  - 5. Listed as a wire connector.
- C. Splice Case Ground Accessories: Provide splice case grounding and bonding accessories manufactured by splice case manufacturer when available. Otherwise, use 16 mm<sup>2</sup> (6 AWG) insulated ground wire with shield bonding connectors.
- D. Irreversible Compression Lugs:
  - 1. Electroplated tinned copper.
  - 2. Two holes spaced on 15.8 mm (5/8 inch) or 25.4 mm (1 inch) centers.
  - 3. Sized to fit the specific size conductor.
  - 4. Listed as wire connectors.
- E. Antioxidant Joint Compound: Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

### **PART 3 - EXECUTION**

#### **3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Conduit Systems:
  - 1. Bond ferrous metallic conduit to ground.
  - 2. Bond grounding conductors installed in ferrous metallic conduit at both ends of conduit using grounding bushing with #6 AWG conductor.
- B. Boxes, Cabinets, and Enclosures:
  - 1. Bond each pull box, splice box, equipment cabinet, and other enclosures through which conductors pass (except for special grounding systems for intensive care units and other critical units shown) to ground.
- C. Corrosion Inhibitors: Apply corrosion inhibitor for protecting connection between metals used to contact surfaces, when making ground and ground bonding connections.
- D. Telecommunications Grounding System:

1. Bond telecommunications grounding systems and equipment to facility's electrical grounding electrode at Intersystem Bonding Termination.
2. Provide hardware as required to effectively bond metallic cable shields communications pathways, cable runway, and equipment chassis to ground.
3. Install bonding conductors without splices using shortest length of conductor possible to maintain clearances required by NEC.
4. Provide paths to ground that are permanent and continuous with a resistance of 1 ohm or less from each raceway, cable tray, and equipment connection to telecommunications grounding busbar.
5. Below-Grade Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with manufacturer's recommendations. After welds have been made and cooled, brush slag from weld area and thoroughly clean joint areas. Notify COR prior to backfilling at ground connections.
6. Above-Grade Bolted or Screwed Grounding Connections:
  - a. Remove paint to expose entire contact surface by grinding.
  - b. Clean all connector, plate and contact surfaces.
  - c. Apply corrosion inhibitor to surfaces before joining.
7. Bonding Jumpers:
  - a. Assemble bonding jumpers using insulated ground wire of size and type shown on drawings or use a minimum of 16 mm<sup>2</sup> (6 AWG) insulated copper wire terminated with compression connectors of proper size for conductors.
  - b. Use connector manufacturer's compression tool.
8. Bonding Jumper Fasteners:
  - a. Conduit: Connect bonding jumpers using lugs on grounding bushings or clamp pads on push-type conduit fasteners. Where appropriate, use zinc-plated external tooth lockwashers or Belleville Washers.
  - b. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers or Belleville washers and nuts. Install protective cover, e.g., zinc-plated acorn nuts, on bolts extending into wireway or cable tray to prevent cable damage.

- c. Grounding Busbars: Fasten bonding conductors using two-hole compression lugs. Use 300 series stainless steel bolts, Belleville Washers, and nuts.
  - d. Slotted Channel Framing and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and Belleville washers or external tooth lock washers.
- E. Other Communication Room Ground Systems: Ground metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray or telecommunications ground busbar, whichever is closer, using insulated 16 mm<sup>2</sup> (6 AWG) ground wire bonding jumpers.
- F. Communications Cable Grounding:
- 1. Bond all metallic cable sheaths in multi-pair communications cables together at each splicing or terminating location to provide 100 percent metallic sheath continuity throughout communications distribution system.
  - 2. Install a cable shield bonding connector with a screw stud connection for ground wire, at terminal points. Bond cable shield connector to ground.
  - 3. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or splice case manufacturer's splice case grounding and bonding accessories. When an external ground connection is provided as part of splice closure, connect to an effective ground source and bond all other metallic components and equipment at that location.
- G. Communications Cable Tray Systems:
- 1. Bond metallic structures of cable tray to provide 100 percent electrical continuity throughout cable tray systems.
  - 2. Where metallic cable tray systems are mechanically discontinuous:
    - a. Install splice plates provided by cable tray manufacturer between cable tray sections so resistance across a bolted connection is 0.010 ohms or less, as verified by measuring across splice plate connection.
    - b. Install 16 mm<sup>2</sup> (6 AWG) bonding jumpers across each cable tray splice or junction where splice plates cannot be used.

3. Bond cable tray installed in same room as telecommunications grounding busbar to busbar.

H. Communications Raceway Grounding:

1. Conduit: Use insulated 16 mm<sup>2</sup> (6 AWG) bonding jumpers to bond metallic conduit at both ends and intermediate metallic enclosures to ground.
2. Cable Tray Systems: Use insulated 16 mm<sup>2</sup> (6 AWG) grounding jumpers to bond cable tray to column-mounted building ground plates (pads) at both ends and approximately 16 meters (50 feet) on centers.

**3.2 FIELD QUALITY CONTROL**

- A. Perform tests per BICSI's Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria.
- B. Conduct continuity test to verify that metallic pathways in telecommunications spaces are bonded to TGB or TMGB.

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**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.
- C. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

**1.3 SUBMITTALS**

- A. In accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, submit the following:
1. Size and location of cabinets, splice boxes and pull boxes.
  2. Layout of required conduit penetrations through structural elements.
  3. Catalog cuts marked with specific item proposed and area of application identified.
- B. Certification: Provide letter prior to final inspection, certifying material is in accordance with construction documents and properly installed.

**PART 2 - PRODUCTS**

**2.1 MATERIAL**

- A. Minimum Conduit Size: 19 mm (3/4 inch).
- B. Conduit:
1. Rigid Galvanized Steel: Conform to UL 6, ANSI C80.1.
  2. Rigid Aluminum: Conform to UL 6A, ANSI C80.5.
  3. Electrical Metallic Tubing (EMT):
    - a. Maximum Size: 105 mm (4 inches).
    - b. Install only for cable rated 600 volts or less.
    - c. Conform to UL 797, ANSI C80.3.
  4. Flexible Galvanized Steel Conduit: Conform to UL 1.
  5. Liquid-tight Flexible Metal Conduit: Conform to UL 360.



6. Direct Burial Plastic Conduit: Conform to UL 651 and UL 651A, heavy wall PVC, or high density polyethylene (HDPE).
7. Surface Metal Raceway: Conform to UL 5.
8. Wireway, Approved "Basket": Provide "Telecommunications Service" rated with approved length way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.

C. Conduit Fittings:

1. Rigid Galvanized Steel Fittings:

- a. Provide fittings meeting requirements of UL 514B and ANSI/ NEMA FB 1.
- b. Sealing: Provide threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water and vapor. In concealed work, install sealing fittings in flush steel boxes with blank cover plates having same finishes as other electrical plates in room.
- c. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
- d. Locknuts: Bonding type with sharp edges for digging into metal wall of an enclosure.
- e. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into metallic body of fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
- f. Erickson (union-type) and Set Screw Type Couplings:
  - 1) Couplings listed for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete.
  - 2) Use set screws of case hardened steel with hex head and cup point to seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
- g. Provide OEM approved fittings.

2. Rigid Aluminum Conduit Fittings:

- a. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are not permitted.

- b. Locknuts and Bushings: As specified for rigid steel and IMC conduit.
- c. Set Screw Fittings: Not permitted for use with aluminum conduit.
- 3. 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.
- 4. 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.
- 5. Liquid-tight Flexible Metal Conduit Fittings:
  - a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
  - b. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
  - c. Provide connectors with insulated throats to prevent damage to cable jacket.
  - d. Provide OEM approved fittings.
- 6. Surface Metal Raceway: Conform to UL 5 and "telecommunications service" rated with approved length-way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.
- 7. Surface Metal Raceway Fittings: As recommended by raceway manufacturer.

8. Expansion and Deflection Couplings:
    - a. Conform to UL 467 and UL 514B.
    - b. Accommodate 19 mm (3/4 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
    - c. Include internal flexible metal braid sized to ensure conduit ground continuity and fault currents in accordance with UL 467, and NEC code tables for ground conductors.
    - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
  9. Rigid Aluminum Fittings:
    - a. Provide malleable iron, steel or aluminum alloy materials; zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
    - b. Locknuts and Bushings: As specified for rigid steel and IMC conduit.
    - c. Set Screw Fittings: Not permitted for use with aluminum conduit.
    - d. Indent type connectors or couplings are prohibited.
    - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are not permitted.
    - f. Provide OEM approved fittings.
  10. Wireway Fittings: As recommended by wireway OEM.
- D. Conduit Supports:
1. Parts and Hardware: Provide zinc-coat or equivalent corrosion protection.
  2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
  3. Multiple Conduit (Trapeze) Hangers: Minimum 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 2.78 mm (12 gage) steel, cold formed, lipped channels; with minimum 9 mm (3/8 inch) diameter steel hanger rods.
  4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Splice, and Pull Boxes:
1. Conform to UL-50 and UL-514A.

2. Cast metal where required by NEC or shown, and equipped with rustproof boxes.
  3. Sheet Metal Boxes: Galvanized steel, except where otherwise shown.
  4. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with wall.
  5. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.
- G. Flexible Nonmetallic Communications Raceway (Innerduct) and Fittings:
1. General: Provide UL 910 listed plenum, riser, and general purpose corrugated pliable communications raceway for optical fiber cables and communications cable applications; select in accordance with provisions of NEC Articles 770 and 800.
  2. Provide Communications Raceway with a factory installed 567 kg (1250 lb.) tensile pre-lubricated pull tape.
  3. Use only metallic straps, hangers and fittings to support raceway from building structure. Cable ties are not permitted for securing raceway to building structure.
  4. Provide fittings to be installed in spaces used for environmental air made of materials that do not exceed flammability, smoke generation, ignitibility, and toxicity requirements of environmental air space.
  5. Size: Metric Designator 53 (trade size 2) or smaller.
  6. Outside Plant: Plenum-rated where each interduct is 75 mm (3 inches) and larger.
  7. Inside Plant: Listed and marked for installation in plenum airspaces and minimum 25 mm (1 inch) inside diameter.
  8. Plenum: Non-metallic communications raceway.
    - a. Constructed of low smoke emission, flame retardant PVC with corrugated construction.
    - b. UL 94 V-0 rating for flame spreading limitation.
  9. Provide innerduct reel lengths as necessary to ensure ducts are continuous; one piece runs from ENTR to MH; MH to MH; DEMARC to MCR/TER; TR to TR. Innerduct connectors are not permitted between rooms.

10. Provide pulling accessories used for innerduct including but not limited to, inner duct lubricants, spreaders, applicators, grips, swivels, harnesses, and line missiles (blown air) compatible with materials being pulled.
- H. Outlet Boxes:
1. Flush wall mounted minimum 11.9 cm (4-11/16 inches) square, 9.2 cm (3-5/8 inches) deep pressed galvanized steel.
  2. 2-Gang Tile Box:
    - a. Flush backbox type for installation in block walls.
    - b. Minimum 92 mm (3-5/8 inches) deep.
- I. Weatherproof Outlet Boxes: Surface mount two gang, 67 mm (2-5/8 inches) deep weatherproof cast aluminum with powder coated finish internal threads on hubs 19 mm (3/4 inch) minimum.
- J. Cable Tray:
1. Provide wire basket type of sizes indicated; with all required splicing and mounting hardware.
  2. Materials and Finishes:
    - a. Electro-plated zinc galvanized (post plated) made from carbon steel and plated to ASTM B 633, Type III, SC-1.
    - b. Remove soot, manufacturing residue/oils, or metallic particles after fabrication.
    - c. Rounded edges and smooth surfaces.
  3. Provide continuous welded top side wire to protect cable insulation and installers.
  4. High strength steel wires formed into a 50 x 100 mm (2 inches by 4 inches) wire mesh pattern with intersecting wires welded together.
  5. Wire Basket Sizes:
    - a. Wire Diameter: 5 mm (0.195 inch) minimum on all mesh sections.
    - b. Usable Loading Depth: 105 mm (4 inch).
    - c. Width: 450 mm (18 inches).
  6. Fittings: Field-formed, from straight sections, in accordance with manufacturer's instructions.
  7. Provide accessories to protect, support and install wire basket tray system.
- K. Cable Duct: Equip with hinged covers, except where removable covers are accepted by COR.
- L. Cable Duct Fittings: As recommended by cable duct OEM.

**PART 3 - EXECUTION**

**3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS**

A. Raceways typically required for cabling systems unless otherwise indicated:

| System   | Specification Section | Installed Method  |
|--|-----------------------|---|
| Grounding  | 27 05 26              | Conduit Not Required  |
| Control, Communication and Signal Wiring                 | 27 10 00              | Complete Conduit Allowed in Non-Partitioned Cable Tray or Cable Ladders |
| Communications Structured Cabling                        | 27 15 00              | Conduit to Cable Tray<br>Partitioned Cable Tray                         |
| Grounding and Bonding for Electronic Safety and Security | 28 05 26              | Conduit Not Required Unless Required by Code                            |
| Physical Access Control System                           | 28 13 00              | Conduit to Cable Tray<br>Partitioned Cable Tray                         |
| Video Surveillance                                       | 28 23 00              | Complete Conduit  |
| Electronic Personal Protection System                    | 28 26 00              | Conduit to Cable Tray,<br>Partitioned Cable Tray                        |
| Fire Detection and Alarm                                 | 28 31 00              | Complete Conduit  |

B. Penetrations:

1. Cutting or Holes:

- a. Locate holes in advance of installation. 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. Cable trays shall not pass through fire partitions, fire walls, smoke partitions,

or floors but shall transition to a "Firestopping cable penetration pathway" as specified in (B)(2) of this section.

- 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.
2. Firestopping cable penetration pathway: Provide 4"SQ fire rated pathways each consisting of an enclosed heavy gauge galvanized steel pathway containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL classified and tested to the requirements of ASTM E814.
- a. 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.

### **3.2 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. Separate cabling types outside of telecommunications room and route through "Firestopping cable penetration pathways" as specified elsewhere in this section. Voice and data cables shall be installed in separate pathways to for an orderly, neat installation to telecommunications racks.
8. Minimum radius of communication conduit bends:

| Sizes of Conduit<br>Trade Size | Radius of Conduit Bends<br>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. Do not use aluminum conduits in wet locations.
  20. Unless otherwise indicated on drawings or specified herein, conceal conduits within finished walls, floors and ceilings.
  21. 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.
  22. 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.
- B. Concealed Work Installation:
1. In Concrete:
    - a. Conduit: Rigid steel.
    - b. Align and run conduit in direct lines.
    - c. Install conduit through concrete beams only when the following occurs:
      - 1) Where shown on structural drawings.
      - 2) As accepted by COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
    - d. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
      - 1) Conduit outside diameter larger than 1/3 of slab thickness is prohibited.
      - 2) Space between Conduits in Slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
      - 3) Install conduits approximately in center of slab to ensure a minimum of 19 mm (3/4 inch) of concrete around conduits.
    - e. Make couplings and connections watertight. Use thread compounds that are NRTL listed conductive type to ensure low resistance

ground continuity through conduits. Tightening set screws with pliers is not permitted.

C. 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.

D. Exposed Work Installation:

1. Unless otherwise indicated on drawings, exposed conduit is only permitted in telecommunications rooms.
  - a. Provide rigid steel, 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.

E. 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.

F. Conduit Supports, Installation:

1. Select AC193 code listed mechanical anchors or fastening devices with safe working load not to exceed 1/4 of proof test load.

2. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
3. Support multiple conduit runs with trapeze hangers. Use trapeze hangers designed to support a load equal or greater than sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other accepted fasteners.
4. Support conduit independent of pull boxes, luminaires, suspended ceiling components, angle supports, duct work, and similar items.
5. Fastenings and Supports in Solid Masonry and Concrete:
  - a. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing concrete.
  - b. Existing Construction:
    - 1) Code AC193 listed wedge type steel expansion anchors minimum 6 mm (1/4 inch) bolt size and minimum 28 mm (1-1/8 inch) embedment.
    - 2) Power set fasteners minimum 6 mm (1/4 inch) diameter with depth of penetration minimum 75 mm (3 inches).
    - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
6. Fastening to Hollow Masonry: Toggle bolts are permitted.
7. Fastening to Metal Structures: Use machine screw fasteners or other devices designed and accepted for application.
8. Bolts supported only by plaster or gypsum wallboard are not acceptable.
9. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
10. Do not support conduit from chain, wire, or perforated strap.
11. Spring steel type supports or fasteners are not permitted except horizontal and vertical supports/fasteners within walls.
12. Vertical Supports:
  - a. Install riser clamps and supports for vertical conduit runs in accordance with NEC.
  - b. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

G. Box Installation:

1. Boxes for Concealed Conduits:
  - a. Flush mounted.
  - b. Provide raised covers for boxes to suit wall or ceiling, construction and finish.
2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables during pulling.
3. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
4. 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.

H. Flexible Nonmetallic Communications Raceway (Innerduct), Installation:

1. Install supports from building structure for horizontal runs at intervals not to exceed 900 mm (3 feet) and at each end.
2. Install supports from building structure for vertical runs at intervals not to exceed 1.2 m (4 feet) and at each side of joints.
3. Install only in accessible spaces not subject to physical damage or corrosive influences.
4. Make bends manually to assure internal diameter of tubing is not effectively reduced.
5. Extend each segment of innerduct minimum 300 mm (12 inches) beyond end of service conduit tie or cable tray. Restrain innerduct ends with wall mount clamps and seal when cable is installed.

**3.3 TESTING**

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

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**SECTION 27 08 00**  
**COMMISSIONING OF COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section includes requirements for commissioning facility communications systems, related subsystems and related equipment. This Section supplements general requirements specified in Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- B. Complete list of equipment and systems to be commissioned is specified in Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and Specification 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Commissioned Systems:
  - 1. Commissioning of systems specified in Division 27 is part of project's construction process including documentation and proof of performance testing of these systems, as well as training of VA's Operation and Maintenance personnel in accordance with requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and Division 27, in cooperation with Government and Commissioning Agent.
  - 2. The facility exterior closure systems commissioning includes communications systems listed in Section 01 19 00 GENERAL COMMISSIONING REQUIRMENTS and 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

**1.2 RELATED WORK**

- A. System tests: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Commissioning process requires review of selected submittals that pertain to systems to be commissioned: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- C. Construction phase commissioning process and procedures including roles and responsibilities of commissioning team members and user training: Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

**1.3 COORDINATION**

- A. Commissioning Agent will provide a list of submittals that must be reviewed by Commissioning Agent simultaneously with engineering review; do not proceed with work of sections identified without engineering and Commissioning Agent's review completed.
- B. Commissioning of communications systems require inspection of individual elements of communications system construction throughout

construction period. Coordinate with Commissioning Agent in accordance with Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and commissioning plan to schedule communications systems inspections as required to support the commissioning process.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for pre-functional checklists, equipment startup reports, and other commissioning documents.
- B. Pre-Functional Checklists:
  - 1. Complete pre-functional checklists provided by commissioning agent to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing.
  - 2. Submit completed checklists to COR and to Commissioning Agent. Commissioning Agent can spot check a sample of completed checklists. If Commissioning Agent determines that information provided on the checklist is not accurate, Commissioning Agent then returns the marked-up checklist to Contractor for correction and resubmission.
  - 3. If Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, Commissioning Agent can select a broader sample of checklists for review.
  - 4. If Commissioning Agent determines that a significant number of broader sample of checklists is also inaccurate, all checklists for the type of equipment will be returned to Contractor for correction and resubmission.
- C. Submit training agendas and trainer resumes in accordance with requirements of Section 01 19 00, GENERAL COMMISSIONING REQUIREMENTS.

#### **PART 2 - PRODUCTS - NOT USED**

#### **PART 3 - EXECUTION**

##### **3.1 FIELD QUALITY CONTROL**

- A. Contractor's Tests:
  - 1. Scheduled tests required by other sections of Division 27 must be documented in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

2. Incorporate all testing into project schedule. Provide minimum seven calendar days' notice of testing for Commissioning Agent to witness selected Contractor tests at sole discretion of Commissioning Agent.
3. Complete tests prior to scheduling Systems Functional Performance Testing.

B. Systems Functional Performance Testing:

1. Commissioning process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions.
2. Commissioning Agent prepares detailed Systems Functional Performance Test procedures for review and acceptance by COR.
3. Provide required labor, materials, and test equipment identified in test procedure to perform tests.
4. Commissioning Agent must witness and document the testing.
  - a. Provide test reports to Commissioning Agent. Commissioning Agent will sign test reports to verify tests were performed.

**3.2 TRAINING**

- A. Training of Government's operation and maintenance personnel is required in cooperation with COR and Commissioning Agent.
- B. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning location, operation, and troubleshooting of installed systems.
- C. Schedule instruction in coordination with COR after submission and approval of formal training plans.

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**SECTION 27 10 00**  
**CONTROL, COMMUNICATION AND SIGNAL WIRING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section includes control, communication and signal wiring for a comprehensive systems infrastructure.
- B. This section applies to all sections of Divisions 27 and 28.

**1.2 RELATED WORK**

- A. Sealing around penetrations to maintain integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Submit written certification from OEM:
  - 1. Indicate wiring and connection diagrams meet National and Government Life Safety Guidelines, NFPA, NEC, NRTL, Joint Commission, OEM, this section and Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
  - 2. Include instructions, requirements, recommendations, and guidance for proper performance of system as described herein.
  - 3. Government will not approve any submittal without this certification.
- C. Provide conduit size requirements.
- D. Closeout Submittals:
  - 1. Provide contact information for maintenance personnel to contact contractor for emergency maintenance and logistic assistance, and assistance in resolving technical problems at any time during warranty period.
  - 2. Provide certified OEM sweep test tags from each cable reel to COR.



3. Furnish spare or unused wire and cable with appropriate connectors (female types) for installation in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.
4. Turn over unused and opened installation kit boxes, coaxial, fiber optic, and twisted pair cable reels, conduit, cable tray, cable duct bundles, wire rolls, physical installation hardware to COR.
5. Documentation: Include any item or quantity of items, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide system documentation required herein.

**PART 2 - PRODUCTS**

**2.1 CONTROL WIRING**

- A. Provide control wiring large enough so voltage drop under in-rush conditions does not adversely affect operation of controls.
- B. Provide cable meeting specifications for type of cable.
- C. Remote Control Cable:
  1. Multi-conductor with stranded conductors able to handle power and voltage required to control specified system equipment, from a remote location.
  2. NRTL listed and pass VW-1 vertical wire flame test (UL 83) (formerly FR-1).
  3. Color-coded Conductors: Combined multi-conductor and coaxial cables are acceptable for this installation, on condition system performance standards are met.
  4. Technical Characteristics:
    - a. Length: As required, in 1K (3,000 ft.) reels minimum.
    - b. Connectors: As required by system design.
    - c. Size:
      - 1) 18 AWG, minimum, Outside.
      - 2) 20 AWG, minimum, Inside.
    - d. Color Coding: Required, EIA industry standard.
    - e. Bend Radius: 10 times cable outside diameter.
    - f. Impedance: As required.
    - g. Shield Coverage: As required by OEM specification.
    - h. Attenuation:

| Frequency in MHz | dB per 305 Meter (1,000 feet), maximum |
|------------------|--|
|------------------|--|

|      |      |
|------|------|
| 0.7  | 5.2  |
| 1.0  | 6.5  |
| 4.0  | 14.0 |
| 8.0  | 19.0 |
| 16.0 | 26.0 |
| 20.0 | 29.0 |
| 25.0 | 33.0 |
| 31.0 | 36.0 |
| 50.0 | 52.0 |

**2.2 COMMUNICATION AND SIGNAL WIRING**

- A. Provide communications and signal wiring conforming to recommendations of manufacturers of systems.
- B. Wiring shown is for typical systems; provide wiring as required for systems being provided.
- C. Provide color-coded conductor insulation for multi-conductor cables.
- D. Connectors:
  - 1. Provide connectors for transmission lines, and signal extensions to maintain uninterrupted continuity, ensure effective connection, and preserve uniform polarity between all points in system.
    - a. Provide AC barrier strips with a protective cover to prevent accidental contact with wires carrying live AC current.
    - b. Provide punch blocks for signal connection, not AC power. AC power twist-on wire connectors are not permitted for signal wire terminations.
  - 2. Cables: Provide connectors designed for specific size cable and conductors being installed with OEM's approved installation tool. Typical system cable connectors include:
    - a. Audio spade lug.
    - b. Punch block.
    - c. Wirewrap.

**2.3 INSTALLATION KIT**

- A. Include connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, cable tray, etc., required to accomplish a neat and secure installation.

- B. Terminate conductors in a spade lug and barrier strip, wire wrap terminal or punch block, so there are no unfinished or unlabeled wire connections.
- C. Minimum required installation sub-kits:
1. System Grounding:
    - a. Provide required cable and installation hardware for effective ground path, including the following:
      - 1) Control Cable Shields.
      - 2) Data Cable Shields.
      - 3) Equipment Racks.
      - 4) Equipment Cabinets.
      - 5) Conduits.
      - 6) Ducts.
      - 7) Cable Trays.
      - 8) Power Panels.
      - 9) Connector Panels.
      - 10) Grounding Blocks.
  2. Wire and Cable: Provide connectors and terminals, punch blocks, tie wraps, hangers, clamps, labels, etc. required to accomplish termination in an orderly installation.
  3. Conduit, Cable Duct, and Cable Tray: Provide conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, cable tray installation in accordance with NEC and documents.
  4. Equipment Interface: Provide any items or quantity of equipment, cable, mounting hardware and materials to interface systems with identified sub-systems, according to OEM requirements and construction documents.
  5. Labels: Provide any item or quantity of labels, tools, stencils, and materials to label each subsystem according to OEM requirements, as-installed drawings, and construction documents.
- D. Cross-Connection System (CCS) Equipment Breakout, Termination Connector (or Bulkhead), and Patch Panels:
1. Connector Panels: Flat smooth 3.175 mm (1/8 inch) thick solid aluminum, custom designed, fitted and installed in cabinet. Install bulkhead equipment connectors on panel to enable cabinet equipment's

signal, control, and coaxial cables to be connected through panel.  
Match panel color to cabinet installed.

a. Voice (or Telephone):

- 1) Provide industry standard Type 110 (minimum) punch blocks for voice or telephone, and control wiring instead of patch panels, each being certified for category =6.
- 2) IDC punch blocks (with internal RJ45 jacks) are acceptable for use in CCS when designed for Category 6 and the size and type of cable used.
- 3) Secure punch block strips to OEM designed physical anchoring unit on a wall location in TRS; console, cabinet, rail, panel, etc. mounting is permitted at OEM recommendation and as accepted by COR. Punch blocks are not permitted for Class II or 120 VAC power wiring.
- 4) Technical Characteristics:
  - a) Number of Horizontal Rows: Minimum 100.
  - b) Number of Terminals per Row: Minimum 4.
  - c) Terminal Protector: Required for each used or unused terminal.
  - d) Insulation Splicing: Required between each row of terminals.

b. Digital or High Speed Data:

- 1) Provide 480 mm (19 inches) horizontal EIA/ECA 310 rack mountable patch panel with EIA/ECA 310 standard spaced vertical mounting holes for digital or high-speed data service CSS, with modular female Category 5E (or on a case by case basis Category 6 for specialized powered systems accepted by SMCS 0050P2H3, (202) 461-5310, OI&T and FMS Services, and COR) RJ45 jacks designed for size and type of UTP or F/UTP cable installed in rows.
- 2) Technical Characteristics:
  - a) Number of Horizontal Rows: Minimum 2.
  - b) Number of Jacks Per Row: Minimum 24.
  - c) Type of Jacks: RJ45.
  - d) Terminal Protector: Required for each used or unused jack.
  - e) Insulation: Required between each row of jacks.

#### **2.4 EXISTING WIRING**

- A. Reuse existing wiring only where indicated on plans and accepted by SMCS 0050P2H3.
- B. Only existing wiring that conforms to specifications and applicable codes can be reused; existing wiring that does not meet these requirements cannot be reused and must be removed by contractor.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General:
  - 1. Install wiring in cable tray or raceway.
  - 2. Seal cable entering a building from underground, between wire and conduit where cable exits conduit, with non-hardening approved compound.
  - 3. Wire Pulling:
    - a. Provide installation equipment that prevents cutting or abrasion of insulation during pulling of cables.
    - b. Use ropes made of nonmetallic material for pulling feeders.
    - c. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached to conductors, as accepted by COR.
    - d. Pull multiple cables into a single conduit together.
- B. Control, Communication and Signal Wiring Installation:
  - 1. Unless otherwise specified in other sections, provide wiring and connect to equipment/devices to perform required functions as indicated.
  - 2. Install separate cables for each system so that malfunctions in any system does not affect other systems, except where otherwise required.
  - 3. Group wires and cables according to service (i.e. AC, grounds, signal, DC, control, etc.); DC, control and signal cables can be included with any group.
  - 4. Form wires and cables to not change position in group throughout the conduit run. Bundle wires and cables in accepted signal duct, conduit, cable ducts, or cable trays neatly formed, tied off in 600 mm to 900 mm (24 inch to 36 inch) lengths to not change position in group throughout run.
  - 5. Concealed splices are not allowed.

6. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure.
  7. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right.
  8. Provide ties and fasteners that do not damage or distort wires or cables. Limit spacing between tied points to maximum 150 mm (6 inches).
  9. Wires or cables must be specifically accepted, on a case by case basis, to be installed outside of conduit. Bundled wires or cables must be tied at minimum 460 mm (18 inches) intervals to a solid building structure; bundled wires or cables must have ultra violet protection and be waterproof (including all connections).
  10. Laying wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not permitted.
  11. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.:
    - a. Only when authorized, can wires or cables be identified and approved to be installed outside of conduit.
    - b. Provide wire or cable rated plenum and OEM certified for use in air plenums.
    - c. Provide wires and cables hidden, protected, fastened and tied at maximum 600 mm (24 inches) intervals, to building structure.
    - d. Provide closer wire or cable fastening intervals to prevent sagging, maintain clearance above suspended ceilings.
    - e. Remove unsightly wiring and cabling from view, and discourage tampering and vandalism.
    - f. Sleeve and seal wire or cable runs, not installed in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers, with an approved fire retardant sealant.
- C. AC Power:
1. Bond to ground contractor-installed equipment and identified Government-furnished equipment, to eliminate shock hazards and to

- minimize ground loops, common mode returns, noise pickup, crosstalk, etc. for total ground resistance of 0.1 Ohm or less.
2. Use of conduit, signal duct or cable trays as system or electrical ground is not permitted; use these items only for dissipation of internally generated static charges (not to be confused with externally generated lightning) that can be applied or generated outside mechanical and physical confines of system to earth ground. Discovery of improper system grounding is grounds to declare system unacceptable and termination of all system acceptance testing.
  3. Cabinet Bus: Extend a common ground bus of at least #10 AWG solid copper wire throughout each equipment cabinet and bond to system ground. Provide a separate isolated ground connection from each equipment cabinet ground bus to system ground. Do not tie equipment ground busses together.
  4. Equipment: Bond equipment to cabinet bus with copper braid equivalent to at least #12 AWG. Self-grounding equipment enclosures, racks or cabinets, that provide OEM certified functional ground connections through physical contact with installed equipment, are acceptable alternatives.

### **3.2 EQUIPMENT IDENTIFICATION**

- A. Control, Communication and Signal System Identification:
  1. Install a permanent wire marker on each wire at each termination.
  2. Identify cables with numbers and letters on the labels corresponding to those on wiring diagrams used for installing systems.
  3. Install labels retaining their markings after cleaning.
- B. Labeling:
  1. Industry Standard: ANSI/TIA-606-B.
  2. Print lettering for voice and data circuits using laser printers ; handwritten labels are not acceptable.
  3. Cable and Wires (hereinafter referred to as "cable"): Label cables at both ends in accordance with industry standard. Provide permanent labels in contrasting colors. Identify cables matching system Record Wiring Diagrams.
  4. Equipment: Permanently labeled system equipment with contrasting plastic laminate or bakelite material. Label system equipment on face of unit corresponding to its source.

5. Conduit, Cable Duct, and Cable Tray: Label conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying system. Label each enclosure according to this standard.
6. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and Record Wiring Diagrams.

### **3.3 TESTING**

- A. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on cables in frequency ranges specified.
- B. Tests required for data cable must be made to confirm operation of this cable at minimum 10 Mega (M) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of  $10^{-6}$  at maximum rate of speed.
- C. Provide cable installation and test records at acceptance testing to COR and thereafter maintain in facility's telephone switch room.
- D. Record changes (used pair, failed pair, etc.) in these records as change occurs.
- E. Test cables after installation and replace any defective cables.

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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. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.
- D. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- E. Low voltage cabling system infrastructure: Section 27 10 00, CONTROL, COMMUNICATION AND SIGNAL WIRING.

**1.3 SUBMITTALS**

- A. Certifications:
1. Submit written certification from OEM indicating that proposed supervisor of installation and proposed provider of contract maintenance are authorized representatives of OEM. Include individual's legal name and address and OEM warranty credentials in the certification.
  2. Pre-acceptance Certification: Submit in accordance with test procedures.
  3. Test system cables and certify to COR before proof of performance testing can be conducted. Identify each cable as labeled on as-installed drawings.
  4. Provide current and qualified test equipment OEM training certificates and product OEM installation certification for contractor installation, maintenance, and supervisory personnel.
- B. Closeout Submittal: Provide document from OEM certifying that each item of equipment installed conforms to OEM published specifications.

#### **1.4 WARRANTY**

- A. Work subject to terms of Article "Warranty of Construction," FAR clause 52.246-21.

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

##### **2.1 PERFORMANCE AND DESIGN CRITERIA**

- A. Provide complete system including "punch down" and cross-connector blocks voice and data distribution sub-systems, and associated hardware including telecommunications outlets (TCO); copper and fiber optic distribution cables, connectors, "patch" cables, "break out" devices and equipment cabinets, interface cabinets, and radio relay equipment rack.
- B. Industry Standards:
1. Cable distribution systems provided under this section are connected to systems identified as critical care performing life support functions.
  2. Conform to National and Local Life Safety Codes (whichever are more stringent), NFPA, NEC, this section, Joint Commission Life Safety Accreditation requirements, and OEM recommendations, instructions, and guidelines.
  3. Provide supplies and materials listed by a nationally recognized testing laboratory where such standards are established for supplies, materials or equipment.
  4. Refer to industry standards and minimum requirements of Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and guidelines listed.
  5. Active and passive equipment required by system design and approved technical submittal; must conform to each UL standard in effect for equipment, when technical submittal was reviewed and approved by Government or date when COR accepted system equipment to be replaced. Where a UL standard is in existence for equipment to be used in completion of this contract, equipment must bear approved NRTL label.
- C. System Performance: Provide complete system to meet or exceed TIA Category 6 .
- 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, data, analog and videotele communications cabling system, including backbone cabling system, patch panels and cross-connections, horizontal cabling systems, jacks, faceplates, and patch cords.
- F. Coordinate size and type of conduit, pathways and firestopping for maximum 40 percent cable fill with subcontractors.
- G. Terminate all interconnecting twisted pair, fiber-optic or coaxial cables on patch panels or punch blocks. Terminate unused or spare conductors and fiber strands. Do not leave unused or spare twisted pair wire, fiber-optic or coaxial cable unterminated, unconnected, loose or unsecured.
- H. Color code distribution wiring to conform to ANSI/TIA 606-B and construction documents, whichever is more stringent. Label all equipment, conduit, enclosures, jacks, and cables on record drawings, to facilitate installation and maintenance.
- I. In addition to requirements in Section 27 05 11, REQUIREMENTS FOR COMMUNICATION INSTALLATIONS, provide stainless steel faceplates with plastic covers over labels.

## **2.2 EQUIPMENT AND MATERIALS**

- A. Cable Systems - Twisted Pair, Fiber optic, Coaxial and Analog:
1. General:
    - a. Provide cable (i.e. backbone, outside plant, and horizontal cabling) conforming to accepted industry standards with regards to size, color code, and insulation.
    - b. Some areas can be considered "plenum". Comply with all codes pertaining to plenum environments. It is contractor's responsibility to review the VA's cable requirements with COR and

- OI&T Service prior to installation to confirm type of environment present at each location.
- c. Provide proper test equipment to confirm that cable pairs meet each OEM's standard transmission requirements, and ensure cable carries data transmissions at required speeds, frequencies, and fully loaded bandwidth.
2. Telecommunications Rooms (TR):
- a. In TR's served with UTP and fiber optic, coaxial and analog backbone cables, terminate UTP cable on RJ-45, 8-pin connectors of separate 48-port modular patch panels, 110A or equivalent type punch down blocks that are dedicated to voice and data applications.
- b. Provide connecting cables required to extend backbone cables (i.e. patch cords, twenty-five pair, etc.), to ensure complete and operational distribution systems.
3. 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: 500 MHz.
- c. Provide four pair 0.326 mm<sup>2</sup> (22 AWG) cable
- d. Terminate all four pairs on same port at patch panel in TR.
- e. Terminate all four pairs on same jack, at work area
- Telecommunication Outlets (TCO):
- 1) Jacks: Minimum four 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. Coaxial and Analog Cables: Bond equipment to ground per TIA standards, such that all grounding systems comply with all applicable National, Regional, and Local Building and Electrical codes.
1. Provide current arrester for each copper or coaxial cable that enters from outside of a building regardless if cable is installed underground or aerial.
2. Provide a gas surge protector/module and bond to earth ground.
- C. Main Cross-connection Subsystem (MCCS): MCCS is common point of distribution for inter- and intra-building copper and fiber optic

backbone system cables, and connections to the voice (telephone) and data cable systems.

D. Voice (or Telephone) Cable Cross-Connection Subsystem:

1. Provide Insulation Displacement Connection (IDC) hardware.
2. Provide the following for each Category 5E (or on a case by case basis Category 6 for specialized powered systems technically accepted by SMCS 0050P2H3, (202) 461-5310, OI&T and FMS Services and COR) Cabling System termination; RJ-45 patch cord connector to RJ-45 patch cord connector.
  - a. Provide terminations to be accessible without need for disassembly of IDC wafer. Provide IDC wafers removable from their mounts to facilitate testing on either side of connector.
  - b. Provide removable designation strips or labels to allow for inspection of terminations.
  - c. Provide cable management system as a part of IDC.
3. Provide IDC connectors capable of re-terminations, without damage, a minimum of 200 IDC insertions or withdrawals on either side of connector panel.
4. Install using only non-impact terminating tool having both a tactile and an audible feedback to indicate proper termination.
5. Provide inputs from, FTS, Local Voice (Telephone) System, or diverse routed voice distribution systems on left side of IDC (110A blocks with RJ45 connections are acceptable alternates to IDC) of MCCS.
6. Provide system outputs from MCCS to voice backbone cable distribution system on the right side of same IDC (or 110A blocks) of MCCS.
7. Do not split pairs within cables between different jacks or connections.
8. Provide UTP cross connect wire to connect each pair of terminals plus an additional 50 percent spare.

E. Data Cross-Connection Subsystems:

1. Provide patch panels with modular RJ45 female to 110 connectors for cross-connection of copper data cable terminations and system ground with cable management system.
2. Provide patch panels conforming to EIA/ECA 310-E dimensions and suitable for mounting in standard equipment racks, with 48 RJ45 jacks aligned in two horizontal rows per panel. Provide RJ45 jacks

of modular design and capable of accepting and functioning with other modular (i.e. RJ11) plugs without damaging jack.

- a. Provide system inputs from servers, data LAN, bridge, or interface distribution systems on top row of jacks of appropriate patch panel.
- b. Provide backbone cable connections on bottom row of jacks of same patch panel.
- c. Provide patch cords for each system pair of connection jacks with modular RJ45 connectors provided on each end to match panel's modular RJ45 female jack's being provided.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install for ease of operation, maintenance, and testing.
- B. Install system to comply with NFPA 70 National Electrical Code, NFPA 99 Health Care Facilities, NFPA 101 Life Safety Code, Joint Commission Manual for Health Care Facilities, and original equipment manufacturers' (OEM) installation instructions.
- C. Cable Systems Installation:
  1. Install system cables in cable duct, cable tray, cable runway, conduit or when specifically approved, flexible NEC Article 800 communications raceway. Confirm drawings show sufficient quantity and size of cable pathways. If flexible communications raceway is used, install in same manner as conduit.
  2. Coordinate outside plant and backbone cables to furnish number of cable pairs for system requirements and obtain approval of COR and IT Service prior to installation.
  3. Bond to ground metallic cable sheaths, etc. (i.e. risers, underground, horizontal, etc.).
  4. Install temporary cable to not present a pedestrian safety hazard and be responsible for all work associated with removal. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and accepted by COR, IT Service, FMS and SMCS 0050P2H3 (202-461-5310) prior to installation.
- D. Labeling:
  1. Industry Standard: Provide labeling in accordance with ANSI/TIA-606-
  2. Print lettering of labels with laser printers; handwritten labels are not acceptable.

3. Label both ends of all cables in accordance with industry standard. Provide permanent Labels in contrasting colors and identify according to system "Record Wiring Diagrams".
4. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and record on "Record Wiring Diagrams".

### **3.2 FIELD QUALITY CONTROL**

#### **A. Interim Inspection:**

1. Verify that equipment provided adheres to installation requirements of this section. Interim inspection must be conducted by a factory-certified representative and witnessed by COR.
2. Check each item of installed equipment to ensure appropriate NRTL label.
3. Verify cabling terminations in telecommunications rooms and at workstations adhere to color code for T568B pin assignments and cabling connections comply with TIA standards.
4. Visually confirm marking of cables, faceplates, patch panel connectors and patch cords.
5. Notify COR of the estimated date the contractor expects to be ready for interim inspection, at least 20 working days before requested inspection date, so interim inspection does not affect systems' completion date.
6. Provide results of interim inspection to COR. If major or multiple deficiencies are discovered, COR can require a second interim inspection before permitting contractor to continue with system installation.
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 and STP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has an overall shield. Test cables after termination and prior to cross-connection.
2. Multi-mode Fiber Optic Cable: Perform end-to-end attenuation tests in accordance with TIA-568-B.3 and TIA-526-14A using Method A, Optical Power Meter and Light Source. Perform verification acceptance test.

**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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