

PROVIDENCE  
VA MEDICAL CENTER  
830 CHALKSTONE AVENUE  
PROVIDENCE, RI 02908

RELOCATE RESPIRATORY AND  
CONVERT SPACE TO SURGICAL

VOLUME 2



ISSUED FOR CONSTRUCTION DOCUMENTS

VA PROJECT NO. 650-10-022

DATE: 07/29/11

**DEPARTMENT OF VETERANS AFFAIRS**

**MASTER SPECIFICATIONS**

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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. Excavation and Backfill: Section 31 20 00, EARTH MOVING.
- D. Concrete and Grout: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- E. Building Components for Attachment of Hangers: Section 05 31 00, STEEL DECKING. Section 05 36 00, COMPOSITE METAL DECKING.
- F. Section 05 50 00, METAL FABRICATIONS.
- G. Section 07 84 00, FIRESTOPPING.
- H. Flashing for Wall and Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- I. Section 07 92 00, JOINT SEALANTS.
- J. Section 09 91 00, PAINTING.
- K. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- L. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- M. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

**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 Resident Engineer 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. Guaranty: In GENERAL CONDITIONS.
  - D. Supports for sprinkler piping shall be in conformance with NFPA 13.
  - E. 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.
  - C. Coordination Drawings: Provide detailed layout drawings of all piping systems. Provide details of the following.
    1. Hangers, inserts, supports, and bracing.
    2. Pipe sleeves.
    3. Equipment penetrations of floors, walls, ceilings or roof.
    4. Sprinkler calculations.
  - 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

101-97 ..... Life Safety Code

**PART 2 - PRODUCTS**

**2.1 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.

**2.2 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.

1. 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.

**2.3 FIRESTOPPING**

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

**2.4 GALVANIZED REPAIR COMPOUND**

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

**2.5 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 Resident Engineer.

D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.



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

## **2.6 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Resident Engineer, 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 Resident Engineer.
- 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.

## **2.7 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 Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer shall be replaced.

2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly exposed materials and equipment.
  - C. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
  - D. 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.
  - E. 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 Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
  - 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 Resident Engineer.
  - B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.

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- 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.

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

**SECTION 21 13 13**  
**WET PIPE SPRINKLER SYSTEMS**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

This section specifies the provisions for the furnishing, installing and finishing of the following:

- A. Hydraulically calculated 100% automatic wet fire sprinkler system design complete and ready for operation for all portions of the project area including, but not limited to all of the following locations as applicable:
  - 1. All renovated support areas and portions of this renovation.
  - 2. Customary access and storage areas, linen rooms, closets, stair landings.
- B. The design and installation of a sprinkler system. Refer to Section 21 13 13 for fire wet sprinklers.
- C. Modification of the existing sprinkler system shall be performed as indicated on the drawings where applicable, and as required by these specifications. Size system by pipe schedule and hydraulic calculations in accordance with NFPA 13.
- D. Existing piping to be reused, existing piping and sprinklers to be replaced or removed as indicated on the drawings. Work to include all necessary piping modifications, new sprinklers and new sprinkler escutcheons. Removal of piping to include all valves, flow switches, supervisory devices, hangers, supports, and associated fire alarm system conduit and wire.
- E. All inspections and testing required by NFPA 13, NFPA 25 and recommended by the equipment manufacturer shall be provided. Work shall include operation of and verification of existing sprinkler system alarm and supervisory devices.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 01 00 00, GENERAL REQUIREMENTS: Work performance.
- B. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- C. Section 07 92 00, JOINT SEALANTS: Sealing around penetrations to prevent moisture and water migration.
- D. Section 09 91 00, PAINTING: Identification and painting of pipe and other devices.
- E. Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.: General mechanical requirements and items common to more than one section of Division 23.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.
- G. Section 28 31 00, FIRE DETECTION & ALARM.

**1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Manufacturer's product submitted has been in satisfactory and efficient operation at three installations similar and equivalent to this Project for five (5) years.

- B. Product Qualifications: Each product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly engaged in manufacturing items of the type specified. Include additional features, not specifically prohibited by the specifications, which are parts of the manufacturer's standard commercial product.
- C. Source Limitations: Each product type shall be the same made by the same manufacturer. Equipment and devices shall be of a make and type listed by UL and approved by FM, or other nationally recognized testing laboratory for the specific purpose for which it is used.
- D. Designer Qualifications: Design work and shop drawings shall be prepared by a licensed engineer practicing in the field of Fire Protection Engineering or a NICET (National Institute for Certification in Engineering Technologies) Level III sprinkler technician.
- E. Installer Qualifications: The installer shall possess a valid State of Massachusetts fire sprinkler contractor's license. As a minimum, the contractor must hold a contractor's license in the state where the work is to be performed. The installer shall have been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past three years.
  - 1. Provide a copy of the installing contractors fire sprinkler state contractor's license.
  - 2. Provide a copy of the NICET Level III Sprinkler Technician's certification that prepared and signed the detailed working drawings unless the drawings are stamped by a registered Fire Protection Professional Engineer (FPPE).
- F. Service Qualifications: There shall be a permanent service organization maintained that will render satisfactory service to this installation within 4 hours of receipt of notification for service. Submit name and address of service organizations.

#### **1.4 DESIGN CRITERIA**

- A. The design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system shall be in strict accordance with VA requirements (DVA Engineering Guide for Fire Protection Design), and the advisory provisions of NFPA 13, 20, 25. Recommendations in appendices shall be treated as requirements.
- B. Perform system design hydraulic calculations in accordance with VA requirements (DVA Engineering Guide for Fire Protection Design) and 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.
  - 1. Sprinkler Protection: Request clarification from the Government for any hazard classification not identified. To determine spacing and sizing, apply the following coverage classifications:
    - a. Light Hazard Occupancy: All offices, waiting, educational areas, corridors, and customary access areas, 0.10 gpm/SF over the hydraulically most remote 1500 SF.
    - b. Ordinary Hazard, Group 1 Occupancy: Mechanical equipment rooms, electric closets, refrigeration service rooms, repair shops, 6.1 L/minute/m<sup>2</sup> (0.15 gpm/SF) over the hydraulically most remote 140 m<sup>2</sup> (1500 SF).
    - c. Ordinary Hazard, Group 2 Occupancy: Storage rooms, trash rooms, file storage areas and Supply Processing and Distribution (SPD), 8.1 L/minute/m<sup>2</sup> (0.20 gpm/SF) over the hydraulically most remote 140 m<sup>2</sup> (1500 SF).
  - 2. Base sprinkler design on the capacity of the measured street water pressure or when applicable the fire pumps in accordance with NFPA 20.
  - 3. Add water allowance of 15 L/s (250 gpm) for inside and outside hose streams to the sprinkler requirements at the connection to the distribution main.

4. The calculated demand including hose stream requirements shall fall no less than 10 percent below the available water supply curve.
  5. Zoning: Sprinkler zones in healthcare occupancies shall conform to the smoke barrier zones.
    - a. For each sprinkler zone provide a control valve, flow switch and a self-contained test and drain assembly with pressure gauge.
    - b. Sprinkler zones in healthcare occupancies shall conform to the smoke barrier and/or fire alarm zones.
    - c. Do not use quick response sprinklers in the same sprinkler zone with other sprinkler types. In partially sprinklered light hazard patient zones that are expanded into fully sprinklered zones, revise the existing system to contain quick response sprinklers.
  6. Water Supply: Base water supply on fire pump test information provided by the Owner. Carry the cost of an additional fire pump test for this project.
- C. Conceal all piping, except pipe in stairwells and rooms without ceilings.
  - D. Locate sprinklers in patient rooms assuming all privacy curtains have 1/2-inch openings in mesh extending 18 inches from ceiling.
  - E. Provide a separate sprinkler valve for other areas as required by NFPA 13.
  - F. Seismic Protection: Seismically brace all new and existing piping systems in accordance with NFPA 13 for Zone Area A.

#### 1.5 SUBMITTALS

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, furnish the following:

- A. Manufacturer's Literature and Data: All devices and equipment shall be Underwriters Laboratories Inc. listed for their intended purpose. Equipment and devices shall be of a make and type listed by Underwriters Laboratories Inc. (UL) and approved by Factory Mutual (FM), or other nationally recognized testing laboratory for their intended purpose. All materials, devices and equipment shall be approved by the VA.
  1. Pipe and Fittings
  2. Sprinklers - each type, temperature and model
  3. Sprinkler Cabinet
  4. Sprinkler Plugs
  5. Pipe Hangers and Supports
  6. Fire protection test data
- B. Shop Drawings: Conforming to the requirements of NFPA 13 and NFPA 20. Submit details with 1:100 (1/8-inch) scale (minimum). Include a site plan showing the piping to the water supply test location. Prepare detailed working drawings that are signed by a NICET Level III Sprinkler Technician and stamped by a registered Fire Protection Professional Engineer (FPPE). **As 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.**
- C. Calculation Sheets: Submit hydraulic calculation sheets in tabular form conforming to the requirements and recommendations in accordance with NFPA 13.

- D. Qualifications: Include, but not limited to the following:
  - 1. Provide a copy of the installing contractor's fire sprinkler state license.
  - 2. Provide a copy of the NICET Level III Sprinkler Technician's certification that prepared and signed the detailed working drawings unless the drawings are stamped by a registered Fire Protection Professional Engineer (FPPE).
- E. Publication issue of NFPA 25 "Inspection, Testing and Maintenance of Water Based Fire Protection Systems" for use by the Resident Engineer.
- F. Coordination Drawings: Refer to Article, SUBMITTALS, in Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- G. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
- H. Certifications: 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 document all parts of the installation. Submit to the Resident Engineer 4 copies of each inspection/testing report tabulating the results, analysis, recommendations documenting that all fire protection work performed is in compliance with all the applicable manufacturers' requirements, codes and contract documents. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a registered Professional Fire Protection Engineer (FPPE), and testing shall be performed by a qualified sprinkler technician.
- I. Final Document Submittals: In accordance with the requirements in Section 01 99 99, PROJECT CLOSEOUT, provide as-built drawings, testing and maintenance instructions including but not limited to, the following:
  - 1. Hydrostatic report and NFPA 13 material and test certificate for each sprinkler system.
  - 2. Hydraulic calculations for each sprinkler system updated to include submittal review comments and any changes to the installation which affect the calculations.
  - 3. One complete set of reproducible as-built drawings showing the installed system with the specific interconnections between the pressure switch and the fire alarm equipment.
  - 4. Operation and Maintenance Manuals: Provide operation and maintenance instruction manuals covering all components of the system updated to include submittal review comments and any equipment substitutions. Provide maintenance instructions on replacing any components of the system including internal parts, periodic cleaning and adjustment of the equipment and components.

#### **1.6 APPLICABLE PUBLICATIONS**

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. Except where a specific date is provided the issue (including amendments, addenda, revisions, supplements, and errata) in effect on the date of Bids/Proposals shall be applicable. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American National Standards Institute (ANSI):
  - American Society of Mechanical Engineers (ASME):
    - A13.1 ..... Scheme for Identification of Piping Systems ANSI/ASME
    - B16.1 ..... Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, 800
    - B16.3 ..... Malleable Iron Threaded Fittings: Classes 150 and 300

- B16.4 ..... Cast Iron Threaded Fittings Classes 125 and 250 ANSI/ASME
- B16.9 ..... Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME
- B16.18 ..... Cast Copper Alloy Solder-Joint Pressure Fittings ANSI/ASME
- B16.22 ..... Wrought Copper and Copper Alloy Solder Joint Pressure Fittings ANSI/ASME
- B16.25 ..... Butt Welding Ends
- B36.10M ..... Welded and Seamless Wrought Steel Pipe
- B. American Society for Testing and Materials (ASTM):
  - A53 ..... Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless
  - A135 ..... Standard Specification for Electric-Resistance-Welded Steel Pipe
  - A795 ..... Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
  - B32 ..... Solder Metal
  - B75 ..... Seamless Copper Tube
  - B88 ..... Seamless Copper Water Tube
  - B251 ..... Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
  - B446 ..... Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650)\* Rod and Bar
  - B813 ..... Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
- C. American Welding Society (AWS):
  - A5.8 ..... Filler Metals for Brazing
  - B2.1 ..... Welding Procedure and Performance Qualifications
  - B2.2 ..... Standard for Brazing Procedure and Performance
- D. National Fire Protection Association (NFPA):
  - 1 ..... Fire Prevention Code
  - 13 ..... Installation of Sprinkler Systems
  - 14 ..... Installation of Standpipe and Hose Systems
  - 17A ..... Standard for wet chemical extinguishing systems
  - 20 ..... Installation of Centrifugal Fire Pumps
  - 24 ..... Installation of Private Fire Service Mains and Their Appurtenances
  - 25 ..... Inspection, Testing and Maintenance of Water Based Fire Protection Systems
  - 70 ..... National Electrical Code



- 72..... National Fire Alarm Code
- 82..... Incinerators, Waste and Linen Handling Systems and Equipment
- 101..... Life Safety Code
- 170..... Fire Safety Symbols
- 1141..... Fire Protection in Planned Building Groups
- 231..... General Storage
- 231C ..... Rack Storage of Materials
- 291..... Fire Flow Testing and Marking of Hydrants
- E. Factory Mutual Engineering Corporation (FM):  
Approved Guide
- F. Underwriters Laboratories, Inc. (UL):  
Fire Protection Equipment Directory  
199 Automatic Sprinklers for Fire Protection Service
- G. Uniform Building Code

## **PART 2 – PRODUCTS**

### **2.1 PIPING & FITTINGS**

- A. Sprinkler systems downstream of the isolation valve on wet pipe systems shall be in accordance with NFPA 13 – Black steel.
- B. Fire Protection water supply within the building up to the sprinkler system isolation valves shall be in accordance with NFPA 13 – Black steel.
- C. Threaded or flanged fittings shall be ANSI B16.4 cast iron, Class 125 minimum. Threaded fittings are not permitted on pipe with wall thickness less than Schedule 40.
- D. All fittings on galvanized piping shall be galvanized in accordance with ASTM A53.
- E. Slip type or clamp-on type rubber gasket fittings shall be listed for each piping application.
- F. Plain end pipe, fittings with locking lugs or shear bolts are not permitted.
- G. Piping Materials Standards:
  - 1. Ferrous piping: ASTM A 795
  - 2. Welded and seamless steel pipe: ANSI/ASTM A 53
  - 3. Wrought steel pipe: ANSI/ASME B36.10M
  - 4. Electric resistance welded steel pipe: ASTM A 135
  - 5. Seamless copper tube: ASTM B 75
  - 6. Seamless copper water tube: ASTM B 88
  - 7. Wrought seamless copper and copper alloy tube: ASTM B 251
  - 8. Fluxes for soldering applications of copper and copper alloy tube: ASTM B 813
  - 9. Brazing filler metal: AWS A5.8

10. Solder metal: 95-5, ASTM B 32

11. Alloy material: ASTM B 446

H. Fitting Materials Standards:

1. Cast iron threaded fitting, Class 125 and 250: ASME B16.4
2. Cast iron pipe flanges and flanged fittings: ASME B16.1
3. Malleable iron threaded fittings, Class 150 and 300 steel: ASME B16.3
4. Factory made wrought steel butt weld fittings: ASME B16.9
5. Buttwelding ends for pipe, valves, flanges, and fitting: ASME B16.25
6. Wrought copper and copper alloy solder joint pressure fittings: ASME B16.22
7. Cast copper alloy solder joint pressure fitting: ASME B16.18

- I. Pipe Identification: Pipe, including specially listed pipe allowed by NFPA 13, shall be marked continuously along its length by the manufacturer in such a way as to properly identify the type of pipe. Pipe identification shall include the manufacturer's name, model designation, or schedule.

2.2 VALVES

- A. Valves shall be in accordance with NFPA 13.
- B. Drain Valves: Threaded bronze angle, globe, ball or butterfly, WOG 1000 kPa (150 lb) equipped with reducer and hose connection with cap or connected to a drain line. Do not use quarter turn ball valves for 50 mm (2 inch) or larger drain valves.
- C. Automatic Ball Drips: Cast brass 20 mm (3/4-inch) in-line automatic ball drip with both ends threaded with iron pipe threads. Automatic ball drains are required in geographical areas subject to freezing temperatures.

2.3 SPRINKLERS

- A. Sprinklers except "institutional" type shall be FM approved. Sprinklers shall be of all brass body construction with a metal Belleville spring seal, coated on both sides with Teflon film. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited.
- B. Quick response sprinklers shall be "standard" type tested in accordance with UL 199 and UL 1626, except where specifically prohibited by their listing or approval. The maximum distance from the deflector to finished ceiling shall be 2 inches for pendent sprinklers. Pendent sprinklers in finished areas shall be provided with semi-recessed adjustable screwed escutcheons and installed within the center one-third of their adjustment. The sprinkler shall be installed in the flush position with the element exposed below the ceiling line. At the specified locations, provide the following type of sprinklers:

LOCATION

TYPE

Mechanical, Electrical Rooms

Quick Response, Upright Pendent, Brass  
(93 Degrees C – 200 Degrees F)

All Areas Not Listed Above

Quick Response, Recessed Pendent, Chrome  
(66-74 Degrees C – 150-165 Degrees F)  
Quick Response, Sidewall Pendent  
(66-74 Degrees C – 150-165 Degrees F)

1. Sprinkler heads in areas with ceilings shall be flush type. Sprinkler heads in areas without ceilings shall be upright type.

#### **2.4 PIPE HANGERS AND SUPPORTS**

- A. Supports, hangers, etc., of an approved pattern placement to conform to NFPA 13. Comply with the requirements for seismic Zone Area A locations. The installation of hangers and supports shall adhere to the requirements set forth in NFPA 13, Standard for Installation of Sprinkler Systems. Hangers or supports not specifically listed for service shall be designed and bear the seal of a Professional Engineer.
- B. System piping shall be substantially supported to the building structure. Hangers shall be designed to support five times the weight of the water filled pipe plus 250 Lb (114 Kg) at each point of piping support.
- C. The points of support shall be adequate to support the system.
- D. The spacing between hangers shall not exceed the value given for the type of pipe as indicated in NFPA 13 tables.
- E. Materials used in the installation or construction of hangers and supports shall be ferrous and listed and approved for such application.
- F. Detailed calculations shall be submitted, when required by the reviewing Authority, showing stress developed in hangers, piping, fittings and safety factors allowed.

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

- A. Exposed piping passing through walls, floors or ceilings shall be provided with chrome plated steel escutcheon plates.
- B. Comply with NFPA 101 Life Safety Code.

#### **2.6 TOOLS AND REPLACEMENT PARTS**

- A. Sprinkler Cabinet:
  1. Provide a minimum 5 percent spare sprinklers of all ratings and types installed with escutcheons, minimum of 2 of each type/or as required by NFPA 13, whichever is more demanding.
  2. Provide a minimum of 2 of each type sprinkler wrenches used.
  3. Install cabinets in each area where directed by the Resident Engineer.
  4. Spare sprinklers shall be kept in a cabinet where ambient temperatures do not exceed 100 degrees F.

#### **2.7 PIPE HANGERS AND SUPPORTS**

- A. Supports, hangers, etc., of an approved pattern placement to conform to NFPA 13. System piping shall be substantially supported to the building structure. The installation of hangers and supports shall adhere to the requirements set forth in NFPA 13, standard for installation of sprinkler systems. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application. Hangers or supports not specifically listed for service shall be designed and bear the seal of a professional engineer.

### **PART 3 – EXECUTION**

#### **3.1 GENERAL**

- A. Contractor shall verify the fire protection system conditions, service capacity via flow tests and determine proper pipe distribution performance. Contractor shall provide a shop drawing layout including documentation basis (eg, hydraulic calculations) prior to the start of installation stamped by a Massachusetts Fire Protection Professional Engineer (FPPE) documenting installation in compliance with all criteria.
- B. Fire protection system shall be maintained operational at all times except for periodic shutdowns limited to 6 hour duration's each.
- C. Contractor shall relocate sprinkler pipes and heads as necessary to clear new construction and equipment installation. New construction shall not block or obscure the proper operation and function of the building fire protection system. If sprinkler heads require relocation a new sprinkler head of the same type, style and rating shall be used.
- D. Install access doors in ceilings of rooms where above ceiling access is required. Provide access doors or panels where control or drain valves are located behind plaster or gypsum walls or ceilings as necessary to install piping above suspended plaster or gypsum ceilings.
- E. All inspections and testing work required by NFPA 25, NFPA 20, NFPA 13 and recommended by the equipment manufacturer shall be provided. Work shall include operation of sprinkler system alarm and supervisory devices.

#### **3.2 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. Each sprinkler zone shall coincide with each smoke barrier and/or fire alarm zone in the building.
- C. Installation of Piping:
  - 1. Piping arrangement shall avoid contact with other piping and equipment and allow clear access to other equipment or devices requiring access or maintenance. Where ceiling mounted equipment exists install sprinklers so as not to obstruct the movement or operation of the equipment. Note – Sidewall heads may need to be utilized.
  - 2. Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. In any situations where bending of the pipe is required, use a standard pipe-bending template.
  - 3. Locate piping in stairways as near to the ceiling as possible to prevent tampering by unauthorized personnel. Provide a minimum headroom clearance of 7 feet – 6 inches.
  - 4. Provide piping clearances in accordance with NFPA 101 to prevent egress obstruction.
  - 5. Conceal piping in spaces which have finished ceilings.
  - 6. Install new piping and sprinklers aligned with natural building lines.
  - 7. Welding: Conform to the requirements and recommendations of NFPA 13.
- D. Drains, Test Pipes and Accessories:
  - 1. Provide a drain at base of risers, drain connection on valved sections, and drains at other locations for complete drainage of the system. Provide valve in drain lines and connect to the central drain riser. Discharge riser outside over splash block, indirectly over

standpipe drain connected to storm sewer, or as indicated. The main drain shall be capable of full discharge test without allowing water to flow onto the floor.

2. 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.
  3. Provide test pipes in accordance with NFPA 13. Test pipes shall be valved and piped to discharge through proper orifice as specified above for drains.
  4. Install switch and valves in easily accessible locations.
- E. Cutout Disks: Created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections, shall be labeled/tagged where they originated. They shall be turned over to the VA Project Engineer by the close of business on the day the work is performed.
- F. 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.
- G. Provide a sprinkler head guard in janitor closets, the elevator machine room and sprinklers within 7 feet of the floor and other areas as required by NFPA 13. In the –TBD– rooms provide cages over the pendent sprinkler heads.
- H. Firestopping shall comply with Section 07 84 00, FIRESTOPPING. All holes through stairways, smoke barrier walls, and fire walls shall be sealed on a daily basis.
- I. Repairs: Repair damage to the building or equipment resulting from the installation of the sprinkler system by the installer at no additional expense to the Government.
- J. Interruption of Service: Request interruptions in writing at least two (2) week prior to the planned work. Impairments to existing sprinkler systems shall be kept to a minimum. These systems shall remain functional as long as possible during the installation of the new system. There shall be no interruption of the existing sprinkler protection, water, electric, or fire alarm services without prior permission of the Contracting Officer.
- 3.3 LABELING
- A. Provide hydraulic design information and signage as required by NFPA 13 and NFPA 14. Securely attached identification signs to control valves, drain valves, and test valves. Locate hydraulic design information at each control valve where there is a zone water flow switch.
- B. Refer to Section 09 91 00, PAINTING for additional requirements.
- 3.4 FIELD INSPECTION, OPERATING AND PERFORMANCE TESTS
- A. Preliminary Testing: Flush each sprinkler system zone of debris. Automatic Sprinkler System in accordance with NFPA 13. Hydrostatically test system as specified in NFPA 13, including the fire department connections, in the presence of the VA Project Engineer (COTR – Contracting Officer's Technical Representative).
- B. Final Inspection and Testing: When all necessary corrections have been accomplished subject system to tests in accordance with NFPA 13 and 25.
1. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  2. Include the operation of all features of the systems under normal operations in test.
  3. Verify application of the system color code and labeling requirements.

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4. Verify type, quantity, location, operation of devices.
  5. Verify sealing of fire/smoke barrier penetrations.
- C. Scheduling: Notify the VA Project Engineer to the schedule of the final inspection and test. Connection to the fire alarm system shall have been in service for at least ten (10) 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.
- 3.5 INSTRUCTIONS TO GOVERNMENT PERSONNEL
- A. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  - B. Furnish the services of a competent instructor for not less than 4 hours for instructing personnel in the operation and maintenance of the system, on the dates requested by the VA Project Engineer.

**--- 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.
  - 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 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- D. Section 05 31 00, STEEL DECKING, Section 05 36 00, COMPOSITE METAL DECKING: Building Components for Attachment of Hangers.
- E. Section 05 50 00, METAL FABRICATIONS.
- F. Section 07 84 00, FIRESTOPPING.
- G. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- H. Section 07 92 00, JOINT SEALANTS.
- I. Section 09 91 00, PAINTING.
- J. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

**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. 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.
  - 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): critical instrumentation.
  - 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 Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
  5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
  6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
  7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
  8. Asbestos products or equipment or materials containing asbestos shall not be used.
- B. 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 Resident Engineer 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. 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 drawings and specifications shall be referred to the RE/COTR for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the RE/COTR at least two weeks prior to commencing installation of any item.
  2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.
- D. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- E. Plumbing Systems: IPC, International Plumbing Code.
- 1.4 SUBMITTALS
- A. Submittals 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.
  - 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, lists of previous installations for selected items of equipment shall be provided. 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. Equipment and materials identification.
    - 2. Fire stopping materials.
    - 3. Hangers, inserts, supports and bracing.
    - 4. Wall, floor, and ceiling plates.
  - H. 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, 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 until 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. Hangers, inserts, supports, and bracing.
    - 2. Pipe sleeves.
    - 3. Equipment penetrations of floors, walls or ceilings.
  - I. Maintenance Data and Operating Instructions:
    - 1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
    - 2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.
    - 3. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- 1.5 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 RE/COTR. Such replacement shall be at no additional cost 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.
  - B. 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), latest edition. 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 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):

Boiler and Pressure Vessel Code (BPVC):

SEC IX-2007..... Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications.
  - C. American Society for Testing and Materials (ASTM):

A36/A36M-2008..... Standard Specification for Carbon Structural Steel

A575-96 (R 2007) ..... Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)

E84-2005 ..... Standard Test Method for Surface Burning Characteristics of Building Materials

E119-2008a ..... Standard Test Methods for Fire Tests of Building Construction and Materials
  - D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:

SP-58-02 ..... Pipe Hangers and Supports-Materials, Design and Manufacture

SP 69-2003 (R 2004)..... Pipe Hangers and Supports-Selection and Application
  - E. National Electrical Manufacturers Association (NEMA):

MG1-2003, Rev. 1-2007... Motors and Generators

International Code Council, (ICC):

IBC-06, (R 2007) ..... International Building Code

IPC-06, (R 2007) ..... International Plumbing Code

## **PART 2 - PRODUCTS**

### **2.1 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.
- 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

### **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

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

### **2.3 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 6 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.

### **2.4 LIFTING ATTACHMENTS**

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

### **2.5 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. 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 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: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 216 mm (8-1/2 inches) by 280 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. A copy of the valve list shall be mounted in picture frames for mounting to a wall.
4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling.

## **2.6 FIRE STOPPING**

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

## **2.7 GALVANIZED REPAIR COMPOUND**

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

## **2.8 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. 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), latest edition, and SECTION 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Submittals based on the International Building Code (IBC), latest edition, SECTION 13 05 41 requirements, 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. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the Resident Engineer in all cases. See these specifications for lateral force design requirements.
- B. Type Numbers Specified: MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
  1. Concrete insert: Type 18, MSS SP-58.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (4 inches) thick when approved by the Resident Engineer for each job condition.
  3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (4 inches) thick when approved by the Resident Engineer 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. Section 05 36 00, COMPOSITE METAL DECKING.
- F. For Attachment to Wood Construction: Wood screws or lag bolts.
- G. 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.

- H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Trapeze hangers are 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 13 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 23 07 11, HVAC, PLUMBING, and BOILER PLANT 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, plastic coated or taped with 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.
- J. 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 cold water shall have insulation that extends a minimum of one 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 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.

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

## 2.9 PIPE PENETRATIONS

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- D. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.
- 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. 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 fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

## 2.10 TOOLS AND LUBRICANTS

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

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

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

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

#### **2.12 ASBESTOS**

- A. Materials containing asbestos are not permitted.

### **PART 3 - EXECUTION**

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

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
- B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance 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. 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 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 RE/COTR where working area space is limited.

2. 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 RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
  3. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
  2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and section 23 09 23 DIRECT DIGITAL CONTROLS FOR HVAC
- J. 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.
- K. 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 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 Para. 3.1 shall apply.



- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. 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 RE/COTR 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 Resident Engineer.
- 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), latest edition, 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. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.5 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.

- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of 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 shall be provided. All materials shall be delivered to RE/COTR 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 RE/COTR. 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. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property. This includes all 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.
- 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 RE/COTR 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.
- D. Asbestos Insulation Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.

### **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. Regulators.
    - b. Pressure reducing valves.
    - c. Control valves and thermostatic elements.
    - d. Lubrication devices and grease fittings.

- e. Copper, brass, aluminum, stainless steel and bronze surfaces.
    - f. Valve stems and rotating shafts.
  - 3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint 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 color as utilized by the pump manufacturer
  - 5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
  - 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.
- 3.8 IDENTIFICATION SIGNS
- A. Pipe Identification: Refer to Section 09 91 00, PAINTING.
- 3.9 STARTUP AND TEMPORARY OPERATION
- A. Start up 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.
- 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 Resident Engineer.
  - B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
  - C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such 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. The Operations and maintenance manuals shall be delivered to RE/COTR not less than 30 days prior to completion of a phase or final inspection.
  - B. All new and temporary equipment and all elements of each assembly 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 guide shall be inserted into the Operations and Maintenance Manual.

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- H. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
  - I. Emergency procedures.
- 3.12 INSTRUCTIONS TO VA PERSONNEL
- A. Instructions shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

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

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

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.

1.2 RELATED WORK

- A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

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. Valves.
  - 2. Pressure Reducing Valves.
  - 3. All items listed in Part 2 - Products.

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 Society for Testing and Materials (ASTM):A536-84(R 2004) Standard Specification for Ductile Iron Castings
- C. American Society of Sanitary Engineering (ASSE)
  - ASSE 1003-01 (R 2003)... Performance Requirements for Water Pressure Reducing Valves
  - ASSE 1012-02..... Backflow Preventer with Intermediate Atmospheric Vent
  - ASSE 1013-05..... Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
- D. International Code Council (ICC)
  - IPC-06 (R 2007) ..... International Plumbing Code
- E. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
- F. SP-25-98..... Standard Marking System for Valves, Fittings, Flanges and UnionsSP-67-02a (R 2004) Butterfly Valve of the Single flange Type (Lug Wafer)
  - SP-70-06 ..... Cast Iron Gate Valves, Flanged and Threaded Ends.
  - SP-72-99 ..... Ball Valves With Flanged or Butt Welding For General Purpose
  - SP-80-03 ..... Bronze Gate, Globe, Angle and Check Valves.
  - SP-110-96 ..... Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

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
- 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.

## **PART 2 – PRODUCTS**

### **2.1 VALVES**

- 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. Ball valves, pressure regulating valves, gate valves, globe valves, and plug valves used to supply potable water shall meet the requirements of NSF 61.
- E. Shut-off:
  - 1. Cold, Hot and Re-circulating Hot Water:
    - a. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-72, 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 4140 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be solder,
    - b. 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 A 536, ductile iron.
      - 1) 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 polyamide 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
- F. Balancing:
  - 1. Hot Water Re-circulating, 80 mm or DN80 (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 (¼" 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.

G. Check:

1. Check valves less than 80 mm or DN80 (3 inches) and smaller) shall be class 125, bronze swing check valves with non metallic Buna-N disc. 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 B 62, solder joints, and PTFE or TFE disc.

H. Globe:

1. 80 mm or DN80 (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 B 62 with solder ends, copper-silicon bronze stem, TPFE or TFE disc, malleable iron hand wheel.

## 2.2 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 ASSE 1013 listed and certified.
- B. Reduced pressure backflow preventers shall be installed in the following applications.
  1. Water make up to heating systems, cooling tower, chilled water system, generators, and similar equipment consuming water.
  2. Atmospheric Vacuum Breaker: ASSE 1001
    - a. Hose bibs and sinks w/threaded outlets.
    - b. All kitchen equipment, if not protected by air gap.
- C. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated duct iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be Noryl (NSF listed). The stem shall be stainless steel conforming to ASTM A276. The seat disc elastomer shall be EPDM. 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.
- D. The atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be either cast bronze. All internal polymers shall be NSF listed. The seat disc elastomer shall be silicone. 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.

## 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 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- C. Valves shall be installed in horizontal piping with stem at or above center of pipe
- D. Valves shall be installed in a position to allow full stem movement.
- E. Check valves shall be installed for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.

**3.3 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. Replace valves shall be replaced if persistent leaking occurs.

**-- E N D --**



**SECTION 22 11 00  
FACILITY WATER DISTRIBUTION  
(PLUMBING SYSTEMS)**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

This section specifies the provisions for the furnishing and installing the domestic water, sanitary sewerage and storm drainage systems including piping, equipment and all necessary accessories.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Division 01, GENERAL REQUIREMENTS: Work performance.
- B. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- C. Section 07 92 00, JOINT SEALANTS: Sealing around penetrations to prevent moisture and water migration.
- D. Section 09 91 00, PAINTING: Identification and painting of pipe and other devices.
- E. Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS: General mechanical requirements and items common to more than one section of Division 22, 23.
- F. Section 23 07 11, HVAC – PLUMBING – BOILER PLANT INSULATION: Piping insulation.

**1.3 QUALITY ASSURANCE**

Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data:
  - 1. Piping, Fittings, Couplings, Adapters, Solder.
  - 2. Dielectric Fittings.
  - 3. Strainers.
  - 4. Valves of all types required.
  - 5. Backflow Preventers.
  - 6. Trap Primers
  - 7. Cleanouts.
  - 8. All required items listed in Part 2 – Products.
  - 9. All fixtures shown on the plumbing schedule and drawings.

- B. Shop Drawing: Details of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.
- C. Coordination Drawings: Refer to Article, SUBMITTALS, in Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- D. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
- E. As-Built Piping Diagrams: Provide detailed drawings for the plumbing systems such as chilled/hot water, steam/condensate system, domestic and plumbing piping.
  - 1. Two sets of full size (Scaled: 1/8" = 1'-0") reproducible drawings.
  - 2. Two sets of half size reproducible drawings.
- F. Certifications: Prior to the next Section of plumbing work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a plumbing system specialist, and testing shall be performed by a qualified technician.

#### 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American National Standards Institute (ANSI):  
American Society of Mechanical Engineers (ASME):  
A11.21.1M ..... Floor Drains ANSI/ASME  
A13.1 ..... Scheme for Identification of Piping Systems ANSI/ASME  
B16.3 ..... Malleable Iron Threaded Fittings ANSI/ASME  
B16.4 ..... Cast Iron Threaded Fittings Classes 125 and 250 ANSI/ASME  
B16.9 ..... Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME  
B16.11 ..... Forged Steel Fittings, Socket-Welding and Threaded ANSI/ASME  
B16.12 ..... Cast Iron Threaded Drainage Fittings ANSI/ASME  
B16.15 ..... Cast Bronze Threaded Fittings ANSI/ASME  
B16.18 ..... Cast Copper Alloy Solder-Joint Pressure Fittings ANSI/ASME  
B16.22 ..... Wrought Copper and Copper Alloy Solder Joint Pressure Fittings ANSI/ASME  
B31.8 ..... Gas Transmission and Distribution Piping Systems ANSI/ASME  
B40.1 ..... Gauges, Pressure Indicating Dial Type - Elastic Element ANSI/ASME  
B40.100 ..... Pressure Gauges and Gauge Attachments ANSI/ASME
- B. American Society of Sanitary Engineers (ASSE):  
1001 ..... Pipe Applied Atmospheric Type Vacuum Breakers  
1010 ..... Performance Requirements for Water Hammer Arresters

- 1013.....Reduced Pressure Principle Backflow Preventers
- 1015.....Double Check Backflow Prevention Assembly
- 1018.....Performance for trap seal primer valve-water supply fed
- 1020.....Vacuum Breakers, Anti-Siphon, Pressure Type
- C. American Society for Testing and Materials (ASTM):
  - A47 .....Ferritic Malleable Iron Castings
  - A53 .....Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless
  - A74 .....Cast Iron Soil Pipe and Fittings
  - A183 .....Carbon Steel Track Bolts and Nuts
  - A312 .....Seamless and Welded Austenitic Stainless Steel Pipe
  - A536 .....Ductile Iron Castings
  - A733 .....Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
  - A888 .....Hubless Cast Iron Soil Pipe and Fittings
  - B32 .....Solder Metal
  - B61 .....Steam or Bronze Castings
  - B62 .....Composition Bronze or Ounce Metal Castings
  - B75 .....Seamless Copper Tube
  - B88 .....Seamless Copper Water Tube
  - B306 .....Copper Drainage Tube (DWV)
  - B584 .....Copper Alloy Sand Castings for General Applications
  - B687 .....Brass, Copper, and Chromium-Plated Pipe Nipples
  - B813 .....Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
  - C564 .....Rubber Gaskets for Cast Iron Soil Pipe and Fittings
  - D2000 .....Rubber Products in Automotive Applications
  - E1120 .....Standard Specification For Liquid Chlorine
  - E1229 .....Standard Specification For Calcium Hypochlorite
- D. American Water Works Association (AWWA):
  - C110 .....Ductile Iron and Gray Iron Fittings - 75 mm thru 1200 mm (3 inch thru 48 inches) for Water and other liquids
  - C151/A21.51.....Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids AWWA/ ANSI
  - C651 .....Disinfecting Water Mains
- E. American Welding Society (AWS):
  - A5.8 .....Filler Metals for Brazing
  - B2.1 .....Welding Procedure and Performance Qualifications

- B2.2 ..... Standard for Brazing Procedure and Performance
- F. Cast Iron Soil Pipe Institute (CISPI):
  - 301 ..... Hubless Cast Iron Soil and Fittings
- G. Factory Mutual (FM):
  - Coupling Used in Hubless Cast Iron Systems for Drains, Waste and Vent Systems
- H. Federal Specifications (Fed. Spec.):
  - A-A-1427C ..... Sodium Hypochlorite Solution
  - A-A-59617 ..... Unions, Brass or Bronze Threaded, Pipe Connections and Solder-Joint Tube Connections
  - L-T-1512A ..... Tape, Pressure Sensitive Adhesive, Pipe Wrapping
  - WW-P-351 ..... Red Brass, Seamless, Standard Pipe Size, Regular and Extra Strong
  - WW-V-35C ..... Valves, Ball, Brass or Bronze
  - WW-V-1967 ..... Valve, Butterfly (Threaded Ends and Solder Ends)
- I. International Association of Plumbing and Mechanical Officials (IAPMO):
  - Uniform Plumbing Code
  - IS-6 ..... Installation Standard
- J. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
  - SP-67 ..... Butterfly Valve of the Single flange Type (Lug Wafer)
  - SP-70 ..... Cast Iron Gate Valves, Flanged and Threaded Ends
  - SP-72 ..... Ball Valves With Flanged or Butt Welding For General Purpose
  - SP-80 ..... Bronze Gate, Globe, Angle and Check Valves
  - SP-110 ..... Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends
- K. National Association of Plumbing - Heating - Cooling Contractors (PHCC):
  - National Standard Plumbing Code
- L. Plumbing and Drainage Institute (PDI):
  - WH-201 ..... Water Hammer Arrestor

## **PART 2 – PRODUCTS**

### **2.1 INTERIOR DOMESTIC WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, Type L, hard drawn tested to 125 psig.
- B. Fittings for Copper Tube:
  - 1. Bronze castings or wrought copper conforming to ANSI B16.18 or B16.22. Unions shall be Bronze, MSS SP 72 & SP 110. Solder or braze joints.
  - 2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) 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.

3. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall 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. Braze joints.

C. Fittings for Stainless Steel:

1. Stainless steel butt-welded fittings, Type 316, Schedule 10, conforming to ANSI B16.9.
2. Grooved fittings, stainless steel, Type 316, Schedule 10, conforming to ASTM A403. Segmental fabricated fittings are not allowed. 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.

D. Adapters: Provide adapters for joining screwed pipe to copper tubing.

E. Solder: ASTM B32, lead and antimony free composition, 95.6-0.4-4 tin-silver-copper Sn Ag Cu using non-corrosive lead free flux.

F. Brazing alloy: AWS A5.8, Classification B Cu P.

G. Reagent Grade Water Piping and Dialysis Water Piping: Not Applicable.

2.2 EXPOSED WATER AND WASTE PIPING

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water and 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, Brass of 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 2-1/2 inches and larger shall be flange type with approved gaskets.
5. Valves: Fed. Spec. WW-V-35C, Ball, Brass or Bronze.

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 DIELECTRIC FITTINGS

- A. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.
- B. 2 inches and Smaller: Threaded dielectric union, ANSI B16.39.
- C. 2-1/2 inches and Larger: Flange union with dielectric gasket and bolt sleeves, ANSI B16.42.
- D. Temperature Rating: 210 Degrees F for water systems, 250 Degrees F for steam condensate and as required for steam service.

2.4 STERILIZATION CHEMICALS

- A. Liquid Chlorine: ASTM E1120.
- B. Hypochlorite: ASTM E1229, or Fed. Spec. AA-1427C, Grade B.

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 under deck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.
- C. Walls: See detail shown on drawings.

2.6 WATER HAMMER ARRESTER

Closed copper tube chamber with permanently sealed 410 kPa (60 psig) air charge above a triple o-ring piston. Three high heat Buna-N O-rings pressure packed and lubricated with FDA approved Dow Corning No. 11 silicone compound. All units shall be designed in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and install in accordance with Plumbing and Drainage Institute requirements. Unit shall be as manufactured by Precision Plumbing Products Inc., Watts or Sioux Chief. Provide water hammer arresters at all solenoid valves, at all groups of two or more flush valves, at all quick opening or closing valves, and at all medical washing equipment.

2.7 SANITARY WASTE, STORM WATER DRAIN AND VENT PIPING

- A. Cast Iron Soil Pipe and Fittings: May be used for sanitary waste and vent piping for extension of piping from the existing. Pipe shall be plain end (no-hub), modified hub, or bell and spigot as required by selected jointing method.
  - 1. Material (Pipe and Fittings): ASTM A74 or ASTM A888 and CISPI 301, Service Class.
  - 2. Joints: Provide one of the following types to suit pipe furnished.
    - a. Double seal, compression-type molded neoprene gasket. Gaskets shall suit class of pipe being jointed.
    - b. Mechanical: Meet the requirements and criteria for pressure, leak, deflection and shear tests as outlined in Factory Mutual No. 1680 for Class 1 couplings.
      - 1) Stainless steel clamp type coupling of elastomeric sealing sleeve, ASTM C564 and a Series 300 stainless steel shield and clamp assembly. Sealing sleeve with center-stop to prevent contact between pipes/fittings being joined shall be marked ASTM C564.
      - 2) Cast iron coupling with neoprene gasket, and stainless steel bolts and nuts.
    - c. 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, leakproof joints.
- B. Copper Pipe and Fittings: May be used for piping above ground, except for urinal drains.
  - 1. Pipe: ASTM B88, Type K, hard drawn copper tested to 125 psig.
  - 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.
    - c. Pumped Waste, Drain, Sewage:

- 1) Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP-72, SP-110. Solder or braze joints. Provide adapters for joining screwed pipe to copper tubing.
- 2) Grooved fittings, 65 mm to 100 mm (2-1/2 to 4 inch) wrought copper ASTM A75 C12200, 125 to 150 mm (5 to 6 inch) bronze castings ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with colored alkyd enamel.
3. Solder: ASTM B32, lead free, 95 TA tin-antimony composition, Ag 95 (Silver) and Sb 5 (Antimony), Sb 5 (Antimony) HA/HB using non-corrosive lead free flux.
4. Brazing alloy: AWS A5.8, Classification BCuP.

## 2.8 CLEANOUTS

- A. Same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts for chemical waste drain pipe shall be of same material as the pipe. Cleanouts shall be easily accessible at each alternate change in pipe direction. Provide a minimum clearance of 600 mm (24 inches) for rodding.
- B. 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 Code.
- C. 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.

## 2.9 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.

## 2.10 TRAP PRIMER

- A. Hydraulic Device: Fifteen millimeter (1/2-inch) inlet and fifteen millimeter (1/2-inch) outlet fully automatic, all brass trap primer valve, activated by a drop in building water pressure, no adjustment required. Model for one (1) to four (4) traps with distribution unit, may be located anywhere in an active cold water line, at each floor drain, at each open trap, as indicated on the drawings or as required by code. Omit distribution unit when serving a single trap. Provide documentation that the product has been tested for compliance to ASSE Standard 1018.

## 2.11 VALVES

- A. Asbestos packing is prohibited.
- B. Shut-off:
  1. Cold, Hot and Recirculating Hot Water:

- a. From 50 mm (2 inches) and Smaller: Ball, MSS SP-72 or SP-110, Type II, Class 125, Style 1 (permits inspection and repair of seats and seals without removing the valve from the line), three piece or double union end construction, full ported, full flow, solder connections, 2760 kPa (400 psi) WOG.
  - C. Balancing:
    - 1. From 50 mm (2 inches) and Smaller: Combination type, calibrated, bronze with bronze disc, equipped with readout valves with integral check valve, indexing position pointer and calibrated name plate, internal EPT O-ring seals and factory molded insulating enclosures.
  - D. Check:
    - 1. From 100 mm (3 inches) and Smaller: Bronze body and trim, swing type, MSS-SP-80, 850 kPa (125 pound) WSP.
  - E. Globe:
    - 1. From 80 mm (3 inches) or Smaller: Bronze body and bonnet, MSS SP-80, 850 kPa (125 pound) WSP. Disk shall be free to swivel on the stem. Composition seating surface disk construction may be substituted for all metal disk construction. Packing shall be a woven non-asbestos material, impregnated with not less than 25 percent, by weight, tetrafluoroethylene resin.
- 2.12 BACKFLOW PREVENTERS
- A. Provide a backflow prevention device at each point in the plumbing system where the potable water supply may encounter a potential source of contamination. Device shall be certified by the American Society of Sanitary Engineers, and be accepted (before installation) by the Boston Water & Sewer Commission. Listed below is a partial list of connections to the potable water system that shall be protected against backflow or back siphoning.
  - B. Reduced Pressure Type: ASSE 1013.
    - 1. Sterilizers.
    - 2. Humidifiers.
  - C. Pressure Type: ASSE 1020.
    - 1. Water make-up to heating systems, cooling tower, chilled water system, and generators.
  - D. Atmospheric Vacuum Breaker: ASSE 1001.
    - 1. Hose bibs and sinks with threaded outlets.
  - E. Double Check Detector Backflow Prevention Assembly: Fire service. ASSE 1015.
- 2.13 PRESSURE GAUGES
- ANSI B40.1 all metal case 114 mm (4-1/2 inches) diameter, bottom connected throughout, graduated as required for service, and identity labeled. Range shall be 0 to --- psi as required.
- 2.14 MISCELLANEOUS DEVICES
- Refer to Drawings and Fixture Schedule.

## PART 3 – EXECUTION

### 3.1 DEMOLITION

- A. Cut and cap branch piping for water, waste and vent from the respective piping systems and disconnect all fixtures shown on drawings, valves, cocks, outlets, casework, cabinets and



equipment, including those furnished by the Government or specified in other Sections. Verify that no other fixtures are connected to deleted lines. All waste drain lines inside the building shall be cut and capped at the nearest termination point to other fed lines below the floor level.

- B. All original building plumbing/steam pipes where originally insulated with asbestos. Work performed on these pipes shall be conducted in compliance with all applicable State & Federal requirements.

### 3.2 GENERAL

- A. The contract drawings are diagrammatic only intended to show general layout of conduit, ductwork, piping, equipment, assemblies, specialties and do not identify all required accessories, components, details, fittings, pipe, offsets, equipment, etc. that may be necessary to properly complete the installation for the purpose intended. Provide all necessary accessories, components, details, fittings, pipe, offsets, equipment, etc based on field measurements and reviewed coordination drawings. Coordinate with other trades for space available and relative location of equipment and accessories to be connected at all locations. It is the intent of the drawings/specifications that the Contractor provides **all** materials, labor and coordination necessary to complete the work described or implied by the contract documents at no additional cost/time to the Government. Interferences and clearance difficulties shall be anticipated and items shall be altered where necessary to avoid the difficulties. Contractor shall determine the exact routing and location of systems prior to fabrication and installation. Accurate field measurements and coordination drawings shall be prepared to establish the locations and characteristics of the various systems (new and existing to remain). Contractor shall propose with submitted coordination drawings other solutions with the same flow characteristics where necessary to avoid interferences and clearance difficulties. **Should the contract documents not agree with themselves the greater quantity of superior work and materials shall be performed.**
- 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. Installation:
  - 1. Comply with the PHCC National Standard Plumbing Code.
  - 2. Install branch piping for water and 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.
  - 3. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.
  - 4. All gravity waste drain lines inside the building with vertical drops over 6 m (20 feet) shall be provided with joint restraint on the vertical drop and horizontal offset or branch below the vertical drop. Joint restraint shall be accomplished by threaded, soldered, lead and oakum or grooved joints or a combination of pipe clamps and tie-rods as detailed in NFPA 24. Vertical joint restraint shall be provided from the fitting at the bottom of the vertical drop through every joint up to the riser clamp at the floor penetration of the floor above. Horizontal joint restraint shall be provided from the same fitting at the bottom of the vertical drop through every joint on the horizontal offset or branch for a minimum of 18 m (60 feet) or to anchoring point from the building structure. Below ground joint restraint shall be accomplished by thrust blocks detailed in NFPA 24.
  - 5. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
  - 6. **Slope floors to floor drains where drainage occurs on a regular or frequent basis, or as otherwise required by the Resident Engineer.**

7. Provide cleanouts for horizontal sanitary lines at every change in direction, and at 50 foot minimum intervals.
  8. Provide hose bibbed chain capped ball valves at every low point in water systems that can trap fluid during a drain down.
  9. Re-hang unsupported existing utility service lines above ceiling where affected by work with suitable support devices in compliance with applicable codes.
  10. Contractor shall utilize pipe freeze technology as specified by Freeze Seal Engineering (New Castle, DE) for attaching new plumbing to existing building systems in the likely event that building risers cannot be shut down.
- D. Piping shall conform to the following:
1. Soil, Waste, Storm Water Drain and Vent to main stacks:

<u>Pipe Size</u>	<u>Minimum Pitch</u>
a. 3 inches and smaller	1 : 50 (1/4" to the foot)
b. 4 inches and larger	1 : 100 (1/8" to the foot)
  2. Exhaust Vent: Extend separately through roof. Sanitary vents shall not connect to exhaust vents.
  3. Domestic Water:
    - a. Where possible, grade all lines to facilitate drainage. Provide hose bibbed chain capped ball valves at bottom of every riser for drain down. All unnecessary traps in circulating lines shall be avoided.
    - b. 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.
  4. Unless shown otherwise, locate piping in ceilings, walls, soffits or otherwise concealed.
- E. Pipe Hangers, Supports and Accessories: Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS. Provide supports as needed at valves, strainers, in-line pumps and other heavy components. Piping layout is based on piping flexibility from sufficient offsets. Placement of supports and hangers should not restrict pipe expansion.
1. Shall be supported in compliance the National Standard Plumbing Code. Support piping securely no greater than 7 foot increments between supports.
  2. Seismic Bracing: Refer to Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  3. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
  4. Floor, Wall and Ceiling Plates, Supports, Hangers:
    - a. Solid or split un-plated cast iron.
    - b. All plates shall be provided with set screws.
    - c. Pipe Hangers: Height adjustable clevis type.
    - d. Adjustable Floor Rests and Base Flanges: Steel.
    - e. Concrete Inserts: "Universal" or continuous slotted type.

- f. 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.
  - g. Riser Clamps: Malleable iron or steel.
  - h. Rollers: Cast iron.
  - i. Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
- 5. 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 6 inches in length and be 16 Gauge steel. The shield shall be sized for the insulation.
- 6. 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 m (20 feet) additional support shall be provided to the center of the span.
- F. Each fixture and piece of equipment shall be supplied with individual ball valves to isolate hot/cold water to each device/fixture independently. These ball valves are in addition to the stop valves normally provided at the device/fixture location. Install valves with stem in horizontal position whenever possible.
  - 1. Valves shall be easily accessible. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc.
  - 2. Locate valve stems in overhead piping in horizontal position. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
  - 3. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
  - 4. Provide unions adjacent to one end of all threaded valves.
  - 5. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
  - 6. Provide hose bibbed chain capped ball valves at every low point in water system that can trap fluid during a drain down.
- G. Offset equipment/component connections and provide unions to allow service for maintenance and repair of serviceable devices with minimal removal of piping. Provide flexibility in equipment connections and branch line takeoffs with 3-elbow swing joints. Provide sufficient offsets, proper placement and type of hangers to allow pipe expansion and movement to avoid pipe stress and failure.
- H. All pipe runs shall be laid out to avoid interference with other work. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 1 inch minimum clearance between adjacent piping or other surfaces. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 1 inch in 40 feet. Provide eccentric reducers to keep bottom of sloped piping flat.
- I. Tee 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.
- J. Connect piping to equipment as shown on drawings and as recommended by the manufacturer.
  - 1. Install components furnished by others such as: Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

2. Minor Piping: Generally, small diameter pipe runs from condensate, drains, and other services are not shown but must be provided.
  3. Unions: Install unions and shut-off ball valves on pressure piping at connections to equipment. Provide unions at all system components to allow service for maintenance and repair of serviceable devices with minimal removal of pipe.
  4. Provide dielectric connections where copper piping is connected to steel piping.
  5. Provide drain connection when a condensate drain system is indicated or required. Condensate drain system shall have cleanouts. 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 at each alternate change in pipe direction. Provide a minimum clearance of 600 mm (24 inches) for rodding.
- K. Penetrations:
1. Seal Proofing: Fill openings around un-insulated pipes penetrating floors and walls. Completely seal clearances around pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  2. Fire Stopping:
    - a. 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 fire stopping materials.
    - b. All temporary, concealed, framing lumber shall comply with MIL-L-19140 for fire retardant treatment, and shall bear the testing agency identification mark and performance rating.
    - c. All penetrations through fire/smoke walls are to be sleeved unless otherwise noted or directed by the VA Project Engineer. Install fire seal material at all penetrations, and troughs penetrating fire/smoke walls. All penetrations through fire/smoke walls (compartmentalization) will be sealed with appropriate fire retardant material on a daily basis, and shall maintain the same integrity as the fire barrier being sealed. The VA will be compensated through contractor contract reduction per day for each fire wall penetration not sealed with acceptable fire retardant material tested in accordance with ASTM E814 (F rating) by the close of business the day that penetration is made.
- L. All mechanical/plumbing lines shall use shut-off ball valves. Where connections are made to existing systems, shut-off ball valves are to be installed. Valves shall be marked with labeled brass tags, and a framed directory installed describing the location and function of each valve. Provide hose bibbed chain capped ball valves at every low point in hydronic systems that can trap fluid during draining. Provide unions and removable pipe sections to all serviceable components in system.
- M. Install automatic trap primers at each floor drain and open traps (eg, at equipment condensate drains) according to manufactures' requirements. Connect trap primers to active water lines with unions and valves for isolation and replacement.
- N. All original building plumbing/steam pipes where originally insulated with asbestos. Work performed on these pipes shall be conducted in compliance with all applicable State & Federal requirements.
- O. Backflow prevention devices shall be installed in an accessible location, 5 (five) feet above finish floor. Register all backflow preventers with the DEP and Boston Water & Sewer Commission prior to the start of construction. Contractor shall be present during initial inspection and testing,

and submit all necessary documentation and as-built drawings. Contractor shall furnish the VA with one (1) additional backflow re-build kit and filter for each device installed.

### 3.3 LEAK TESTING

- A. Test system either in its entirety or in sections. Test hot systems at design maximum temperature.
- B. Tests as approved by the Resident Engineer. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. System shall be tight at all joints with no loss in test pressure.
- C. Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.
- D. Potable, Reagent Grade Water Systems:
  - 1. Operating Test: Fill systems with water and maintain hydrostatic pressure at 2.0 times maximum operating pressure (minimum 690 kPag - 100 psig) for 2 hours.
  - 2. Hydrostatic Test: Fill systems with water and maintain hydrostatic pressure at 1.5 times design pressure (minimum 690 kPag - 100 psig) for 2 hours. For water systems the design maximum pressure would usually be the static head or expansion tank maximum pressure plus pump head.
- E. Soil, Waste, Storm Water Drain, Vent Systems: Conduct before trenches are backfilled or fixtures are connected. Conduct water test or air test as directed by the Resident Engineer.
  - 1. Water Test: If entire system is tested, tightly close all openings in pipes except 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. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts.
  - 2. Air Test: Maintain air pressure of 35 kPag (5 psig) for at least 15 minutes. Use force pump and calibrated mercury column gage.
  - 3. Verifying Accuracy of Low-Pressure Gages: Using a U-tube of mercury one end of the open U-tube is connected to the gage by a tube containing a valve for the injection of air. Air pumped into the connecting tube causes the mercury to stand at different levels in each arm of the U-tube. Each 2 inches of differential between the mercury-column levels represents a pressure of approximately 1 psig. A differential of 10.17 inches of mercury should register on the gage as 5 psig. A transparent plastic tube several feet long attached to an analog gage and filled with water provides a means of an accurate check of low pressures. Each vertical foot of water in the tube above the level of the gage exerts a pressure of 0.43 psig. Thus, if the tube is held so that the water level is 5 ft above the gage, the gage should read slightly more than 2 psig.
  - 4. Final Tests: One of the following tests shall 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 (two ounces) of peppermint into each line or stack.

- F. All Other Piping Tests: Fill systems with water and maintain hydrostatic pressure at 1.5 times design pressure or 2.0 times actual maximum operating conditions (minimum 690 kPag - 100 psig) for minimum 2 hour duration. For water systems the design maximum pressure would usually be the static head or expansion tank maximum pressure plus pump head.

### **3.4 FLUSHING AND STERILIZATION**

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
  - 1. Initial Flushing: Flush all new/existing pipes. 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 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, and remove any component that 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 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 hoses, temporary and permanent piping and Contractor's booster pumps. Purge piping system until clean as approved by the Resident Engineer to flush construction materials from system.
  - 2. Cleaning: Utilizing compatible products in the system, 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 6 feet per second. Circulate each section as approved by the Resident Engineer. Drain and prepare for final sterilization.
- B. Use either liquid chlorine or hypochlorite for sterilization.

### **3.5 IDENTITY LABELING**

- A. Services: Identify systems (Examples: HW, CW, HWR; Hot Water, Cold Water, Hot Water Return) conforming to ANSI A13.1 in width and placement of color band, size and color of legend, unless specified otherwise, on piping, exposed, above removable ceilings, in accessible pipe spaces, interstitial spaces, and behind access panels.
  - 1. Legend shall be pressure sensitive vinyl markers or stencil applied (painted on). Legends shall be placed to be clearly visible from operating position. Use arrow to indicate direction of flow.
  - 2. Place legends 8 feet apart on straight runs of piping, where pipes pass through walls or floors, and adjacent to all operating accessories such as valves, regulators, strainers and cleanouts.
  - 3. Identify pipe contents with sufficient additional details such as temperature, pressure, and contents to identify possible hazard.
  - 4. Legend shall give name in full or in approved abbreviated form.
- B. Equipment: Shall be labeled with engraved black phenolic plates for name and source of energy utilizing the hospital nomenclature as directed by the VA Project Engineer.

**3.6 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS**

- A. Verify type, quantity, location, operation of devices. Examples: Dielectric Fittings, Unions, Valves, Measuring Devices, Strainers.
- B. Perform applicable pressure tests for each system.
- C. Verify size, type, connectivity, pitch of system sections.
- D. Verify operation of trap primers.
- E. Verify that the piping system has been flushed, cleaned and filled.
- F. Verify application of the system color code and labeling requirements.
- G. Verify compliance with the pipe support/restraint and accessories requirements.
- H. Replace disposable start-up strainers after several days of operation with regular strainers.
- I. Adjust red set hand on pressure gages to normal working pressure.
- J. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

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

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

PART 1 - GENERAL

1.1 DESCRIPTION

This section pertains to sanitary sewer and vent systems, including piping, equipment 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 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Pipe Insulation.
- E. Section 07 92 00 Joint Sealants: Sealant products.

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. Floor Drains.
  - 3. Cleanouts.
  - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

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 Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - A112.6.3-01 (R 2007) ..... Standard for Floor and Trench Drains
  - A13.1-07 ..... Scheme for Identification of Piping Systems
  - B16.3-06 ..... Malleable Iron Threaded Fittings, Classes 150 and 300.
  - B16.4-06 ..... Standard for Grey Iron Threaded Fittings Classes 125 and 250
  - B16.12-98 (R 2006) ..... Cast Iron Threaded Drainage Fittings
  - B16.15-06 ..... Cast Bronze Threaded Fittings, Classes 125 and 250



- C. American Society for Testing and Materials (ASTM):
- A47/A47M-99 (R 2004)..... Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process
  - A53/A53M-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
  - A536-84(R 2004) ..... Standard Specification for Ductile Iron Castings
  - B32-08 ..... Standard Specification for Solder Metal
  - B75-02 ..... Standard Specification for Seamless Copper Tube
  - B306-02 ..... *Standard Specification for Copper Drainage Tube (DWV)*
  - B584-06a ..... Standard Specification for Copper Alloy Sand Castings for General Applications
  - C564-03a ..... Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
  - D2000-08..... Standard Classification System for Rubber Products in Automotive Applications
  - D2564-04E1 ..... Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
  - D2665-08..... *Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings*
- D. International Code Council:
- IPC-06..... International Plumbing Code
- E. Cast Iron Soil Pipe Institute (CISPI):
- 301-05 ..... Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
  - 310-04 ..... Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- F. American Society of Sanitary Engineers (ASSE):
- 1018-01 ..... Trap Seal Primer Valves – Potable, Water Supplied
- G. Plumbing and Drainage Institute (PDI):
- PDI WH-201 ..... Water Hammer Arrestor

This section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.

## 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:
2. 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.
3. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310.

**B. Copper Tube, (DWV):**

1. Copper DWV tube sanitary waste, drain and vent pipe may be used for piping above ground, except for urinal drains.
2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.
4. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

**2.2 EXPOSED WASTE PIPING**

- A.** Full iron pipe size chrome plated brass piping shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
1. The Pipe shall meet Fed. Spec. WW-P-351, standard weight.
  2. The Fittings shall conform to ANSI B16.15, cast bronze threaded fittings with chrome finish, (125 and 250).
  3. Nipples shall conform to ASTM B 687, Chromium-plated.
  4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- B.** In unfinished Rooms such as mechanical Rooms, chrome-plated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09 91 00, PAINTING.

**2.3 SPECIALTY PIPE FITTINGS**

- A.** Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
- 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. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); and not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged sanitary line.
- B. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.
- C. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.

## **2.5 FLOOR DRAINS**

- A. Floor drain shall comply with ANSI 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 2.2 kg (16-ounce) soft copper membrane, 600 mm (24 inches) square or another approved waterproof membrane shall be provided.
- B. Floor drain shall comply with ANSI A112.6.3. The type B floor drain shall be constructed of galvanized cast iron with medium duty nickel bronze grate, double drainage pattern, clamping device, without sediment bucket but with secondary strainer in bottom. The grate shall be 175 mm (7 inches) minimum.

## **2.6 TRAPS**

- A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as pipe connected to. Slip joints are 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 system shall be electronic type conforming to ASSE 1044.
  - 1. The controller shall have a 24 hour programmable timer, solid state, 6 outlet zones, minimum adjustable run time of 1 minute for each zone, 12 hour program battery backup, manual switch for 120VAC power, 120VAC to 24VAC internal transformer, fuse protected circuitry, UL listed, 120VAC input-24VAC output, constructed of enameled steel or plastic.
  - 2. The solenoid valve shall have a brass body, Buna "N" seats, normally closed, 5.98 kPa (125 psi) rated, 24VAC.

3. The control wiring shall be copper in accordance with the latest edition of the National Electric Code, Article 725 and not less than 18 gauge. All wiring shall be in conduit and in accordance with Division 26 of the specifications.
4. The vacuum breaker shall conform to ASSE 1001.

## **2.8 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 waterproof 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 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. Unless specifically indicated on the drawings, the minimum slope shall be 2% slope.
- H. The piping shall be installed free of sags and bends.
- I. Seismic restraint shall be installed where required by code.
- J. 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.
- K. 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.

- L. 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"
- M. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".

### **3.2 JOINT CONSTRUCTION**

- A. 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.
- B. For threaded joints, thread pipe and 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.
- C. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.

### **3.3 SPECIALTY PIPE FITTINGS**

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

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

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, 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 cooper 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 fittings 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 (1/2 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 (3/4 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. 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, Supports, Hangers shall have the following characteristics:
1. Solid or split unplated cast iron.
  2. All plates shall be provided with set screws.
  3. Height adjustable clevis type pipe hangers.
  4. Adjustable floor rests and base flanges shall be steel.
  5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  6. Riser clamps shall be malleable iron or steel.
  7. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- G. Miscellaneous materials shall be provided as specified, required, directed or as noted 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 provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- I. Penetrations:
1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
  2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- J. 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%

### 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.
4. Final Tests: Either one of the following tests may be used.
  - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 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.

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

**SECTION 22 40 00  
PLUMBING FIXTURES**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the provisions for the furnishing, installing and finishing of plumbing fixtures, associated trim and fittings necessary to make a complete installation from wall or floor connections to rough piping, and certain accessories. Refer to the plans for more details.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 07 92 00, JOINT SEALANTS: Sealing between fixtures and other finish surfaces.
- B. Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

**1.3 QUALITY ASSURANCE**

Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data:
  - 1. All required items listed in Part 2 – Products.
  - 2. All fixtures shown on the plumbing schedule and drawings.
  - 3. Submit plumbing fixture information in an assembled brochure, showing cuts and full detailed description of each fixture.
- B. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
- C. Certifications: Prior to the next Section of plumbing work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a plumbing system specialist, and testing shall be performed by a qualified technician.

**1.5 APPLICABLE PUBLICATIONS**

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American with Disabilities Act (ADA):  
Section 4-19.4 ..... Exposed Pipes and Surfaces



Appendix B.4.24 ..... Sinks

- B. American National Standard Institute (ANSI):  
The American Society of Mechanical Engineers (ASME):  
A112.6.1M ..... Supports for Off-the-Floor Plumbing Fixtures for Public Use  
A112.19.3M ..... Stainless Steel Plumbing Fixtures (Designed for Residential Use)
- C. American Society of Sanitary Engineers (ASSE):  
1016 ..... Performance Requirements for Individual Thermostatic, Pressure  
Balancing and Combination Pressure Balancing and  
Thermostatic Control Valves for Individual Fixture Fittings
- D. American Society for Testing and Materials (ASTM):  
A276 ..... Stainless and Heat-Resisting Steel Bars and Shapes
- E. National Association of Architectural Metal Manufacturers (NAAMM):  
Metal Finishes Manual
- F. National Sanitation Foundation (NSF):  
61 ..... Drinking Water System Components-Health Effects

**PART 2 – PRODUCTS**

**2.1 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.

**2.2 STOPS**

- A. Provide lock-shield loose key or screw driver pattern angle stops, straight 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 Resident Engineer.
- C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing.
- D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe.
- E. Provide stainless steel drain guard for all lavatories not installed in casework.
- F. Provide cover for stops per A.D.A 4-19.4.

**2.3 ESCHUTCHEONS**

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. Provide only in finished rooms. Mechanical rooms are not considered finished rooms.

**2.4 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 1.5 to 1.7 GPM for lavatories (0.5 GPM for fixture S-1 and S-2); 2.0 to 2.2 GPM for sinks, 2.75 to 3.0 GPM for rinse sinks.
  - 2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 25 and 80 PSIG.
  - 3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self clearing action, and is capable of easy manual cleaning.
- C. Device manufactured by OMNI Products, Inc. or equal, meeting the specified requirements is a measure of quality.

**2.5 SINKS**

- A. Dimensions for sinks and laundry tubs are specified, length by width (distance from wall) and depth.
- B. (S-1) Sink (Single compartment sink, refer to additional specification for sink model and description self-rimming, back faucet ledge).
  - 1. Faucet: Equal to Chicago 116.222.AB.1 solid brass construction, dual-beam sensor, 5/8" spout, battery powered, integral temperature control mixer, 0.5 gpm, vandal-proof spray outlet.
  - 2. Drain: Grid strainer, stainless steel with tailpiece
  - 3. Trap: Cast cooper alloy, chrome plated, 40 mm (1-½ inch), P-trap with cleanout plug, wall connection and escutcheon.
  - 4. Supplies: Chrome plated, ½" flexible risers with angle stops.
- C. (S-2) Sink (Single Compartment, Sinks, refer to architectural specification for sink model number and description)
  - 1. Faucet: Equal to Chicago 116.432.AB.1 Solid brass construction, dual-beam sensor, deck mounted combination faucet with removable replacement unit containing all parts subject to ware, battery powered, temperature control mixer with spout outlet 150 mm (6 inches above deck). Faucet shall be polished chrome plated copper alloy.
  - 2. Drain: Grid strainer, stainless steel, with tailpiece.
  - 3. Trap: Cast copper alloy chrome plated, 40 mm (1-1/2 inch) P-trap with cleanout plug, wall connection and escutcheon.
  - 4. Supplies: Chrome plated, ½" flexible risers with angle stops.
- D. (EW-1) Eyewash, Guardian, No. G1898, left-handed, wall mounted, drop-down eye/face wash. Lawler 911-E for single eyewash mixing valve with integral cold water by-pass, for tepid water to the emergency eyewash, located below the counter.
- E. Refer to Drawings and Fixture Schedule for additional information.

**2.6 MISCELLANEOUS DEVICES**

Refer to Drawings and Fixture Schedule.

### 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, etc. **Provide suitable blocking in hollow partitions and walls to support the weight of each fixture and miscellaneous items.** 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.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 1/4-inch diameter bolts, 20 threads per inch, extend at least 3 inches into masonry; to 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 1/4-inch threaded studs, 20 threads per inch, and shall extend at least 1-1/4 inches into wall.
- G. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- H. 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 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS

- A. Verify type, quantity, location, operation of devices.
- B. Verify application of the device labeling requirements.
- C. Verify operation of automatic air vents and trap primers.
- D. Verify tightness of accessible bolted connections with published data.
- E. Perform applicable tests required in accordance with manufacturer's recommendations'.
- F. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

--- E N D ---

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

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. Central Healthcare Gas Systems: Consisting of oxygen, and compressed air services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets, rough-ins, and all necessary parts, accessories, connections and equipment. Match existing station outlet and inlet terminal connections.

**1.2 RELATED WORK**

- A. Sealing around pipe penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. Sealing around pipe penetrations through the floor to prevent moisture migration: Section 07 92 00, JOINT SEALANTS.
- C. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS. Requirements for commissioning, systems readiness checklist, and training.

**1.3 QUALITY ASSURANCE**

- A. Materials and Installation: In accordance with NFPA 99, (2005) and as specified.
- B. Equipment Installer: Show technical qualifications and previous experience in installing laboratory and healthcare equipment on three similar projects. Submit names and addresses of referenced projects. Installers shall meet the qualifications of ANSI/ASSE Standard 6010.
- C. Equipment Supplier: Show 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 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 ANSI/ASSE Standard 6030. Such testing shall be performed by a party other than the installing contractor.
- E. Provide 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 will 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 documentation 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 a certification that all results of tests were within limits allowed by this specification.
- H. Installing contractor shall maintain as-built drawings of each completed phases for verification; and, shall provide the complete set at the time of final systems certification testing, for

certification by the Third Party Testing Company. As-built drawings shall be provided on prints and in digital format. The digital format shall be in the native CAD system required for the project design. 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.

- I. "Hot taps" are not permitted 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 not allowed.

#### **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. Piping.
  2. Valves.
  3. Inlet and outlet cocks
  4. Station outlets and rough-in assemblies.
- C. 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. 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, analyzed and verified in accordance with the requirements of this specification.
- E. 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.

#### **1.5 TRAINING**

- A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the laboratory and healthcare gas systems, on the dates requested by COTR.
- B. Coordinate with other requirements specified in Section 01 00 00, GENERAL REQUIREMENTS.

#### **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 for Testing and Materisl (ASTM):  
B819-(R2006) ..... Seamless Copper Tube for Medical Gas Systems
- C. American Society of Mechanical Engineers (ASME):  
A13.1-07 ..... Scheme for Identification of Piping Systems  
B16.22-01(R2005) ..... Wrought Copper and Bronze Solder-Joint Pressure Fittings  
B40.100 (2005) ..... Pressure Gauges and Gauge Attachments Boiler and Pressure Vessel Code -

- Section VIII-07 ..... Pressure Vessels, Division I
- Section IX-07 ..... Welding and Brazing Qualifications
- D. American Welding Society (AWS):
  - AWS A5.8-04..... Brazing Filler Metal
  - AWS B2.2-91 ..... Standard for Brazing Procedure and Performance Qualification  
(Modified per NFPA 99)
- E. Compressed Gas Association (CGA):
  - C-9-04..... Standard Color Marking of Compressed Gas Cylinders
  - G-4.1 (2009) ..... Cleaning Equipment for Oxygen Service
  - G-10.1(2008) ..... Nitrogen, Commodity
  - P-9-01 ..... Inert Gases Argon, Nitrogen and Helium
  - V-1-05..... Standard for Compressed Gas Cylinder Valve Outlet and Inlet  
Connections
- F. National Electrical Manufacturers Association (NEMA):
  - ICS-6-93(R2006) ..... Industrial Controls and Systems Enclosures
- G. National Fire Protection Association (NFPA):
  - 99-05..... Health Care Facilities
- H. United States Pharmacopoeia XXI/National Formulary XVI (USP/NF)
- I. Manufacturing Standardization Society (MSS):
  - MSS-SP-72-99..... Ball Valves With Flanged or Butt Welding For General Purpose
  - MSS-SP-110-96..... Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and  
Flared Ends
  - MSS-SP-73-03..... Brazing Joints for Copper and Copper Alloy Solder Pressure  
Fittings

## **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. 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 VALVES**

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

1. Seventy five millimeter (2 1/2 inches) and smaller: Bronze/ brass body, Fed. Spec. MSS SP72 & 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, 4125 kPa ( 600 psi) WOG minimum working pressure, with locking type handle, cleaned for oxygen use and labeled for intended service

### **B. Check:**

1. Eighty millimeter (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, 2750 kPa (400 psi) WOG minimum working pressure.

## **2.3 STATION OUTLETS**

- ### **A.**
- For all services consisting of a quick coupler and inlet supply tube. Provide coupler that is non-interchangeable with other services, and leak proof under three times the normal working pressure. 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 and inlet securely to rough-in to prevent floating and provide each with a capped stub length of 6 mm (1/4-inch) (10 mm outside diameter) (3/8-inch outside diameter) tubing for connection to supply. Identification of each gas service shall be permanently cast into the back plate and shall be visible through a transparent plastic guard. Label stub tubing for appropriate service.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- ### **A.**
- In accordance with current NFPA. Run buried oxygen piping in PVC protective pipe for entire length including enclosure of fittings and changes of direction.
- ### **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.
- 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. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.
- J. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.
- K. 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.
- L. Provide 40mm (1 1/2 inch) diameter line pressure gage downstream of zone valve in cabinets.

### 3.2 TESTS

- A. Initial Tests: Blow down, and high and low pressure leakage tests as required by current NFPA with documentation.
- B. 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).



- c. Needle valve air outlets must deliver 1.5 scfm with a pressure drop of no more than five 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 Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior to notice.

### 3.3 CONNECTION TO EXISTING MEDICAL GAS SYSTEM:

- A. Contactor shall test the existing system for hydrocarbons, dew point, etc. If problems are present, the resident engineer (RE) would notify the facility of the results. The facility would then make the necessary repairs and/ or maintenance.
- B. Install shut-off valve at the connection of new line to existing line.
- C. Coordinate time for shut-down of the existing healthcare system with the VA medical center.
- D. Shut off all oxygen and medical air zone valves and gas riser valves if the section to be connected to cannot be totally isolated from the remainder of the system.

- E. Prior to any work being done, check the new pipeline for particulate or other forms of contamination.
- F. Insure that the correct type of pipe tubing and fittings are being used.
- G. Make a spot check of the existing pipelines in the facility to determine the level of cleanness present.
- H. Reduce the pressure to zero and make the tie-in as quickly as possible. A nitrogen purge is not required since this would require another opening in the pipe.
- I. After the tie-in is made and allowed to cool, slowly bleed the source gas back into the pipeline. Test the work area for leaks with soapy water and repair any leaks.
- J. 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 outlet. After the outlet blows clear into a white cloth, make an additional check at a zone most distant from the work. Perform all required current NFPA tests after connection.

#### **3.4 COMMISSIONING**

- A. Provide commissioning documentation 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.

#### **3.5 DEMONSTRATION AND TRAINING**

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

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

**SECTION 23 05 11**  
**REQUIREMENTS FOR MECHANICAL INSTALLATIONS**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. Basic methods and requirements for Division 23, MECHANICAL, apply to all sections of Division 22, 23.
- B. Furnish and install mechanical systems, equipment and accessories in accordance with the specifications and drawings.
- C. Verify in advance of performing any work the availability, type, capacity, location of mechanical systems necessary to perform the work.
- D. 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 offered in documents.
  - 3. Shall: Mandatory.
  - 4. May: Optional.

**1.2 RELATED WORK – MINIMUM WORK PERFORMANCE REQUIREMENTS**

No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Verify all dimensions, clearances, information and assumptions on existing conditions. All work shall be performed within approved tolerances, meet the requirements of the manufacturer and be neat, straight, plumb, level, smooth. Contractor is responsible for reviewing all contract documents for discrepancies prior to commencing any and all work. Contractor shall notify the Project Engineer of any variances with adequate time so that alternate solutions can be established without disrupting the established construction schedule. Data and information furnished or referred to in the construction documents is for the Contractor's use. The Government assumes no responsibility for any interpretation of or conclusion drawn from the data or information made by the contractor based on the information made available by the Government. Nor does the Government assume responsibility for any understanding reached or representation made concerning conditions that can affect the work by any of its officers or agents before the execution of this contract, unless that understanding or representation is expressly stated in the contract.
- B. Division 01, GENERAL REQUIREMENTS: Work performance.
- C. References to the APPLICABLE PUBLICATIONS are a minimum requirement standard. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date of Invitation for Bids shall be applicable. Drawings and specification sections shall govern in those instances where contract document requirements are greater than those specified in the APPLICABLE PUBLICATIONS

**1.3 COORDINATION**

Coordinate work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the

purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Coordinate the location of all work, equipment and components with other trades and equipment installers to prevent interferences, and maintain proper use and access to all items and spaces. Refer to the **"Coordination Drawing Checklist"** for further details. General Contractor is responsible for coordinating all equipment and components being installed with the placement location and dimension requirements. Prior to job execution each trade shall submit "complete" coordinated shop drawings indicating all equipment and material layouts with locations from walls/columns, bottom/top elevations, vibration isolators, supports, dimensions, utility requirements and equipment submittal numbers. Each trade shall maintain a set of working drawings to document as-built information as the work progresses and submit to the Project Engineer monthly for review.
- B. All work shall be coordinated with other trades to avoid conflicts and to obtain a neat competent installation that will afford maximum accessibility for easy and proper operation, maintenance, service and headroom. All work shall be installed in a manner that permits easy accessibility and proper removal of system components requiring periodic service. Any items determined to be in non-compliance shall be corrected by the Contractor at no additional expense to the Government.
- C. The drawings show or describe the general arrangement of equipment, articles, assemblies, appurtenances but do not show all required fittings, drains, air vents, supports and may not identify all required accessories, components, fittings, and offsets that are necessary to properly complete the installation for the purpose intended. The contract drawings are diagrammatic only intended to show general layout of conduit, ductwork, piping, equipment, terminals, specialties and not intended to show all required offsets, details, accessories and equipment to be connected. Provide all necessary fittings, offsets and pipe runs based on field measurements and reviewed coordination drawings. Coordinate with other trades for space available and relative location of equipment and accessories to be connected at all locations. The Contractor shall alter locations of items where necessary to avoid interference and clearance difficulties. Locations of components and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. The Contractor shall determine the exact routing and location of systems prior to fabrication and installation. Accurate field measurements and coordination drawings shall be prepared to establish the locations and characteristics of the various systems (new and existing to remain). It is the intent of the drawings/specifications that the Contractor provides **all** materials, labor and coordination necessary to complete the work described or implied by the contract documents at no additional cost/time to the Government. The Contractor shall propose with submitted coordination drawings other dimensions with similar characteristics where necessary to avoid interferences and clearance difficulties. **Should the contract documents not agree with themselves the greater quantity of superior work and materials shall be performed.**
- D. Coordinate all mechanical (eg, HVAC), electrical, plumbing (MEP) utility service, fire protection sprinkler system shutdowns and space access three (3) weeks in advance with the Project Engineer. Due to facility scheduling and access difficulties, some shutdowns and the performance of certain work will need to be performed during prime-time by the Contractor. Arrange phases and perform work to insure utility services for other buildings and areas at all times as required.
- E. Before placement and installation of work subject to tests the Contractor shall coordinate and notify the Resident Engineer in sufficient time to enable testing personnel to be present at the site in time for proper testing and field inspection. Such prior notice shall be not less than two (2) weeks unless otherwise designated by the Resident Engineer.
- F. For further details and requirements refer to Section 01 45 99, QUALITY CONTROL – INSPECTION – TESTING SERVICES.

**1.4 QUALITY ASSURANCE**

- A. Independent Mechanical System Inspection/Testing Organization:
  - 1. Agency that is financially independent of equipment manufacturer, supplier, and installer. Inspection/Testing of the entire mechanical system shall be performed by an independent agency regularly involved in the specified work.
  - 2. Certification: Documentation upon completion of inspection/testing to include results, names of independent agency individuals performing work, detailed procedures followed for inspection/testing, and certification that all results were within the limits specified.
- B. When Factory Testing Is Specified:
  - 1. The Government shall have the option of witnessing factory tests. Contractor shall notify the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
  - 2. Four (4) copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
  - 3. When equipment fails to meet factory test and re-inspection is required, the Contractor shall be liable for all additional expenses, including expenses of the Government.
- C. Products 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. All construction firms and personnel shall be experienced and qualified specialists in the applicable industrial and institutional construction.
- D. Product Criteria:
  - 1. Materials, equipment and associated systems shall be comprised of high quality industrial-class and institutional-class products of current production by manufacturers that are experienced specialists in the required products.
  - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly. Asbestos products, or equipment or materials containing asbestos shall not be used.
  - 3. Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located reasonably close to the site.
  - 4. When more than one unit of the same class of product is required, such units shall be the products of a single manufacturer.
  - 5. Brand Names: Certain items may be identified by brand name make and model. Identification of these items by a "brand name" description is intended to indicate the quality and salient (physical, functional, or performance) characteristics of products that will be satisfactory and is not intended to be restrictive. Unless clearly indicated in the offer that an "equal" product is offered, the offer shall be considered as offering a referenced brand name product. Offers of "equal" products or items will be considered for this award if such product or item is clearly identified in the offer and is determined by the Government to fully meet the salient (physical, functional, or performance) characteristics of the product or item named. The Government's determination as to the acceptability of the "equal" product shall be based on information furnished or otherwise identified in the offer, as well as other information reasonably available to the Government. If the item cited is no longer available, the manufacturer's currently available item that replaces the cited model shall be provided.

- E. Assemblies and Components:
    - 1. Manufacturers of assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
    - 2. Components shall be compatible with each other and with the total assembly for the intended service.
    - 3. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
    - 4. Components of an assembled unit need not be products of the same manufacturer.
    - 5. Constituent parts that are similar shall be the product of a single manufacturer.
  - 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 Resident Engineer 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. Plumbing Systems: NAPHCC National Standard Plumbing Code.
  - H. HVAC Systems: ASHRAE; SMACNA; Massachusetts Building & Mechanical/Plumbing Code.
  - I. HVAC Equipment Tolerances: Equipment shall be factory balanced to the required tolerance and re-balanced on site, as necessary.
    - 1. Flow Rate: Section 23 05 93, TESTING, ADJUSTING, BALANCING FOR HVAC.
    - 2. After air/hydronic/steam balance work is completed perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
    - 3. Vibration: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
  - J. Before any welding is performed, contractor shall submit documentation certifying that welders have been trained to 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. Provisions of ASME B31 series "Code for Pressure Piping".
    - 3. American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  - K. Pipe Drilling: All pipe drilling for new taps shall remove the plug that is drilled out from the pipe and wire the plug to the new tap for verification that plug did not fall into the pipe.
  - L. Guaranty: In accordance with WARRANTY OF CONSTRUCTION (FAR 52.246-21).
  - M. For further details and requirements refer to Section 01 45 99, QUALITY CONTROL – INSPECTION – TESTING SERVICES.
- 1.5 QUALIFICATIONS OF PRODUCTS AND SERVICES
- Approval by Contracting Officer is required of product and services of proposed manufacturers, suppliers, installers and will be based upon submission by Contractor of certification that:
- A. Installer Qualifications: The installer has technical qualifications, licenses and specialized experience in installing products similar in material, design, and extent to those indicated with a record of successful in-service performance. Submit list of acceptable installations.

- B. **Manufacturer Qualifications:** The manufacturer is regularly engaged in manufacturing the specified material as a principal product with a minimum of five (5) years experience.
- C. **Product Qualifications:** The design, model and size of each item shall have been in satisfactory and efficient operation on at least three (3) installations for three (3) years. Submit list of acceptable product installations.
- D. **Source Limitations:** Each product type shall be the same and the product of a single manufacturer.
- E. **Service Qualifications:** There shall be a permanent service organization maintained that will render satisfactory service to restore operations within four (4) hours of receipt of notification in event of an emergency or within 24 hours in a non-emergency. Submit name and address of service organizations.

#### **1.6 EQUIPMENT REQUIREMENTS**

- A. The contract drawings are diagrammatic only intending to show general runs and locations of systems and equipment, and not intended to show all required details and accessories. All work shall be accurately laid out and coordinated with other Trades to avoid conflicts and afford maximum accessibility for easy of operation, service, maintenance and headroom. All work shall be installed in a manner permitting removal of components requiring periodic replacement and maintenance without damage to other parts of equipment and system components.
- B. Where variations from the contract requirements are necessary in accordance with Section 01 45 99, **QUALITY CONTROL – INSPECTION – TESTING SERVICES**, and requested in accordance Section 01 33 23, **SHOP DRAWINGS – PRODUCT DATA – SAMPLES**, the installation methods, connecting work and related components shall be included at no additional cost to the Government.

#### **1.7 EQUIPMENT INSTALLATION REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than recommended by the manufacturer.
- C. **Inaccessible Equipment:**
  - 1. Equipment shall be installed at conveniently accessible locations viewable in a direct line of sight parallel and/or perpendicular to the building lines as determined by the Government. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
  - 2. "Conveniently accessible" is defined as being capable of being reached and serviced without the use of ladders, or without reaching or climbing or crawling under or over or behind obstacles such as motors, fans, pumps, pipes, belt guards, high voltage lines, transformers, and ductwork.
- D. **Certifications:** Submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.

#### **1.8 EQUIPMENT IDENTIFICATION**

- A. Install an identification sign that will clearly indicate information required for use and maintenance of items, devices and other significant equipment. All installed equipment shall be labeled with name and source of energy utilizing the hospital nomenclature as directed by the

Project Engineer. Mechanical, Electrical, Plumbing systems shall be color code labeled with contents and flow direction in 8 foot intervals.

- B. Nameplates: 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.
- C. Equipment Identification: Other labels shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 3/16-inch high. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

#### 1.9 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the valve"), this reference shall be deemed to apply to as many such devices as are necessary to complete the installation shown on the drawings and recommended by the manufacturer for the purpose intended.

#### 1.10 TEST STANDARDS

- A. All material and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and material which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Contractor shall engage independent testing companies specialized and certified in the required testing of all installed equipment and components not performed by the manufacturer. The testing firms shall be professionally independent of the manufacturers, suppliers, installers of the equipment and systems evaluated. Testing and inspection shall be performed during a minimum of two periods (rough and final phases) of mechanical construction.
- C. Definitions:
  - 1. Listed; equipment or device of a kind mentioned which:
    - a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.
    - b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
  - 2. Labeled; equipment or device is when:
    - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.
    - b. The laboratory makes periodic inspections of the production of such equipment.
    - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
  - 3. Certified; equipment or product is which:
    - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
    - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.



- c. Bears a label, tag, or other record of certification.

**1.11 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, furnish the following:

- A. Manufacturer's Literature and Data: Submit under the pertinent specification section.
  - 1. Equipment, components and materials shown on drawings and/or identified.
  - 2. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  - 3. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Resident Engineer.
  - 4. Submit all starters that are part of the mechanical package provided by the mechanical contractor.
  - 5. Submit electric motor data and variable speed drive data with the driven equipment.
  - 6. Fire-stopping materials.
- B. Coordination Drawings: Provide complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to SUBCONTRACTS AND WORK COORDINATION (VAAR 852.236-80), and Section 01 45 99, QUALITY CONTROL – INSPECTION – TESTING SERVICES. In addition, provide details of the following:
  - 1. Duct and pipe identification and size.
  - 2. Duct, Pipe or equipment penetrations of floors, walls, ceilings, or roofs.
  - 3. Sleeves, hangers, vibration isolation, inserts, supports, bracing sizes and locations.
  - 4. All equipment and component layouts with submittal & drawing tag, utility requirements, dimensions, locations off walls & column lines, top and bottom elevations.
  - 5. Mechanical space layout details including above all the ceiling areas throughout the project showing all existing/new equipment, piping, ductwork, major raceways/conduit, etc.
- C. Manuals: Submitted in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
  - 1. Maintenance and Operation Manual, submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS, for systems and equipment as required 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 words on the cover: "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. 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 manual 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 startup, 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. Lubrication schedule including type, grade, temperature range, and frequency.
  - j. 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. The list shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
  - k. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- D. 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.
- E. 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. Submittals shall be assembled using the Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, sample Cover Sheet (Attachment A) and Checklist Table (Attachment B) forms.
  - 2. Submittals shall contain the list of items being used, applicable specification paragraph numbers and/or drawing numbers (and other information required for exact identification of location for each item); manufacturer and brand, referenced Publication (if any) and such additional information as may be required by specifications for particular item.
  - 3. Submit each section separately.
- F. 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.
- G. 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 that has not had prior approval will not be permitted at the job site.
- 1. Approvals will be based on complete submission of manuals together with shop drawings.
  - 2. Provide copies of approved HVAC submittals to the Testing, Adjusting and Balancing subcontractor.

- H. Visual/Mechanical Inspections & Tests: Submit tentative schedules for the Division 22, 23 required inspections and tests. Refer to the Mechanical System Inspecting & Testing Checklist (Attachment A) for the minimum requirements and details.
  - I. As-Built System Diagrams: Provide detailed drawings for the mechanical systems.
    - 1. AUTOCAD and PDF file drawings on CD (Version as required by the VA).
    - 2. Two sets of full size (Scaled: 1/8" = 1'-0") reproducible drawings.
    - 3. Two sets of half size reproducible drawings.
  - J. Certifications: After completion of each Section of mechanical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.
  - K. 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.
- 1.12 PRODUCT DELIVERY, STORAGE AND HANDLING
- A. Delivery: 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.
  - B. Protection: Equipment and material shall be protected during shipment and storage against physical damage, dirt, moisture, rain and cold.
    - 1. Equipment and material placed on the job site shall remain in the custody of the Contractor until 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. Painted surfaces shall be protected with factory installed removable heavy craft paper, sheet vinyl or equal. 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.
    - 3. Damaged equipment shall be replaced or repaired to original operating condition as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the Government.
    - 4. Existing equipment and systems being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected against any damage.
  - C. Cleaning:
    - 1. 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, operating and painting.
    - 2. Prior to final inspection and acceptance of the facilities and areas for beneficial use by the Government, the equipment and systems shall be thoroughly cleaned and painted.
    - 3. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.
    - 4. In addition, the following special conditions apply:

- a. Cleaning shall be thorough. Use 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.
- b. Control and instrument panels shall be cleaned; damaged surfaces repaired, and touched-up with matching paint obtained from panel manufacturer.
- c. 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 proper finish.

#### 1.13 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. Except where a specific date is provided the issue (including amendments, addenda, revisions, supplements, and errata) in effect on the date of Bids/Proposals shall be applicable. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. Publications listed in each Division 22, 23 specification Section form a part of this specification to the extent referenced.
- B. Air Movement and Control Association (AMCA):
  - 410.....Recommended Safety Practices for Air Moving Devices
- C. American Society of Mechanical Engineers (ASME):
  - Boiler and Pressure Vessel Code (BPVC):
    - Section IX .....Qualifications Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
  - Code for Pressure Piping:
    - B31.1 .....Power Piping, with Amendments
- D. American Society for Testing and Materials (ASTM):
  - A36/A36M .....Carbon Structural Steel
  - A575 .....Steel Bars, Carbon, Merchant Quality, M-Grades
  - E84 .....Surface Burning Characteristics of Building Materials
  - E119 .....Fire Tests of Building Construction and Materials
- E. American National Standard Institute (ANSI):
  - B31.1 .....Power Piping
- F. Air Conditioning and Refrigeration Institute (ARI):
  - 430.....Central Station Air-Handling Units
- G. Federal Specifications (Fed. Spec.):
  - FF-S-325.....Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
- H. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
  - SP-58.....Pipe Hangers and Supports – Materials, Design and Manufacture
  - SP-69.....Pipe Hangers and Supports – Selection and Application

- SP-127 .....Bracing for Piping Systems, Seismic – Wind – Dynamic, Design, Selection, Application
- I. National Association of Plumbing - Heating - Cooling Contractors (NAPHCC):  
.....National Standard Plumbing Code
- J. National Electrical Manufacturers Association (NEMA):  
MG-1 .....Motors and Generators
- K. National Fire Protection Association (NFPA):  
70 .....National Electrical Code  
90A .....Installation of Air Conditioning and Ventilating Systems  
101 .....Life Safety Code
- L. Occupational Safety and Health Administration (OSHA):  
Part 1910 .....Occupational Safety and Health Standards
- M. Rubber Manufacturers Association (ANSI/RMA):  
IP-20 .....Drives Using Classical V-Belts and Sheaves - Cross Sections A, B, C, D, and E  
IP-21 .....Drives Using Double-V (Hexagonal) Belts (AA, BB, XX, DD Cross Sections)  
IP-22 .....Drives Using Narrow Multiple V-Belts (3V, 5V, and 8V Cross Sections)

## **PART 2 – PRODUCTS**

### **2.1 ASSEMBLED PRODUCTS**

- A. Provide maximum standardization of components to reduce spare part requirements. 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.
- B. 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.
- C. 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.

- D. 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.

## 2.2 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 with quantity, size and style required.
- 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: 25.5 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 adjustable-pitch or fixed-pitch drive as follows:
    - a. Fan speeds up to 1800 RPM: 7.5 kw (10 horsepower) and smaller.
    - b. Fan speeds over 1800 RPM: 2.2 kw (3 horsepower) and smaller.
  2. Provide fixed-pitch drives for drives larger than those listed above.

3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, 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.

## 2.3 DRIVE GUIDES

- 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. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- B. 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.
- C. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured to be removable without disassembling pipe, duct, or electrical connections to equipment.
- D. Access for Speed Measurement: 25 mm (1 inch) diameter hole at each shaft center.

## 2.4 ELECTRIC MOTORS

- A. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient motors where 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 may be split phase or permanent split capacitor (PSC).
- C. Poly Phase Motors: NEMA Design B, squirrel cage, induction type.
- 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.
    - b. Other wiring 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.
  5. Motors utilized with variable frequency drives shall be rated "inverter-ready" per NEMA Standard, MG-1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- 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

specified, 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 mega ohm between stator conductors and frame, to be determined at the time of final inspection.

## **2.5 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Section 26 29 11, LOW VOLTAGE MOTOR STARTERS.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, shall be product of a single manufacturer.
- C. Motors shall be energy efficient type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- 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.

## **2.6 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and maintenance manuals. 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. 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. Plumbing: Provide for all valves (Fixture stops not included).
  - 2. HVAC: Provide for all valves.
  - 3. Valve tags: Engraved black filled numbers and letters not less than 1/2-inch high for number designation, and not less than 1/4-inch for service designation on 19 gage 1-1/2 inches round brass disc, attached 2.1 with brass "S" hook or brass chain.
  - 4. 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.
  - 5. 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 thumbtack in ceiling.

## **2.7 PIPE AND EQUIPMENT SUPPORTS/RESTRAINTS**



- A. Vibration Isolators: Refer to Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/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 Resident Engineer in all cases.
- 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 that 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. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- E. Attachment to Concrete Construction:
  - 1. Concrete insert: Type 18, MSS SP-58.
  - 2. Self-drilling expansion shields and machine bolt expansion anchors: Fed. Spec. FF-S-325, permitted in concrete not less than 102 mm (4 inches) thick. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-325.
  - 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (4 inches) thick when approved by the Resident Engineer for each job condition. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-325.
- F. 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. Attachment to Metal Pan or Deck: Not Applicable.
- H. Attachment to Wood Construction: Wood screws or lag bolts.
- I. 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.
- J. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 38mm by 38mm (1-1/2 inches by 1-1/2 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, for insulated piping at each hanger.

- K. Pipe Hangers and Supports: MSS SP-58, use hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC – PLUMBING – BOILER PLANT INSULATION, for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports. Provide Type 40 insulation 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.
    - g. U-bolt clamp: Type 24.
    - h. Uninsulated copper tube: Hangers, clamps and other support material in contact with tubing shall be copper plated, plastic coated or wrapped with non adhesive isolation tape to prevent electrolysis.
    - i. Insulated copper tube: Provide pre-insulated calcium silicate shields sized for copper tube.
    - j. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending 1 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.
  3. Convertor and Expansion Tank Hangers:
  4. 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.
- L. 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 used with it.
    - 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. Shields may have one or more of the following features to support the load: Structural inserts with 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.
- M. Seismic Restraint of Equipment, Ductwork and Piping: Seismic restraint of equipment, ductwork and piping is required for projects in seismic areas where peak horizontal ground acceleration A max is 0.10g or greater. The A max values are listed in VA Handbook H-08-8, titled "Earthquake Resistant Design Requirements for VA Hospital Facilities".
1. Seismic force design criteria:
    - a. Piping resiliently supported: 120 percent of the weight of the system components and contents.
    - b. Piping not resiliently supported: 60 percent of the weight of the system components and contents.
    - c. Except as noted above; meet the more severe requirements of the Local Code and the latest Uniform Building Code for determining seismic force Fp.
  2. Provide one of the following as applicable:
    - a. Design and installation to meet the criteria listed above, and meet requirements of the latest Sheet Metal and Air Conditioning Contractors National Association (SMACNA), Seismic Restraint Manual Guidelines for Mechanical Systems for the prescribed Seismic Hazard Level (SHL).
    - b. Design and installation shall meet the criteria listed above, and shall meet the most current requirements of the National Uniform Seismic Installation Guidelines (NUSIG). Contractor shall submit all design tables and information for the design force levels, stamped and signed by a professional engineer registered in the State where the project is located.
    - c. Where SMACNA or NUSIG requirements are not met completely, submit proposed alternate details and calculations to completely address seismic bracing requirements. Such designs shall use the more severe of the Local Code and the Uniform Building Code requirements for determining seismic forces, and be performed, stamped and signed by a professional engineer registered in the State where the project is located. Revise if necessary any details shown on the contract drawings for vertical support and lateral bracing, and submit for the approval of the Resident Engineer to meet the required design criteria.

## **2.8 PIPE PENETRATIONS**

- A. Provide 18 gage galvanized sheet metal sleeves for pipe passing through floors, interior walls, and partitions, unless otherwise specified. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent liquid spills from passing to a lower level provide the following as applicable:
  - 1. At sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  - 2. At blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. At 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 from the Resident Engineer.
- D. 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.
- E. Galvanized Steel Pipe 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 workrooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- F. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- G. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- H. 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 firestopping material and sealant to prevent the spread of fire, smoke, liquids, and gases.
- 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 firestopping material and sealant to prevent the spread of fire, smoke, and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

## **2.9 TOOLS AND LUBRICANTS**

- A. Tools: Furnish the Resident Engineer, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. 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.

## PART 3 – EXECUTION

### 3.1 GENERAL

- A. Proper precautions shall be taken so that adjacent occupied areas shall not be disturbed or contaminated during construction. The VA Project Engineer shall be consulted three (3) weeks in advance for approval of work schedules in occupied areas. Due to hospital scheduling and access difficulties some work will likely require prime-time performance by the Contractor. Work above ceilings in areas beyond the construction boundary shall be cleaned and closed with matching undamaged materials by the close of each day.
- B. Verify in advance of performing any work the availability, type, capacity, location of energy systems (eg, Mechanical, Electrical, Plumbing) necessary to perform the work. Provide all necessary labor, material and coordination to complete the work described or implied by the construction documents for equipment to operate in the manner intended at no additional cost or time to the Government. In the event that the characteristics of any equipment do not agree with the characteristics of the available system, make the necessary modifications. All appurtenances, assemblies, articles, equipment, components, and materials furnished shall be new and free from defects, and be of the most suitable grade, size and capacity for the purpose intended, unless otherwise specified or approved by the VA Project Engineer. **Should the contract documents not agree with themselves the greater quantity of superior quality materials and work shall be used.**
- C. All appurtenances, assemblies, articles, equipment, components, and materials installed shall be complete for operation, service and maintenance for the purpose intended not limited to the details and information provided. All appurtenances, assemblies, articles, equipment, components, materials and execution shall be in conformance with the contract documents, manufacturer's written procedures and recommendations, latest editions of all applicable Federal/State/City codes, regulations, ordinances, and the jurisdiction having authority (JHA) as applicable. Except where specific dates are given, the issue (including amendments, addenda, revisions, supplements, and errata) in effect on the date of Invitation for Bids shall be applicable. **In the event that criteria requirements conflict, the most stringent requirement (the greater quantity of superior quality materials and work) shall be met.**
- D. Construction shall not block proper access to new/existing appurtenances, assemblies, articles, equipment, components, and materials requiring operation, service and maintenance whether detailed on the drawings or not. Access must be conveniently placed as determined by the VA Project Engineer.
- E. Properly relocate any existing systems (including but not limited to plumbing/steam lines, ducts, pipes, conduits, hangers, fixtures, surface mounted devices, suspension systems) considered interfering with the installation of new construction at no additional expense to the Government, and after confirming plans with the VA Project Engineer. This will include the relocation and/or reinstallation of items within the construction boundaries to perform and complete all necessary work as required.
- F. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to original condition. Care shall be used during removal and installation to avoid damaging the surrounding surfaces. Damaged surfaces and items within the contract limits shall be patched, repaired, refinished, painted and/or replaced as necessary with materials comparable to the surrounding material and surface equal to new conditions unless otherwise noted or directed by the VA Project Engineer. Finished surfaces shall be indistinguishable from the surrounding area.
- G. All installed equipment shall be labeled with name and source of energy utilizing the facility nomenclature as directed by the VA Project Engineer. Energy systems (eg, Mechanical, Electrical, Plumbing) shall be color code labeled with contents and flow direction in 8 foot intervals.

- H. All original building plumbing/steam pipes are insulated with asbestos. Work performed on these pipes will be coordinated with other trades and conducted in compliance with all applicable State & Federal requirements.
- I. Trace "all" systems (new, existing), verify designations, and provide new directories and VA supplied system schedules for all new and existing systems within the construction boundary. Maintain the documented conditions during installation and verify at the completion of construction.
- J. Utilize pipe freeze technology as specified by Freeze Seal Engineering (New Castle, DE) for attaching new work to existing building systems in the likely event that building utilities cannot be shut down.

### **3.2 DEMOLITION AND MAINTAINING UTILITY SERVICES**

- A. During the execution of work, deactivation, relocation, rerouting, removal of existing equipment and systems shall be performed by the Contractor as required by the job conditions to facilitate the installation of the new systems.
- B. Continuous operation of existing systems is required during demolition, tie-ins, relocation, rerouting and removal work. Outages required for construction purposes shall be scheduled in a manner that shall afford the shortest possible duration. Shutdowns shall be scheduled with the facility for specified mutually agreeable periods. After each period, the interruption shall cease and the service restored to normal operation and the process repeated until the work is completed. Due to the hospital schedules and access difficulties, some shutdowns and the performance of certain work shall be performed during prime time by the contractor.
- C. Maintain and restore all utilities (including plumbing, medical gases, electric branch circuits and feeders) servicing undisturbed regions which pass through the renovated areas. Contractor shall utilize deep scan metal detectors prior to coring/drilling holes in existing structure, and ground detecting core/drill equipment during operation to avoid damaging active existing systems buried in the existing structures.
- D. Devices that are not scheduled for deactivation and are loop fed from devices being removed shall be fed from the extended existing system unless otherwise specified. Where existing components are removed from continuous lengths due to architectural modifications, the remaining system shall be reconnected to the system as required by the job conditions. Re-hang unsupported existing to remain appurtenances as required by the job conditions with suitable supports in compliance with applicable requirements.
- E. Remove mechanical appurtenances in affected areas. Remove all abandoned materials, equipment, components, articles, assemblies, appurtenances within the construction area including but not limited to ducts, pipes, utilities, hangers, suspension systems, fixtures (MEP), surface mounted device boxes, switches, receptacles, wires, conduits back to the termination point where they originate (eg, panel, riser). When utility feeds other active devices, components shall be removed back to the nearest termination point. All removed components shall be terminated properly. Other existing items not compatible with the new construction shall be removed unless otherwise directed by the Project Engineer.
- F. Care shall be used during removal and installation to avoid damaging the surrounding surfaces. Damaged surfaces and items within the contract limits shall be patched, repaired, refinished, painted and/or replaced as necessary with materials to match the existing surrounding material and surface unless otherwise noted or directed by the Project Engineer. Where existing items are removed, ceiling/wall/floor areas shall be patched to match surrounding material and surface. Finished surfaces shall be indistinguishable from the surrounding area.
- G. Where device installation into existing walls is necessary the installation shall include all modifications required by the job conditions to recess the device.
- H. For further details refer to Section 02 41 00, DEMOLITION.

### 3.3 INSTALLATION

- A. In the event that criteria requirements conflict, the most stringent requirement (the greater quantity of superior work and materials) shall be met.
- B. Coordinate location of equipment, components, materials and articles with other trades. Locate equipment, components, materials and articles clear of proper operation and service to other equipment, components, materials and articles (eg, windows, doors, openings, lights, outlets), and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- C. Construction shall not block proper access to new/existing materials, equipment, components, articles, assemblies, appurtenances requiring operation, service and maintenance **whether detailed on the drawings or not**. Access must be conveniently placed as determined by the VA Project Engineer.
- D. Unless shown otherwise, locate piping and control wiring in ceilings, walls, soffits or otherwise concealed. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to original condition.
- E. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer shall be replaced.
  - 2. Protect all finished parts of equipment from rust prior to operation by means of protective coating and wrapping. Close openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemicals, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- F. 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 work.
- G. Work in Existing Building:
  - 1. Perform as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, Article, RESTORATION, alterations, relocation and restoration of existing systems and equipment.
  - 2. Arrange, phase and perform alterations to existing utility services to assure the least interference with normal operations of the facility.
- H. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- I. Electrical and Pneumatic Interconnection of Controls and Instruments: 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.
- J. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and communication switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.
- K. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

- L. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- M. Install piping expansion joints as per manufacturer's recommendations.
- N. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- O. Cut required openings through existing masonry and reinforced concrete using diamond core rotary drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation. All openings must be patched (and fire/smoke sealed if applicable).

#### **3.4 TEMPORARY PIPING AND EQUIPMENT**

- A. Continuity of operation of existing utilities shall generally require temporary installation or relocation of equipment and piping.
- B. Contractor shall provide all required utilities. 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.
- C. Temporary utilities shall be completely removed and any openings in structures sealed upon completion of permanent work. Provide necessary blind flanges and caps to seal open piping remaining in service.

#### **3.5 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 shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to the Resident Engineer for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

#### **3.6 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. Only drill or burn holes in structural steel with the prior approval of the Resident Engineer.



- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
  - C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work.
  - D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Support piping securely no greater than 7 foot increments between supports. Provide a support within one foot of each elbow. Provide additional supports at valves, strainers, in-line pumps and other heavy components.
  - 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: 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.
  - 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. Foundations shall have horizontal dimensions that exceed base frame dimensions by at least 150 mm (6 inches) on all sides. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
    - 3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
    - 4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
  - H. Plumbing horizontal and vertical pipe supports: For additional requirements refer to the NAPHCC National Standard Plumbing Code.
  - I. Provide additional equipment, ductwork and pipe supports/restraints as necessary to meet the requirements of PART 2. Re-hang unsupported existing fixtures and utility service lines above ceiling where affected by work with suitable support devices in compliance with applicable codes. All pipes, ducts, conduits, fixtures, equipment, utility and service lines are to be independently supported from the concrete slab not exceeding 8 foot intervals between supports. Light fixtures are to be supported with two (2) safety chains in trapeze style at all four (4) corners.
- 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. Equip all devices with required lubrication fittings or devices. Lubricate all devices requiring lubrication prior to initial operation. Field check all devices for proper lubrication.
- B. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

### **3.9 INSPECTIONS, OPERATING AND PERFORMANCE TESTS**

- A. Schedule and perform all required inspections and tests for each system as required by the manufacturers and specified in the contract documents. Conduct inspections and tests required in various Sections of specifications in presence of an authorized representative (Resident Engineer – COTR) of the Contracting Officer scheduled two (2) weeks in advance.
- B. Within one (1) week after completion of each phase of work in each applicable Section, submit to the Resident Engineer 4 copies of each inspection/testing report tabulating the results, analysis, recommendations documenting that all work performed including material/installation is in compliance with all the applicable manufacturers' requirements, codes and contract requirements. Inspections, tests or similar services shall be performed and certified by qualified mechanical system specialists from an independent agency.
- C. Inspections (visual/mechanical) and Tests shall be performed during a minimum of two (2) periods (rough and final). Performance shall include all new and existing to be reused components. Performance shall include running the equipment and controls as applicable through their complete operational cycles with all components installed and system balancing complete. Additional periods may be necessary due to project phasing and construction coordination. Inspection and Tests require documentation reports.
- D. Test instruments, materials, labor to be supplied by the testing agency (an independent certified testing company) furnished by the Contractor.
- E. Verify that all installed and existing equipment, devices, components are clean and free of debris.
- F. Verify compliance of all material, workmanship and installation with approved Submittals, applicable Codes, and contract requirements. Verify nameplate data with drawings and specifications.
- G. Inspect all installed and reused equipment for physical integrity, anchorage, alignment, grounding, required clearances & mechanical condition for proper operation within manufacturer's tolerances and applicable requirements.
- H. Obtain either equipment vendor approval or perform all test procedures recommended by manufacturers and demonstrate that all equipment and components meet the manufacturer's requirements and are installed properly, complete and ready for use for the purpose intended.
- I. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values. Document all inspections and tests with detailed results. Provide a startup and checkout report indicating the performance of the systems with documentation demonstrating that all requirements were successfully completed for each task.
- J. 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. All systems must be completely operational meeting the requirements of the contract documents without defective

installation/materials at the time of beneficial occupancy. Contractor is responsible for all VA costs associated with the delinquent execution of this effort.

- K. When completion of certain work or system occurs at a time when final settings and adjustments cannot be properly made to make performance tests due to seasonal conditions, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.
- L. Make tests under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- M. Pre-test equipment and systems and make corrections required for proper operation of such systems before requesting final tests. Final test will not be conducted unless pre-tested.
- N. Systems shall be balanced, controlled and coordinated. A system is defined as the entire complex that must be coordinated to work together during normal operation to produce results for which the system is designed. For example, air conditioning supply air is only one part of entire system that provides comfort conditions for a building. Other related components are return air, exhaust air, steam, chilled water, refrigerant, hot water, controls and electricity, etc. Another example of a complex that involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate and other related components.
- O. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonably short period of time during which operating and environmental conditions remain reasonably constant.
- P. Individual test result of any component, where required, will only be accepted when submitted with the test results of related components and of the entire system.
- Q. Minimum Tests required (requires witness of VA and documentation report):
  - 1. Refer to ATTACHMENT A "Mechanical System Inspecting & Testing Checklist".
  - 2. Perform other tests and inspections as required in other parts of the contract documents.
  - 3. Upon completion, submit written certification with documentation to the Project Engineer demonstrating that the requirements were successfully completed for each task.

### 3.10 INSTRUCTIONS TO GOVERNMENT PERSONNEL

- A. Each applicable trade shall provide qualified, factory-trained representatives to furnish detailed instructions to Department of Veterans Affairs assigned personnel in the operation and complete maintenance for each system and piece of equipment. Instructions for different items of equipment that are component parts of a complete system shall be given in an integrated, progressive manner. All instructors for every piece of component equipment in a system shall be available until instructions for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. The first 2 hour session shall be presented after submittal approval and equipment delivery, but before installation of any equipment. The second 2 hour session shall be accomplished two weeks prior to the final inspection. All instruction periods shall be at such times as scheduled by the Resident Engineer and shall be considered concluded only when the Resident Engineer is satisfied in regard to complete and thorough coverage of information.
- B. Instructional services of competent instructors shall be provided for a minimum of 4 hours of onsite training to designated Government employees covering the overall installation, operational methods, adjustments, care and periodic maintenance requirements for their systems.

- C. Each instructor shall be familiar with all parts of their respective system and shall be trained in operating theory as well as practical operation and maintenance practices. Factory trained instructors shall be employed wherever practical and available. The Department of Veterans affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the Resident Engineer, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.
- D. Utilize the maintenance manual for the system or equipment as a text for instruction. **Instruction shall include a full and extensive review of the maintenance and operation manual.** Failure to execute this task shall require additional training sessions when this information is made available.
- E. Unless otherwise required or approved, the instruction shall be given during the regular work week after the equipment has been accepted and turned over to the Government for regular operation. Where significant changes or modifications in equipment are made under the terms of the guarantee, additional instruction shall be provided as may be necessary to acquaint the operating personnel of the changes or modifications. When more than four man-days (32 hours) of instruction are specified in other sections, approximately half of the time shall be classroom instruction and the other half at the site of the system or equipment.
- F. Upon completion, submit written acknowledgment with documentation to the Project Engineer demonstrating that the required instructions were successfully completed for each discipline.

--- E N D ---

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

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one Section of Division 26.
- B. Section 26 29 11, LOW VOLTAGE MOTOR STARTERS: Starters, control and protection for motors.

**1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data as applicable.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting, material, horsepower, RPM, enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- C. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS. Complete operating and maintenance manuals shall be provided including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver copies to the Resident Engineer not less than 4 weeks prior to final inspection.
- D. Certifications:
  - 1. Prior to the next Section of work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

2. Motors have been properly applied, installed, adjusted, lubricated, and tested.

#### 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. Federal Specifications (Fed. Spec.):  
CC-M-1807 ..... Motors, Alternating Current, Fractional and Integral Horsepower (500 HP and Smaller)
- B. National Fire Protection Association (NFPA):  
70 ..... National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):  
MG1 ..... Motors and Generators  
MG2 ..... Safety Standard for Construction and Guide for Selection, Installation and Use

### PART 2 – PRODUCTS

#### 2.1 MOTORS

- A. For For alternating current, fractional and integral horsepower motors, Fed. Spec. CC-M-1807, NEMA Publications MG1 and MG2 shall apply.
- B. Voltage ratings shall be as follows:
  1. Single phase:
    - a. Motors connected to 120 volt systems: 115 volts.
    - b. Motors connected to 208 volt systems: 200 volts.
    - c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
  2. Three phase:
    - a. Motors connected to 208 volt systems: 200 volts.
    - b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
    - c. Motors, 74.6 kW (100 HP) or larger, connected to 240 volt systems: 230 volts.
    - d. Motors, 74.6 kW (100 HP) or larger, connected to 480 volt systems: 460 volts.
    - e. Motors connected to high voltage systems: Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.
- C. Number of phases shall be as follows:
  1. Motors, less than 373 W (1/2 HP): Single (1) phase.
  2. Motors, 373 W (1/2 HP) and larger: Three (3) phase.
  3. Exceptions:
    - a. Hermetically sealed motors.

- b. Motors for equipment assemblies, less than 745 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- D. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rise for the motor insulations.
- E. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.
- F. Motor Enclosures:
  - 1. Shall be the NEMA types shown on the drawings for the motors.
  - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed.
  - 3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- G. Additional requirements for specific motors, as indicated in other sections, shall also apply.
- H. Energy-Efficient Motors:
  - 1. When higher than standard efficiency motors are specified or indicated, they shall be rated using the IEEE Standard No. 112, Method B, test procedures, as detailed in NEMA MG1 12.53.a. The nameplate shall identify the NEMA Nominal Efficiency indicated on the drawings.
  - 2. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.
- I. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.
- J. Premium efficiency motors shall be used where  $\text{energy cost/kW} \times (\text{hours use/year}) > 50$ .

### **PART 3 – EXECUTION**

#### **3.1 INSTALLATION**

Installation shall be in accordance with the NEC, and as required by the contract documents.

#### **3.2 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS**

- A. Schedule and perform all required inspections and tests for each piece of equipment as required by the manufacturers and specified in the contract documents in the presence of the Resident Engineer. Performance shall include all new and existing to be reused components. Performance shall include running the equipment and controls as applicable through their complete operational cycles with all components installed.
- B. Megger all motors after installation, before start-up. All devices shall test free from grounds.

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- C. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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



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

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

This section specifies the provisions for the furnishing and installing for noise criteria, vibration tolerance, and vibration isolation for HVAC and plumbing work.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 23 05 93, TESTING, ADJUSTING, BALANCING FOR HVAC: Requirements for sound and vibration tests.

**1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- B. Testing Agency Qualifications: Current membership with the Acoustical Society of America and board certified by the Institute of Noise Control Engineering with a record of successful in-service performance. Submit list of acceptable installations.
- C. Noise Criteria:

1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed NC 35 within the occupied room, except as follows:

<u>Type of Room</u>	<u>Noise Criteria</u>
All (unless otherwise indicated)	NC-35
Waiting Areas	NC-40
Corridors (Public)	NC-40
Toilet & Shower Rooms	NC-40
Holding Rooms	NC-40
Laboratories	NC-40
Surgery	NC-40
Procedure	NC-40

2. For equipment that has no sound power ratings scheduled on the plans, the Contractor shall select equipment such that the foregoing noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE 1995 Systems Handbook, Chapter 43, SOUND AND VIBRATION CONTROL. An average value of 5 db shall be used as the room attenuating effect, i.e., the difference between sound power level emitted to room and sound pressure level in room.

3. In absence of specified measurement requirements, measure equipment noise levels 3 feet from equipment and at an elevation of maximum noise generation.

- a. Equipment:

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

- b. Piping: Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

- c. Ductwork: Section 23 31 00, HVAC DUCTS & CASINGS.

- D. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

#### 1.4 SUBMITTALS

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data:

1. Vibration isolators:

- a. Floor mountings.
- b. Hangers.
- c. Snubbers.
- d. Thrust restraints.
- e. Bases.
- f. Seismic restraint provisions and bolting.
- g. Acoustical enclosures.

- B. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

- C. Support & Restraint Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, standard connections, manufacturer's recommendations, behavior problems (vibration, thermal, expansion etc.) associated with equipment or piping.

- D. Testing Agency Qualifications: Submit names and qualifications of company personnel proposed for Project. Submit information on recently completed projects. Submit list of test equipment.

- E. Certifications: Prior to the next Section of mechanical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an

Independent Inspection/Testing Organization – Inspection shall be performed by a noise control acoustical system specialist, and testing shall be performed by a qualified technician.

#### 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): Systems Handbook, Chapter 43, Sound and Vibration Control.
- B. American Society for Testing and Materials (ASTM):
  - A123 .....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - A307 .....Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
  - D2240 .....Standard Test Method for Rubber Property - Durometer Hardness
- Manufacturers Standardization (MSS):
  - SP-58 .....Pipe Hangers and Supports-Materials, Design and Manufacture
- Occupational Safety and Health Administration (OSHA):
  - 1910 .....Occupational Noise Exposure

### PART 2 – PRODUCTS

#### 2.1 GENERAL

Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer, but subject to minimum requirements indicated in the following schedule:

- A. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 Durometer and have a straight-line deflection curve.
- B. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- C. Weather Exposure: Isolators, including springs, exposed to weather shall be hot dip galvanized after fabrication. Hot-dip zinc coating shall not be less than 609 grams per square meter (2 ounces per square foot) by weight complying with ASTM A123. In addition provide limit stops to resist wind velocity. Comply with the design wind velocity as per VA Construction Standard CD-54.
- D. Color code isolators by type and size for easy identification of capacity.
- E. VIBRATION ISOLATOR SELECTION GUIDE:
  - 1. Terminal and Air Handling Units: Mason Industries model SSLFH.
  - 2. Exhaust Fan: Mason Industries model DNHS with Mason SCB Type 3 seismic cable restraints.
  - 3. Ductwork & Piping: Mason Industries model SCB Type 3 cable restraints.
  - 4. Sound Attenuators: Mason Industries model IAC 3HS.

## 2.2 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENTS

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

## 2.3 VIBRATION ISOLATORS

- A. Floor Mountings:
  - 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
  - 2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
  - 3. Captive Spring Mount for Seismic (Type SS):
    - a. Design mounts to resiliently resist seismic forces in all directions. Snubbing shall take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4–inch) before contacting snubbers. Mountings shall have a minimum rating of one G as calculated and certified by a registered structural engineer.
    - b. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.
  - 4. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators proceeding, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting. Isolators shall have a minimum seismic rating of one G.
  - 5. Pads (Type D), Washers (Type W), Bushings (Type L): Pads shall be felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
  - 6. Seismic Pad (Type DS): Pads shall be felt, cork neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced duck and neoprene, with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
  - 1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than

- 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
  3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
  4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
- C. Snubbers: Each spring mounted base shall have a minimum of 4 all-directional or 8 two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4-inch). Air gap between hard and resilient material shall neither be less than 3 mm (1/8-inch) nor more than 6 mm (1/4-inch). Restraints shall be capable of withstanding design load without permanent deformation.
- D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4-inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

## 2.4 BASES

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.
- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (4 inches).
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating pre-located equipment anchor bolts and pipe sleeves. Level concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (6 inches). Form shall include 13 mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (8 inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16-inch).
- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4-inch) clearance for wind resistance.

Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

## **2.5 ACOUSTICAL ENCLOSURES IN MECHANICAL ROOMS**

Provide where shown on the drawings. Enclosures shall be removable and sectional, of a size and weight that sections can be readily handled with typical lifting and moving equipment available in the equipment room. Enclosures must contain access openings, observation ports, lights, and ventilation where required for normal operation, observation and servicing.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

#### **A. Vibration Isolation:**

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

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

### **3.2 FIELD ADJUSTING**

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

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- G. Adjust active height of spring isolators.
- H. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the provisions for the testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems.
- B. TAB includes the following:
  - 1. Design Review Report.
  - 2. Systems Readiness Report.
  - 3. Duct Air Leakage Report.
  - 4. Vibration and sound measurements.
  - 5. Planning systematic TAB procedures.
  - 6. Systems Inspection report for conformance with design.
  - 7. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
  - 8. Recording and reporting all results.
- C. Terminology:
  - 1. Basic TAB used in this Section: Chapter 36, "Testing, Adjusting and Balancing" of 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 condenser water.
  - 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**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS: General mechanical requirements and items common to more than one section of Division 22, 23.
- B. Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/EQUIPMENT: Noise and Vibration Requirements.



- C. Section 23 07 11, HVAC – PLUMBING – BOILER PLANT INSULATION: Piping and Equipment Insulation.
  - D. Section 23 09 23, DDC SYSTEM FOR HVAC: Controls and Instrumentation Settings.
  - E. Section 23 31 00, HVAC DUCTS & CASINGS: Duct Leakage.
- 1.3 QUALITY ASSURANCE
- A. Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  - B. TAB 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. TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC air, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
    - 3. TAB Specialist: The TAB Specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding contract award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to contract completion and must be performed by an approved successor.
    - 4. TAB Specialist Responsibilities:
      - a. The General Contractor within 60 days after the notice to proceed shall identify TAB Specialist who shall be responsible for supervising, coordinating, scheduling and reporting all TAB work and related activities and provide necessary information as required by the Resident Engineer.
      - b. TAB Specialist will be coordinating, scheduling and reporting all TAB work and related activities and shall provide necessary information as required by the Resident Engineer. The TAB Specialist shall follow all TAB work through its satisfactory completion and directly supervise all TAB work.
      - c. Final markings of settings of all HVAC adjustment devices.
      - d. Permanently mark location of duct test ports.
      - e. TAB Specialist 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.

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.
- C. Test Equipment Criteria: The test equipment/instruments 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 the instrument manufacturer. Provide calibration history of the instruments to be used for TAB.
- D. TAB Criteria:
  1. Take a sufficient quantity of readings that will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until two (2) consecutive identical values are obtained.
  2. One or more of the applicable AABC or NEBB publications, supplemented by SMACNA and ASHRAE Handbook "HVAC Applications" Chapter 36, shall be the basis for planning, procedures, and reports.
  3. Flow rate tolerance: Values are based on discussion in ASHRAE Handbook "HVAC Applications", Chapter 36. Air filter resistance during tests, artificially imposed if necessary, shall be at least 90 percent of final values for pre-filters and after-filters.
    - a. Air handling unit cubic feet per minute: Minus 0 percent to plus 10 percent.
    - b. All other fans: Minus 0 percent to plus 10 percent.
    - c. Air terminal units (Max): Minus 5 percent to plus 10 percent.
    - d. Exhaust hoods/cabinets: Minus 0 percent to plus 10 percent.
    - e. Minimum outside air: Minus 0 percent to plus 10 percent.
    - f. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 10 percent to plus 10 percent.
    - g. Heating hot water pumps and hot water coils: Minus 10 percent to plus 10 percent.
    - h. Chilled water and condenser water pumps: Minus 0 percent to plus 10 percent.
    - i. Chilled water coils: Minus 5 percent to plus 5 percent.
  4. Systems shall be adjusted for energy efficient operation as described in PART 3.
  5. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for the air distribution (including all fans), steam and hydronic systems as follows:
    - a. When field TAB work begins.
    - b. During each partial final inspection and the final inspection for the project.
- E. Minimum Required Reporting:
  1. Comments:
    - a. Design versus final performance
    - b. Notable characteristics of system
    - c. Description of systems operation sequence
    - d. Outdoor fresh air and exhaust flows
    - e. Test conditions
  2. Air Moving Equipment:
    - a. Manufacturer

- b. Model/Serial number
  - c. Location
  - d. Arrangement/Class/Discharge
  - e. Air flow, specified and actual
  - f. Return air flow, specified and actual
  - g. Outside air flow, specified and actual
  - h. Total static pressure (total external) specified and actual
  - i. Inlet pressure
  - j. Discharge pressure
  - k. Sheave Make/Size/Bore
  - l. Number of belts including Make/Size
  - m. Fan RPM
- 3. V-Belt Drive:
  - a. Identification/location
  - b. Required driven RPM
  - c. Driven sheave, diameter and RPM
  - d. Belt, size and quantity
  - e. Motor sheave diameter and RPM
  - f. Center to center distance, maximum, minimum, and actual
- 4. Electric Motors:
  - a. Manufacturer
  - b. Model/Frame
  - c. HP/BHP
  - d. Phase, voltage, amperage, nameplate, actual, no load
  - e. RPM
  - f. Service factor
  - g. Starter size, rating, heater elements
  - h. Sheave Make/Size/Bore
- 5. Return Air/Outside Air:
  - a. Identification/location
  - b. Design air flow
  - c. Actual air flow
  - d. Design return air flow
  - e. Actual return air flow
  - f. Design outside air flow
  - g. Actual outside air flow

- h. Return air temperature
- i. Outside air temperature
- j. Required mixed air temperature
- k. Actual mixed air temperature
- l. Design outside/return air ratio
- m. Actual outside/return air ratio
- 6. Exhaust Fan:
  - a. Manufacturer
  - b. Model/Serial number
  - c. Location
  - d. Air flow, specified and actual
  - e. Total static pressure (total external) specified and actual
  - f. Inlet pressure
  - g. Discharge pressure
  - h. Sheave Make/Size/Bore
  - i. Number of Belts including Make/Size
  - j. Fan RPM
- 7. Duct Traverse:
  - a. System zone/branch
  - b. Duct size
  - c. Area
  - d. Design velocity
  - e. Design air flow
  - f. Test velocity
  - g. Test air flow
  - h. Duct static pressure
  - i. Air temperature
  - j. Air correction factor
- 8. Air Distribution:
  - a. Air terminal number
  - b. Room number/location
  - c. Terminal type
  - d. Terminal size
  - e. Area factor
  - f. Design velocity
  - g. Design air flow

- h. Test (final) velocity
  - i. Test (final) air flow
  - j. Percent of design air flow
9. Terminal Unit:
- a. Manufacturer
  - b. Identification/Model number
  - c. Location
  - d. Type, constant, variable, single, dual duct
10. Cooling Coil:
- a. Manufacturer
  - b. Identification/number
  - c. Location
  - d. Service
  - e. Air flow, design and actual
  - f. Entering air DB temperature, design and actual
  - g. Entering air WB temperature, design and actual
  - h. Leaving air DB temperature, design and actual
  - i. Leaving air WB temperature, design and actual
  - j. Water flow, design and actual
  - k. Water pressure drop, design and actual
  - l. Entering water temperature, design and actual
  - m. Leaving water temperature, design and actual
  - n. Air pressure drop, design and actual
11. Heating Coil:
- a. Manufacturer
  - b. Identification number
  - c. Size/Model
  - d. Location
  - e. Service
  - f. Air flow, design and actual
  - g. Water flow, design and actual
  - h. Water pressure drop, design and actual
  - i. Entering water temperature, design and actual
  - j. Leaving water temperature, design and actual
  - k. Entering air temperature, design and actual
  - l. Leaving air temperature, design and actual

- m. Air pressure drop, design and actual
- 12. Pump:
  - a. Manufacturer
  - b. Identification number
  - c. Size/Model
  - d. Impeller
  - e. Service
  - f. Design flow rate, pressure drop, BHP
  - g. Actual flow rate, pressure drop, BHP
  - h. Discharge pressure
  - i. Suction pressure
  - j. Total operating head pressure
  - k. Shut off, discharge and suction pressures
  - l. Shut off, total head pressure
- 13. Duct Leak Test:
  - a. Description of ductwork under test
  - b. Duct design operating pressure
  - c. Duct design test static pressure
  - d. Duct capacity, air flow
  - e. Maximum allowable leakage duct capacity times leak factor
  - f. Test Apparatus:
    - (1) Blower
    - (2) Orifice, tube size
    - (3) Orifice size
    - (4) Calibration date
  - g. Test static pressure
  - h. Test orifice differential pressure
    - (1) Leakage
    - (2) TBD
- 1.4 SUBMITTALS

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

  - A. TAB Agency:
    - 1. Submit names and qualifications of TAB agency officers, job supervisor and TAB Specialists within 60 days after the notice to proceed.
    - 2. Submit information on TAB Specialists' three recently completed projects.

3. Submit list of proposed test equipment.
- B. Cleaning Agency Qualifications: Submit names and qualifications of company officers and job supervisor. Submit information on three recently completed projects. Submit list of proposed test equipment.
- C. Submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work for use by the Resident Engineer.
- D. Submit for Review and Approval:
  1. Design Review Report within 60 days 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 and contract documents. This report is to be submitted during early stages of the project in order to allow timely correction of deficiencies.
  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. These reports shall be submitted prior to or at the time of requesting final inspection or partial final inspections of contract work.
  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.
- F. Certifications: When appropriate and **well in advance of beneficial occupancy**, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Certification shall be performed by a registered professional Mechanical Engineer, inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.

#### 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):  
HVAC Applications Ch 37..... Testing, Adjusting, and Balancing  
HVAC Applications Ch 47..... Sound and Vibration Control  
Standard 111 ..... Practices for Measurement, Testing, Adjusting, and Balancing  
of Building Heating, Ventilation, Air-conditioning, and  
Refrigeration Systems
- B. Associated Air Balance Council (AABC):  
AABC National Standards for Total System Balance
- C. National Air Duct Cleaners Association (NADCA)  
1992..... Assessment, Cleaning, and Restoration of HVAC Systems

ACR-2002 ..... Assessment, Cleaning, and Restoration of HVAC Systems

- D. National Environmental Balancing Bureau (NEBB):
  - Procedural Standards for Testing, Adjusting, Balancing of Environmental System
  - Procedural Standards for the Measurement and Assessment of Sound and Vibration
  - Procedural Standards for Building Systems Commissioning
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  - HVAC SYSTEMS - Testing, Adjusting and Balancing

## **PART 2 – PRODUCTS**

### **2.1 PLUGS**

Provide plastic plugs with gasket to seal holes drilled in ductwork for test purposes to prevent air leakage.

### **2.2 INSULATION REPAIR MATERIAL**

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

### **2.3 MATERIALS**

Replacement of adjustable pulleys, additional balancing dampers, additional fan belts, pressure taps and fitting, hydronic balancing valves and any other devices or equipment required to effect proper testing, adjusting and balancing shall be provided by the Contractor at no additional cost to the Government.

## **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.
- C. Allow sufficient time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.
- D. Coordinate TAB procedures with any phased construction completion requirements for the project. Systems serving completed phases of the project will require TAB for such phases prior to partial final inspections and for final phase inspection. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.

### **3.2 DESIGN REVIEW REPORT**

TAB Specialist shall review the Contract Plans and specifications and advise the Resident Engineer of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. 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. 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.
- B. 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.
  - 1. Verify that systems are complete and operable before commencing work. Verify that all items such as ductwork, piping, ports, terminals, connectors etc. required for TAB are installed. Inspect each system to ensure that it is complete including installation and operation of controls.
  - 2. Ensure the following conditions and provide a report to the Resident Engineer:
    - a. Fans are rotating correctly.
    - b. Pumps are rotating correctly.
    - c. All control devices are installed, complete and operable.
    - d. Systems are started and operating in a safe and normal condition.
    - e. Proper thermal overload protection is in place for electrical equipment.
    - f. Filters are clean and in place. Install temporary media in addition to final filters.
    - g. Duct systems are clean of debris. See ATTACHMENT A "Air Conveyance System Cleaning" in Section 23 31 00, HVAC DUCTS & CASINGS.
    - h. Duct system leakage is minimized. See "Duct Pressure & Leakage Tests and Repairs" in Section 23 31 00, HVAC DUCTS & CASINGS.
    - i. Air coil fins are cleaned and combed.
    - j. Air outlets are installed and connected.
    - k. Fire, smoke and volume dampers are in place and open.
    - l. Access doors are closed and duct end caps are in place.
    - m. Steam systems are flushed, sealed and pressurized.
    - n. Hydronic systems are flushed, filled and vented.
    - o. Proper strainer baskets are clean and in place.
    - p. Service and balance valves are open.
- 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 duct sizes and routing devices. TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

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

- A. See paragraphs under "Duct Pressure & Leakage Tests and Repairs" in Section 23 31 00, HVAC DUCTS & CASINGS.
- B. Witness and report deficiencies of system.

### **3.5 SYSTEM READINESS REPORT**

- A. Inspect each System to ensure that it is complete including installation and operation of controls.

- B. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

### 3.6 TAB REPORTS

- A. Submit an intermediate report for 50 percent of systems and equipment tested and balanced to establish satisfactory test results.
- B. The TAB contractor shall provide raw data immediately in writing to the Resident Engineer if there is a problem in achieving intended results before submitting a formal report.
- C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval.
- D. Do not proceed with the remaining systems until intermediate report is approved by the Resident Engineer.

### 3.7 TAB PROCEDURES

Coordinate TAB with Section 23 09 23, DDC SYSTEM FOR HVAC. Tab shall be performed in accordance with the requirements of the Standards under which TAB agency is certified by either AABC or NEBB.

- A. General: During TAB all related system components shall be in full operation. Fan 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 air and water systems for test and balance work.
  - 1. Ensure recorded data represents actual measured or observed conditions.
  - 2. After adjustment, take measurement to verify balance has not been disrupted or that such disruption has been rectified.
  - 3. **Permanently mark setting of valves, dampers, and other adjustment devices allowing setting to be restored.** Set and lock memory stops.
  - 4. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
  - 5. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Resident Engineer.
    - a. Temperature regulation verification by hourly readings for three consecutive eight (8) hour days.
    - b. Three inspections within 90 days of occupancy for temperature and flow verification.
    - c. Opposite season adjustment of systems.
- B. Air Balance and Equipment Tests: Include air handling unit, fan, diffusers/outlets/inlets.
  - 1. Artificially load the air filters in air handling units to simulate the midpoint resistance. Balance the duct distribution system when in this mode.
  - 2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS. Provide replacement fan and motor sheaves with belts too properly balance fans.
  - 3. Test and record motor full load nameplate rating and actual ampere draw.
  - 4. Test and balance systems in all specified modes of operation, including economizer, and fire emergency modes. Verify that dampers and other controls function properly.

5. Adjust all main supply and return air duct to proper design CFM.
  6. Record final measurements for air handling equipment performance data sheets. Test and record system static pressures, fan suction and discharge.
  7. Test and adjust each diffuser, grille and register. Reading and tests of diffusers, grilles and registers shall include design velocity (FPM) and as adjusted velocity, design CFM and adjusted CFM.
  8. Test and record outside, mixed air and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle).
  9. Test and adjust air handling and distribution systems to provide required or design supply, return, outside and exhaust air quantities.
  10. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
  11. In coordination with the ATC contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.
  12. Measure air quantities at air inlets and outlets. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
  13. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
  14. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Achieve volume control adjustment by duct internal devices such as dampers and splitters.
  15. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
  16. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
  17. Adjust outside air automatic dampers, outside air, return air and exhaust dampers for design conditions.
  18. Measure temperature conditions across air, return air, and exhaust dampers.
  19. Where modulating dampers are provided, take measurement and balance at extreme conditions.
  20. Measure and record pressure differentials between designated spaces such as --- Rooms, etc.
- C. Hydronic Balance and Equipment Tests: Includes forced circulation of liquids and/or vapors through circulating pumps, converters, coils, coolers and condensers.
1. Prepare itemized equipment schedules, listing all heating and/or cooling elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all heating or cooling elements, zone balancing valves, circuit pumps and ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions and measured conditions. Prepare individual pump report sheets for each zone or circuit.
  2. Adjust hydronic systems to provide required or design quantities. Adjust flow rates for coils to values on equipment submittals if different from values on contract drawings.

3. Adjust hydronic systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
4. Record final measurements for hydronic equipment performance data sheets. Include entering and leaving hydronic temperatures for heating/cooling coils, and converters. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and hydronic temperature measurements at the same time.
5. Use calibrated Venturi tubes, orifices, or other metered fitting and pressure gages to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
6. Effect system balance with automatic control valves fully open to heat transfer elements.
7. Balance systems at hydronic design flow and then verify that variable flow controls function properly. Effect adjustment of hydronic water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
8. Test pumps and adjust flow where necessary. Record the following on pumps report sheets:
  - a. Suction and discharge pressure.
  - b. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
  - c. Pressure drop across pump in feet of water and total GMP pump is handling under full flow conditions.
9. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
- D. Steam Heat Balance and Equipment Tests: Includes converters, coils, and exchangers.
  1. Prepare itemized equipment schedules, listing all heating elements and equipment in the systems to be balanced. List in order on equipment schedules, by zone according to the design, all heating elements, zone balancing valves and ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions and measured conditions.
  2. Adjust heating systems to provide required or design quantities. Adjust flow rates for coils to values on equipment submittals if different from values on contract drawings.
  3. Adjust heating systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
  4. Record final measurements for equipment performance data sheets. Include entering and leaving temperatures for heating coils, and converters. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and heating temperature measurements at the same time.
  5. Use calibrated Venturi tubes, orifices, or other metered fitting and pressure gages to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

6. Effect system balance with automatic control valves fully open to heat transfer elements.
7. Balance systems at design flow and then verify that variable flow controls function properly. Effect adjustment of steam heat distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

### 3.8 VIBRATION TESTING

- A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS. Provide measurements for all rotating HVAC equipment 1/2 horsepower and larger, including fans and motors.
- B. Record initial and final measurements for each unit of equipment on test forms. Where vibration readings exceed the allowable tolerance and efforts to make corrections have proved unsuccessful, forward a separate report to the Resident Engineer.

### 3.9 SOUND TESTING

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/EQUIPMENT.
  1. Take readings in rooms designated by the Resident Engineer.
  2. TBD
- 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, formulae and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:
  1. Where sound pressure levels are specified, including the NC Criteria in Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/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 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 - 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) and 16 meters (50 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 measure sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Resident Engineer and the necessary sound tests shall be repeated.

### 3.10 MARKING OF SETTINGS

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

### 3.11 IDENTIFICATION OF TEST PORTS

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 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS

- A. Verify sequence of operation for each device.
- B. Perform applicable leakage, vibration and sound tests.
- C. Verify application of the device labeling requirements.
- D. Inspect installation and equipment for conformance with design.
- E. Inspect the quality of construction and installation before insulating.
- F. Verify application of the system color code and labeling requirements.
- G. Verify compliance with the support/restraint and accessories requirements.
- H. Perform applicable equipment, air/hydronic/steam adjusting and balancing.
- I. Verify quantity, size, type of access doors, air volume dampers, fire/smoke dampers.
- J. Verify size, type, connectivity of system sections, low loss fittings/transitions and air outlets/inlets.
- K. Verify size, quantity, location, operation of all flow measuring devices, controls and instrumentation.
- L. Permanently mark setting of valves, dampers, and other adjustment devices allowing setting to be restored. Set and lock memory stops.
- M. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

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- N. Inspect air conveyance system cleanliness to the indicated NADCA standards and VA protocols – refer to ATTACHMENT A “Air Conveyance System Cleaning” in Section 23 31 00, HVAC DUCTS & CASINGS.
- O. Verify air conveyance system cleanliness to the indicated NADCA standards and VA protocols – refer to ATTACHMENT B “Air Conveyance System Cleanliness Verification” in Section 23 31 00, HVAC DUCTS & CASINGS.
- P. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values. Document all inspections and tests with detailed results. Provide a startup and checkout report indicating the performance of the systems with documentation demonstrating that all requirements were successfully completed for each task.

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

**SECTION 23 07 11**  
**HVAC – PLUMBING – BOILER PLANT INSULATION**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the provisions for the furnishing and installing field applied insulation for thermal efficiency and condensation control for the following:
  - 1. HVAC piping, ductwork and equipment.
  - 2. Plumbing piping and equipment.
  - 3. Existing HVAC piping, ductwork and equipment, plumbing piping and equipment, and equipment after asbestos abatement.
- B. Terminology:
  - 1. ASJ: All-Service-Jacket white finish facing.
  - 2. Air conditioned space: Space directly supplied with heated or cooled air.
  - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16°C (60°F) or below.
  - 4. Concealed: Ductwork and piping above ceilings and in chases, interstitial space, and pipe spaces.
  - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical and electrical equipment rooms. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
  - 6. FSK: Foil-Scrim-Kraft facing.
  - 7. Hot: Ductwork handling air at design temperature above 16°C (60°F); equipment or piping handling media above 41°C (105°F).
  - 8. Kcm: Density, kilograms per cubic meter (Pcf: Density, pounds per cubic foot).
  - 9. Runout: Branch pipe connection from main.
  - 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 Fahrenheit temperature difference).
  - 12. HPS: High pressure steam (414 kPa [60 psi] gage and above).
  - 13. HPR: High pressure steam condensate return.
  - 14. MPS: Medium pressure steam (110 kPa [16 psi] gage thru 415 kPa [59 psi] gage).
  - 15. MPR: Medium pressure steam condensate return.
  - 16. LPS: Low pressure steam (103 kPa [15 psi] gage and below).
  - 17. LPR: Low pressure steam condensate return.



- 18. PC: Pumped condensate.
- 19. HWH: Hot water heating supply.
- 20. HWHR: Hot water heating return.
- 21. GH: Hot glycol-water heating supply.
- 22. GHR: Hot glycol-water heating return.
- 23. CW: Cold water.
- 24. SW: Soft water.
- 25. HW: Hot water.
- 26. CH: Chilled water supply.
- 27. CHR: Chilled water return.
- 28. GC: Chilled glycol-water supply.
- 29. GCR: Chilled glycol-water return.
- 30. RS: Refrigerant suction.

## **1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

## **1.3 QUALITY ASSURANCE**

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- B. Performance Criteria:
  - 1. Comply with NFPA 90A, NFPA 101 as applies to pipe penetrations of fire or smoke barriers, NFPA 251 time-temperature fire conditions required for fire barrier penetration.
  - 2. Test methods: ASTM E84, UL 723, or NFPA 255.
  - 3. Specified k factors are at 24°C (75°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.
  - 5. Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory will be required to show that surface burning characteristics for materials to be used do not exceed specified ratings.
- 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**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data: All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
  - 1. Insulation materials: Each type used. State surface burning characteristics.
  - 2. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
  - 3. Insulation accessory materials: Each type used, including valve extension handles.
  - 4. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
  - 5. Make reference to applicable specification paragraph numbers for coordination.
  - 6. Sealing of ends of cut insulation.
- B. Samples:
  - 1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/blanket; 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.
- C. Certifications: Prior to the next Section of mechanical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.

**1.5 PRODUCT STORAGE AND HANDLING**

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**

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American Society for Testing and Materials (ASTM):
  - A167 .....Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - B209 .....Aluminum and Aluminum-Alloy Sheet and Plate
  - C411 .....Hot-Surface Performance of High-Temperature Thermal Insulation
  - C449 .....Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
  - C533 .....Calcium Silicate Block and Pipe Thermal Insulation

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- C534 ..... Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- C547 ..... Mineral Fiber Preformed pipe Insulation
- C552 ..... Cellular Glass Thermal Insulation
- C553 ..... Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
- C585 ..... Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
- C612 ..... Mineral Fiber Block and Board Thermal Insulation
- C1126 ..... Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
- C1136 ..... Flexible, Low Permeance Vapor Retarders for Thermal Insulation
- D1668 ..... Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
- E84 ..... Surface Burning Characteristics of Building Materials
- E119 ..... Fire Tests of Building Construction and Materials
- E136 ..... Behavior of Materials in a Vertical Tube Furnace at 750 °C
- B. Federal Specifications (Fed. Spec.):
  - L-P-535E ..... Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate)
  - HH-B-100B ..... Barrier Material Vapor (For Pipe, Duct and Equipment Thermal, Insulation)
  - HH-I-558C(3) ..... Insulation, Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)
- C. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):
  - SP58 ..... Pipe Hangers and Supports Materials, Design, and Manufacture
- D. Military Specifications (Mil. Spec.):
  - MIL-A-3316C ..... Adhesives, Fire-Resistant, Thermal Insulation
  - MIL-A-24179A ..... Adhesive, Flexible Unicellular-Plastic Thermal Insulation
  - MIL-C-19565C(1) ..... Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
  - MIL-C-20079H ..... Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
- E. National Fire Protection Association (NFPA):
  - 90A ..... Installation of Air Conditioning and Ventilating Systems
  - 96 ..... Standards for Ventilation Control and Fire Protection of Commercial Cooking Operations
  - 101 ..... Life Safety Code
  - 251 ..... Standard Methods of Fire Tests of Building Construction and Materials
  - 255 ..... Surface Burning Characteristics of Building Materials

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- F. Underwriters Laboratories, Inc (UL):  
 723..... Tests for Surface Burning Characteristics of Building Materials

**PART 2 – PRODUCTS**

**2.1 MINERAL FIBER**

- A. ASTM C612 (Board, Block), Class 1 or 2,  $k = 0.037$  Watt per meter, per degree C (0.26), external insulation for temperatures up to 204°C (400°F).
1. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms, and attics containing air handling units, and ductwork exposed to outdoor weather:
    - a. 2 inch thick insulation faced with ASJ (white all service jacket): Supply air duct, Return air duct, mixed air plenums, pre-filter housing, unlined air handling units, and after-filter housing.
    - b. Outside air ducts: No insulation required.
  2. Cold equipment: 1-1/2 inch thick insulation faced with ASJ.
    - a. Chilled water pumps, water filter, chemical feeder pot or tank.
    - b. Pneumatic, cold water storage and surge tanks.
  3. Hot equipment: 1-1/2 inch thick insulation faced with ASJ.
    - a. Convertors, air separators, steam condensate pump receivers.
    - b. Reheat coil casing and separation chamber on steam humidifiers located above ceilings.
    - c. Domestic water heaters and hot water storage tank.
- B. ASTM C553 (Blanket, Flexible), Type I, Class B-5, Density 32 kcm (2 pcf),  $k = 0.04$  Watt per meter, per degree C (0.27), for use at temperatures up to 204°C (400°F):
1. Air ductwork: 50 mm (2 inch) thick insulation faced with FSK.
  2. Not Applicable.
- C. ASTM C547 (Preformed, Molded), Class 1,  $k = 0.037$  Watt per meter, per degree C (0.26). Fittings, Flanges, Valves, Pipe and Tubing covering, standard thickness by industry standard, for temperatures up to 450°F, in nominal thickness in inches specified in table below, for piping above ground:

Nominal Thickness of Molded Mineral Fiber Insulation, inches				
Nominal Pipe Size, inches:	1 & Below	1-1/4 to 3	4 to 6	8 & Above
251-350 F (HPS, HPR, MPS, MPR)	2.0	2.5	3.5	3.5
212-250 °F (LPS, Vents for PRV safety valves receivers and flash tanks)	1.0	2.0	2.0	2.0
100-211 °F (LPR, PC, HWH, HWHR, GH, GHR)	1.0	1.5	2.0	2.0
a. Runouts to fan coil units	0.5	-	-	-
b. Runouts to reheat coils	0.5	-	-	-

Nominal Thickness of Molded Mineral Fiber Insulation, inches				
Nominal Pipe Size, inches:	1 & Below	1-1/4 to 3	4 to 6	8 & Above
40-60 °F (CH, CHR, GC, GCR)	1.0	1.5	2.0	2.5
a. Runouts to fan coil units	0.75	-	-	-
b. Ice water piping	1.0	1.5	2.0	-
50 °F and less (RS for DX refrigeration)	1.0	1.5	-	-
Domestic hot/cold water supply/return	0.50	0.75	1.0	1.5
Condensate control	0.75	0.75	0.75	-

## 2.2 MINERAL WOOL OR REFRACTORY FIBER

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

## 2.3 RIGID CELLULAR PHENOLIC FOAM

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1, k = 0.021(0.15), for temperatures up to 121°C (250°F) with vapor retarder and all service jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, k = 0.021 (0.15), for temperatures up to 121°C (250°F) with rigid cellular phenolic insulation and covering, vapor retarder and all service jacket.
- C. NFPA 90A burning characteristics requirements of flame spread not over 25 and smoke developed not over 50.
- D. Nominal thickness in inches specified in table below, for piping above ground:  
 Not Applicable – Not Used.

Nominal Thickness of Rigid Closed-Cell Phenolic Foam, inches				
Nominal Pipe Size, inches:	1 & Below	1-1/4 to 3	4 to 6	8 & Above
	-	-	-	-
212-250 °F (LPS, Vents for PRV safety valves receivers and flash tanks)	0.5	1.0	1.0	-
100-211 °F (LPR, PC, HWH, HWHR, GH, GHR)	0.5	0.75	1.0	-
a. Runouts to fan coil units	0.5	-	-	-
b. Runouts to reheat coils	0.5	-	-	-
40-60 °F (CH, CHR, GC, GCR)	0.75	0.75	1.0	1.5
a. Runouts to fan coil units	0.5	-	-	-
b. Ice water piping	0.5	0.75	1.0	-
50 °F and less (RS for DX refrigeration)	0.5	0.75	-	-
Domestic hot/cold water supply/return	0.50	0.5	0.75	0.75
Condensate control	0.75	0.75	0.75	0.75

**2.4 CELLULAR GLASS CLOSED-CELL**

- A. ASTM C552, density 136 kcm (8.5 pcf) nominal,  $k = 0.055$  Watt per meter, per degree C (0.38).
- B. NFPA 90A burning characteristics requirements of flame spread not over 25 and smoke developed not over 50.
- C. Pipe insulation for temperatures up to 200°C (400°F).
- D. Minimum thickness in inches specified in table below, for chilled water and refrigerant piping:

Nominal Thickness of Cellular Glass Insulation, inches				
Nominal Pipe Size, inches:	1-1/2	2 to 6	8 to 12	14 & Above
40-60 °F (CH, CHR)	2.0	3.0	3.0	4.0

- E. 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.

**2.5 POLYISOCYANURATE CLOSED-CELL RIGID**

- A. Preformed (fabricated) pipe insulation, ASTM C591, Type IV,  $K=0.027(0.19)$ , for use at temperatures up to 149°C (300°F) with factory applied PVDC or all service jacket vapor retarder with polyvinyl chloride premolded fitting covers.
- B. Equipment and duct insulation, ASTM C 591, Type IV,  $K=0.027(0.19)$ , for use at temperatures up to 149°C (300°F) with PVDC or all service jacket vapor retarder jacket.
- C. NFPA 90A burning characteristics requirements of flame spread not over 25 and smoke developed not over 50.
- D. Nominal thickness in inches specified in table below, for piping above ground:  
Not Applicable – Not Used.

**2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C534,  $k = 0.033$  Watt per meter, per degree C (0.27), flame spread not over 25, smoke developed not over 100, for temperatures from minus 4°C (40°F) to 93°C (200°F). No jacket required.
- B. Nominal thickness in inches specified in table below, for piping above ground:

Nominal Thickness of Flexible Elastomeric Cellular Insulation, inches				
Nominal Pipe Size, inches:	1 & Below	1-1/4 to 3	4 to 6	8 & Above
100-200 °F (HWH, HWHR, GH, GHR)	1.0	1.5	-	-
a. Runouts to fan coil units, reheat coils	0.75	1.5	-	-
40-60 °F (CH, CHR, GC, GCR)	1.0	1.5	-	-
a. Runouts to fan coil units, cooling coil condensate piping	0.75	1.5	-	-

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Nominal Thickness of Flexible Elastomeric Cellular Insulation, inches				
Nominal Pipe Size, inches:	1 & Below	1-1/4 to 3	4 to 6	8 & Above
b. Ice water, RS for DX refrigeration	1.0	1.5	-	-
Domestic hot water supply and return	0.50	0.75	1.0	1.50

- C. Minimum 20 mm (3/4-inch) thick insulation for pneumatic control lines for a minimum distance of 6 m (20 feet) from discharge side of the refrigerated dryer.
- D. Use Class S (Sheet), 20 mm (3/4-inch) thick for the following:
  - 1. Chilled water pumps.
  - 2. Bottom and sides of metal basins for winterized cooling towers (where basin water is heated).
  - 3. Chillers, insulate any cold chiller surfaces subject to condensation that has not been factory insulated.
  - 4. Piping inside refrigerators and freezers: Provide heat tape under insulation.

**2.7 DUCT WRAP FOR KITCHEN HOOD GREASE DUCTS**

Not Applicable.

**2.8 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: Type I and Type II.
  - 1. Temperature – 1200°F 1700°F
  - 2. Density – 232 (14.5) 288 (18)
  - 3. Thermal conductivity – 0.059 (0.41) 0.078 (0.540)
  - 4. TBD –
- E. Nominal thickness in inches specified in table below, for piping other than in boiler plant:

Nominal Thickness of Calcium Silicate Insulation, inches				
Nominal Pipe Size, inches:	1	1-1/4 to 3	4 to 6	Over 6
200-500 °F (HPS, HPR)	2-1/2	3.0	4.0	4.0

- 1. Engine Exhaust for Emergency Generator and Diesel Driven Fire Pump: Not Applicable.
- 2. ETO Exhaust (High Temperature): Not Applicable.
- 3. Kitchen Exhaust Ductwork: Not Applicable.
- 4. MRI Quench Vent Insulation: Not Applicable.

**2.9 INSULATION FACINGS AND JACKETS**

- A. Fed. Spec. HH-B-100 for Vapor Barrier Types I (exposed ductwork) and II (concealed ductwork):

1. Type I, higher strength with low vapor transmission (0.02 perm rating), Beach puncture 50 units: Use for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be All-Service-Jacket (ASJ) or vapor retarder (PVDC) type.
    - a. 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. Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 100 mm (4 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.
  2. Type II, medium strength with medium vapor transmission, Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or vapor retarder (PVDC) type for concealed ductwork and equipment.
  3. 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 when utilized for outside service.
  4. Factory composite materials may be used if they have been tested and certified by the manufacturer, and witnessed by the VA to meet Beach puncture units specified above. Witnessing of the test may be waived by the Department of Veterans Affairs.
  5. 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-535E, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
  6. Fire and smoke treatment of jackets and facings shall be permanent. The use of water soluble treatments is not acceptable.
  7. Pipe insulation jackets shall have a minimum 40 mm (1-1/2 inch) lap at longitudinal joints and not less than 80 mm (3 inch) butt strips at end joints. Facing on board, blanket and block insulation shall have 50 mm (2 inch) laps or a minimum 80 mm (3 inch) butt strips. Butt strip material shall be the same as the jacket or facing. Laps and butt strips may be self-sealing type with factory applied pressure sensitive adhesive.
- B. Metal Protective Jacket (used in Mechanical Room, Decontamination Room, and Pipe Shaft):
1. Sheet aluminum: ASTM B209, 3003 alloy, H-14 temper, 0.4 mm (0.016-inch) thick. Provide moisture barrier lining for service temperatures 16°C (60°F) or less except where applied over a Type I or II jacket. Longitudinal lap shall be at least 50 mm (2 inches) wide. For service temperatures 16°C (60°F) or less, seal all jacket laps in accordance with Mil. Spec. MIL-C-19565, Type II Coating.
  2. Fitting covers: Factory fabricated from not lighter than 0.5 mm (0.020-inch) thick type 3003 sheet aluminum.
  3. Bands: 20 mm (3/4-inch) wide aluminum on maximum 450 mm (18 inch) centers.
  4. Provide metal jackets over insulation as follows:
    - a. All piping and round or oval ducts exposed to outdoor weather.
    - b. Piping exposed in building, within 1500 mm (5 feet) off the floor, which connects to sterilizers, kitchen, and laundry equipment. Jacket may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
    - c. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.



**2.10 INSULATION ACCESSORY MATERIALS**

- A. Pipe Covering Protective Saddles: Provide for all insulated piping. Install with metal insulation shields furnished with pipe supports, Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

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

- B. Minimum length in inches specified in table below, for insert blocks:

Minimum Length of Insert Blocks, inches				
Nominal Pipe Size, inches:	6 & Below	8, 10, 12	14 to 16	Over 16
Insert Block Length	6.0	9.0	12.0	14.0

- C. Adhesive, Mastic, Cement:

1. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
2. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
3. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
4. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
5. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
6. Other: Insulation manufacturers' published recommendations.

- D. Mechanical Fasteners:

1. Pins, anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
2. Staples: Outward clinching monel or stainless steel.
3. Wire: 1.3 mm thick (18 gage) soft annealed galvanized, or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
4. Bands: 20 mm (3/4-inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

- E. Reinforcement and Finishes:

1. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
2. Glass fiber fitting tape: Mil. Spec. MIL-C-20079, Type II, Class 1.
3. Tape for Flexible Unicellular Insulation: Scotch No. 472, Nashua PE-12, or as recommended by the insulation manufacturer.

4. Hexagonal wire netting: 25 mm (1 inch) mesh, 0.85 mm thick (22 gage) galvanized steel.
5. 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.
6. 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°C (40°F) to 121°C (250°F). Below 4°C (40°F) and above 121°C (250°F) provide double layer insert. Provide color matching, vapor barrier, pressure sensitive tape.

#### 2.11 FIRESTOPPING MATERIAL

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

#### 2.12 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 on "Quality Assurance".

### PART 3 – EXECUTION

#### 3.1 GENERAL REQUIREMENTS

- A. **Required pressure tests of all pipe and duct joints and connections shall be completed and the work approved by the Resident Engineer prior to any 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 with external wrap insulation. Do not use scrap pieces of insulation where a full length section will fit. Provide valve handle extensions.
- C. Objects shall be reinsulated to comply with this specification where removal of piping and equipment insulation is required to comply with Section 02 82 11, ASBESTOS ABATEMENT, unless pipes and/or equipment are to be removed as part of the demolition work.
- D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings. Vapor barriers shall be continuous and uninterrupted throughout systems with operating temperature 16°C (60°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).
- E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation. Cover all exposed raw insulation with white sealer or jacket material.
- F. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

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- G. Insulation on piping and equipment shall be terminated square at items not to be insulated, such as access openings and nameplates. Cover all exposed insulation with either white sealer or jacket material. Seal all overlapping joints.
- H. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- I. Repair existing damaged insulation within the construction area. All mechanical/plumbing lines remaining within the construction area shall be appropriately insulated to comply with this specification whether new or existing as required.
- J. HVAC work not to be insulated:
  - 1. Internally insulated ductwork and air handling units. Omit insulation on relief air ducts (Economizer cycle exhaust air).
  - 2. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
  - 3. Equipment: Expansion tanks, flash tanks, hot water pumps, steam condensate pumps.
  - 4. 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.
- K. Plumbing work not to be insulated:
  - 1. Piping and valves for fire protection system.
  - 2. Chromium plated brass piping.
  - 3. Piping for waste & vent.
- L. Boiler plant work not to be insulated: Not Applicable.
- M. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- N. 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.
- O. Firestop Pipe and Duct Insulation:
  - 1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed and as defined in Section 07 84 00, FIRESTOPPING.
  - 2. Seal opening between insulation and pipe sleeve with firestopping material. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
    - a. Pipe or duct chase walls and floors
    - b. Pipe risers through room floors
    - c. Smoke partitions
    - d. Fire partitions
- P. Freeze protection of above grade outdoor piping (over heat tracing tape): Not Applicable
- Q. Provide metal jackets over insulation as follows:
  - 1. All piping and ducts exposed to outdoor weather.

2. Piping exposed in building, within 1800 mm (6 feet) of the floor that connects to equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

### **3.2 INSTALLATION REQUIREMENTS**

#### **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. 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 to a smooth finish.
  - c. Cold equipment: Apply 3000 mm by 3000 mm (10 feet by 10 feet) mesh glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor barrier 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.
  - d. Chilled water pumps: Insulate with removable and replaceable 1 mm thick (20 gage) aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.
3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics, and ductwork exposed to outdoor weather:
  - a. 50 mm (2 inch) thick insulation faced with ASJ (white all service jacket): Supply air duct, unlined air handling units and after filter housing.
  - b. 50 mm (2 inch) thick insulation faced with ASJ (white all service jacket): Return air duct, mixed air plenums and prefilter housing.
  - c. 25 mm (1 inch) thick insulation faced with ASJ (white all service jacket): Outside air intake ducts.
4. Cold equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
  - a. Chilled water pumps, water filter, chemical feeder pot or tank.
  - b. Pneumatic, cold storage water and surge tanks.
5. 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.
  - c. Domestic water heaters and hot water storage tanks (not factory insulated).

6. Class B-5 duct insulation for humid climates and fringe areas as defined in the ASHRAE Fundamentals handbook.
- B. Flexible Mineral Fiber Blanket:
1. Adhere insulation to metal with 100 mm (4 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 barrier 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 fan 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: 50 mm (2 inch) thick insulation faced with FSK.
    - b. Above ceilings for other than roof level: 50 mm (2 inch) thick insulation faced with FSK.
  4. Concealed return air duct above ceilings at a roof level, unconditioned areas, and in chases with external wall or containing steam piping; 50 mm (2 inch) thick, insulation faced with FSK. Concealed return air ductwork in other locations need not be insulated.
  5. Return air duct in interstitial spaces: 50 mm (2 inch) thick, insulation faced with FSK.
  6. Concealed outside air duct: 50 mm (2 inch) thick, insulation faced with FSK.
  7. Exhaust air duct from refrigerated areas: 50 mm (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 barrier 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°C (61°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°C (40°F), or above 121°C (250°F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
    - c. Factory molded, Fed. Spec. HH-I-558, Form E 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°C (60°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).

- D. Rigid Cellular Phenolic Foam: Not Applicable – Not Used
1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121°C (250°F).
  2. Provide secure attachment facilities such as welding pins.
  3. Apply insulation with joints tightly drawn together.
  4. Apply adhesives, coverings, neatly finished at fittings, and valves.
  5. Final installation shall be smooth, tight, neatly finished at all edges.
- E. Cellular Glass Insulation:
- 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. Seal all vapor barrier 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.
- F. Polyisocyanurate Closed-Cell Rigid Insulation: Not Applicable – Not Used
1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for piping, equipment and ductwork for temperature up to 149°C (300°F) provided insulation thickness requirement does not exceed 38 mm (1-1/2 inches).
  2. Install insulation, vapor retarder and jacketing per manufacturer's recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor retarder integrity.
  3. Install insulation with all joints tightly butted (except expansion) joints in hot applications).
  4. If insulation thickness exceeds 63 mm (2-1/2 inches), install as a double layer system with longitudinal (lap) and butt joint staggering as recommended by manufacturer.
  5. For cold applications, vapor retarder shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor retarder shall be used to attach the vapor retarder or jacketing. No wire ties capable of penetrating the vapor retarder shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
  6. 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 PVC elbow jacket is prohibited on cold applications.
  7. For cold applications, the vapor retarder on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor retarder adhesive tape.
  8. All PVC and metal jacketing shall be installed so as to naturally shed water. Joints shall point down and shall be sealed with either adhesive or caulking (except for periodic slip joints).
  9. Underground piping: Follow instructions for above ground piping but the vapor retarder jacketing shall be 6 mil thick PVDC or minimum 30 mil thick rubberized bituminous membrane. Sand bed and backfill shall be a minimum of 150 mm (6 inches) all around insulated pipe.
- G. Flexible Elastomeric Cellular Thermal Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
  2. Pipe and tubing insulation:
    - a. Use proper size material. Do not stretch or strain insulation.
    - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
    - 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.
- 3.3 APPLICATION – BOILER PLANT PIPES, VALVES, STRAINERS AND FITTINGS  
Not Applicable.
- 3.4 APPLICATION – BOILER FLUE GAS SYSTEMS  
Not Applicable.
- 3.5 APPLICATION – BOILER DEAERATING FEEDWATER HEATER, TANKS  
Not Applicable.
- 3.6 APPLICATION – HEATED OR TRACED OIL FACILITIES OUTSIDE OF BUILDING  
Not Applicable.
- 3.7 FIELD INSPECTIONS AND PERFORMANCE TESTS
- A. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  - B. Verify type, thickness, extent applied to Building, HVAC/Plumbing systems, devices, equipment.
  - C. Verify proper attachment and termination of joints, seams, ends.
  - D. Inspect the quality of installation.
  - E. Make necessary modifications for compliance with applicable criteria.

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

**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 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 the HVAC systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
- C. 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 this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.
- B. The following HVAC systems will be commissioned:
  - 1. Air Handling Systems (including terminal units)
  - 2. Heating Hot Water Systems (Boilers, controls, instrumentation and gages, flues, heating water pumps and motors, Variable Speed Drives, mixing valves).
  - 3. Direct Digital Control System (BACnet or similar Local Area Network (LAN), Operator Work Station hardware and software, building controller hardware and software, terminal unit controller hardware and software, all sequences of operation, system accuracy and response time).



**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 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.

**3.2 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. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

**3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:**

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

**3.4 TRAINING OF VA PERSONNEL**

- A. Training of the VA's operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

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

**SECTION 23 21 13  
HYDRONIC PIPING**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the provisions for the furnishing and installing all water piping for a complete operating system, including integral components, parts, accessories, connections specified herein.
- B. Water piping to HVAC equipment, include the following:
  - 1. Chilled, heating hot/cold water piping.
  - 2. Condensate, drain and vent piping
  - 3. Extension of domestic water make-up piping.
  - 4. Glycol-water piping.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- B. Section 07 92 00, JOINT SEALANTS: Sealing around penetrations to prevent moisture and water migration.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for piping.
- D. Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.: General mechanical requirements and items common to more than one section of Division 23.
- E. Section 23 07 11, HVAC – PLUMBING – BOILER PLANT INSULATION: Piping insulation.

**1.3 QUALITY ASSURANCE**

Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, which includes welding qualifications.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data:
  - 1. Pipe and Tubing, with specification, class or type, and schedule.
  - 2. Fittings, Couplings, Solder, including miscellaneous adapters.
  - 3. Flanges, Gaskets and Bolting.

4. Pipe and Equipment supports. Submit calculations for variable spring and constant support hangers. Seismic bracing details for piping where applicable.
  5. Valves of all types required.
  6. All specified hydronic system components.
  7. Flexible connectors, pipe alignment guides, expansion joints, expansion compensators.
  8. Thermometers, Gages, Strainers, Test Wells, Water Flow Measuring Devices.
  9. Schematic drawings, performance charts and installation/maintenance instructions.
  10. Automatic Air Vents (chilled water and hot water heating).
  11. Backflow Preventers, Vacuum Breakers.
  12. All items listed in Part 2 – Products.
  13. All components detailed on the mechanical schedule and drawings.
- B. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels: Convertors, Air Separators, Expansion Tanks, Flash Tanks.
- C. Coordination Drawings: Refer to Article, SUBMITTALS, of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- D. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
- E. As-Built Piping Diagrams: Provide detailed drawings for the mechanical systems such as chilled/hot water, steam/condensate system, domestic and plumbing piping.
1. Two sets of full size (Scaled: 1/8" = 1'-0") reproducible drawings.
  2. Two sets of half size reproducible drawings.
- F. Certifications: Prior to the next Section of mechanical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.

#### 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American National Institute Standard (ANSI):
- B1.20.1 .....Pipe Threads, General Purpose
- B. American Society of Mechanical Engineers (ASME):
- B16.1 .....Cast Iron Pipe Flanges and Flanged Fittings
- B16.3 .....Malleable Iron Threaded Fittings, Classes 150 and 300
- B16.4 .....Cast Iron Threaded Fittings, Classes 125 and 250
- B16.5 .....Pipe Flanges and Flanged Fittings
- B16.9 .....Factory-Made Wrought Steel Butt Welding Fittings

B16.11 .....Forged Steel Fittings, Socket-Welding and Threaded  
 B16.14 .....Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads  
 B16.22 .....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings  
 B16.23 .....Cast Copper Alloy Solder Joint Drainage Fittings  
 B16.24 .....Bronze Pipe Flanges and Flanged Fittings, Class 150 and 300  
 B16.39 .....Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300  
 B16.42 .....Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300  
 B31.1 .....Power Piping  
 B40.100 .....Pressure Gauges and Gauge Attachments  
 BPVC-CC-N.....Boiler and Pressure Vessel Code

**C. American Society for Testing and Materials (ASTM):**

A47 .....Ferritic Malleable Iron Castings  
 A53 .....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless  
 A106 .....Seamless Carbon Steel Pipe for High-Temperature Service  
 A126 .....Gray Iron Castings for Valves, Flanges, and Pipe Fittings  
 A181 .....Forgings, Carbon Steel, for General-Purpose Piping  
 A183 .....Carbon Steel Track Bolts and Nuts  
 A216 .....Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service  
 A234 .....Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service  
 A285 .....Pressure Vessel Plates, Carbon Steel, Low-and-Intermediate-Tensile Strength  
 A307 .....Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength  
 A516 .....Pressure Vessel Plates, Carbon Steel, for Moderate-and- Lower Temperature Service  
 A536 .....Ductile Iron Castings  
 B32 .....Solder Metal  
 B61 .....Steam or Valve Bronze Castings  
 B62 .....Composition Bronze or Ounce Metal Castings  
 B88 .....Seamless Copper Water Tube  
 B813 .....Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube

**D. American Water Works Association (AWWA):**

C110 .....Ductile Iron and Grey Iron Fittings for Water

**E. American Welding Society (AWS):**

A5.8 .....Filler Metals for Brazing

- B2.1 .....Welding Procedure and Performance Qualifications
- B2.2 .....Standard for Brazing Procedure and Performance
- F. Copper Development Association, Inc. (CDA):
  - CDA A4015.....Copper Tube Handbook
- G. Expansion Joint Manufacturer's Association, Inc. (EJMA):
  - EMJA .....Expansion Joint Manufacturer's Association Standards
- H. Federal Specification (Fed. Spec.):
  - GG-G-76E .....Gages, Pressure and Vacuum, Dial Indicating ( For Air, Steam, Oil Water, Ammonia, Chlorofluro Hydrocarbon and Compressed Gases)
  - WW-T-696E .....Traps, Steam and Air
  - WW-V-35C .....Valves, Ball, Brass or Bronze
  - WW-V-1967 AMD 1....Valves, Butterfly (Threaded Ends and Solder Ends), Brass or Bronze
- I. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:
  - SP-67 .....Butterfly Valves
  - SP-70 .....Cast Iron Gate Valves, Flanged and Threaded Ends
  - SP-71 .....Cast Iron Swing Check Valves, Flanged and Threaded Ends
  - SP-72 .....Ball Valves for General Service
  - SP-78 .....Cast Iron Plug Valves, Flanged and Threaded Ends
  - SP-80 .....Bronze Gate, Globe, Angle and Check Valves
  - SP-84 .....Valves - Socket Welding and Threaded Ends
  - SP-85 .....Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
- J. Military Specifications (Mil. Spec.):
  - MIL S 901D.....Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, and Systems
  - MIL-STD-105 .....Sampling Procedures and Tables for Inspection by Attributes
  - MIL-V-3 .....Packaging of Valves, Fittings, and Flanges
- K. National Board of Boiler and Pressure Vessel Inspectors (NB):
  - Relieving Capacities of Safety Valves and Relief Valves
- L. Tubular Exchanger Manufacturers Association:
  - TEMA Standards

## **PART 2 – PRODUCTS**

- 2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES
  - Provide in accordance with Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

## 2.2 PIPE AND TUBING

- A. Chilled/Hot Water (Supply/Return), Condensate, Vent:
  - 1. Piping 2 inches and Smaller: ASTM B88, Type K, hard drawn copper tested to 125 psig.
  - 2. Piping 2-1/2 inches and Larger: ASTM A53 Grade B, Schedule 40, seamless steel.
- B. Extension of Domestic Make-up Water: ASTM B88, Type K, hard drawn copper.
- C. Cooling Coil Condensate Drain Piping:
  - 1. From air handling units: Copper water tube, ASTM B88, Type L.
  - 2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L.

## 2.3 FITTINGS FOR STEEL PIPE

- A. 2 inches and Smaller: Welded or screwed joints. Mechanical couplings are optional for water piping only.
  - 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: ASME B16.3, 150 pound malleable iron. ASME B16.4, 125 pound cast iron, 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 3/4-inch garden hose thread, with hose cap nut.
- B. 2-1/2 inches and Larger: Welded or flanged joints. Mechanical couplings and fittings are optional for water piping only.
  - 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 °C (220 °F). Convuluted, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
    - b. Flange bolting: ASTM A307, Grade B, carbon steel machine bolts or studs and nuts.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and thredolets 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.
- D. Mechanical Pipe Couplings and Fittings: May be used, with cut or roll grooved pipe, in water service up to 230 °F in lieu of welded, screwed or flanged connections.
  - 1. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A183.
  - 2. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.

3. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

#### **2.4 FITTINGS FOR COPPER TUBING**

- A. Solder Joint: Wrought copper, ASME B16.22. Cast brass, ASME B16.23, may be used with Type K tubing in drain systems.
  1. Joints shall be made up in accordance with recommended practices of the materials applied.
  2. Solder: ASTM B32, lead free, 95 TA tin-antimony composition, Ag 95 (Silver) and Sb 5 (Antimony), Sb 5 (Antimony) HA/HB using non-corrosive lead free flux.
  3. Brazing alloy: AWS A5.8, Classification BCuP.
- B. 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. Braze joint with cadmium free brazing alloy.
- C. Bronze Flanges and Flanged Fittings: ASME B16.24.
- D. Adapters: Provide adapters for joining screwed pipe to copper tubing. Couplings and fittings shall be of the same manufacturer.

#### **2.5 DIELECTRIC FITTINGS**

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 2 inches and Smaller: Threaded dielectric union, ASME B16.39.
- C. 2-1/2 inches and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- D. Temperature Rating: 210 Degrees F for water systems.

#### **2.6 SCREWED JOINTS**

- A. Pipe Thread: ANSI B1.20.1.
- B. Lubricant or Sealant: Pipe thread sealant or other compound approved for the intended service.

#### **2.7 VALVES**

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure. Provide valve extension handles for all insulated pipe applications.
- C. Provide chain operators for valves 4 inches and larger when the centerline is located 8 feet or more above the floor or operating platform.
- D. Gate Valves:
  1. 2 inches and Smaller: Bronze, MSS-SP-80, 150 lb., wedge disc, rising stem, union bonnet.
  2. 2-1/2 inches and Larger: Flanged, outside screw and yoke.
    - a. High pressure steam 413 kPa (60 psi) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, 1034 kPa (150 psi) at 260 °C (500 °F), 11-1/2



to 13 percent chrome stainless steel solid disc and seats. Provide factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.

- b. All other services: MSS-SP-70, iron body, bronze mounted, 861 kPa (125 psi) wedge disc.
- E. Globe, Angle and Swing Check Valves:
  - 1. 2 inches and Smaller: MSS-SP-80, bronze, 1034 kPa (150 lb). Globe and angle valves shall be union bonnet with metal plug type disc.
  - 2. 2-1/2 inches and Larger:
    - a. Globe valves for high pressure steam: Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 150 psi at 500 °F, 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
    - b. All other services: 125 psi, flanged, iron body, bronze trim, MSS-SP-85 for globe valves and MSS-SP-71 for check valves.
- F. 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.
  - 1. Body: Cast iron, ASTM A126, Class B; or steel, ASTM A216, Class WCB; or ductile iron, ASTM 536, flanged, grooved, or wafer type.
  - 2. Seat, disc and spring: 18-8 stainless steel; or bronze, ASTM B62. Seats may be elastomer material.
- G. Butterfly Valves: May be used in lieu of gate valves in water service except for direct buried pipe. Provide stem extension to allow 2 inches of pipe insulation without interfering with valve operation.
  - 1. 2 inches and Smaller: Fed. Spec. WW-V-1967.
  - 2. 2-1/2 inches and Larger: MSS-SP-67, flange lug type (for end of line service) or grooved end rated 175 psi working pressure at 200 °F.
    - 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 6 inches and Smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
      - 2) Valves 8 inches and Larger: Enclosed worm gear with hand wheel, and where required, chain-wheel operator.
- H. Ball Valves, 3 inches and Smaller:
  - 1. Ball, Fed. Spec. WW-V-35C, Type II, Bronze body, Class 400 (400 psig service pressure rating), Style 1 (permits inspection and repair of Teflon seats and seals without removing the valve from the line), full ported, full flow, screwed or solder connections, MSS SP-72,

2760 kPa (400 psig) WOG working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.

2. Ball, Fed. Spec. WW-V-35C, Type II, ASTM A105 forged carbon steel body, ASTM A276 nitrided Type 316 stainless steel ball and stem, MTFE stem packing and body seal, RPTFE seat and stem bearing, adjustable packing gland, blow-out proof stem, Class 400 (400 psig service pressure rating), Style 3 (requires the entire valve to be removed from the line for either inspection or repair), full ported, full flow, screwed or solder connections, MSS SP-72, 2760 kPa (400 psig) WOG working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation
  - I. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size and be one of the following types.
    1. Butterfly valve as specified herein with memory stop.
    2. Eccentric plug valve: Iron body, bronze or nickel-plated iron plug, bronze bearings, adjustable memory stop, operating lever, rated 125 psi and 250 °F.
  - J. Circuit Setter Valve: 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. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
  - K. Automatic Balancing Control Valves: Shall be line size and factory calibrated to maintain constant flow (plus or minus 5 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.
    1. Gray iron ASTM A126 or brass body, rated 175 psi at 200 °F, with stainless steel piston and spring.
    2. Brass or ferrous body designed for 300 psi service at 250 °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.
  - L. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.
- 2.8 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, 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. Flow Measurement/Balance Valves: A system comprised of two valves of bronze and stainless steel metallurgy designed for 175 psig pressure at 250 degrees F, with thermal insulation sleeve.
    - 1. Measurement and shut-off valve: An on/off ball valve with integral high regain venturi and dual quick connect valves with integral check valves and color coded safety caps for pressure/temperature readout.
    - 2. A butterfly balancing valve as specified herein, with memory stop and quick connect valve for pressure/temperature readout.
  - F. Insertion Turbine Type Sensor: Section 23 09 23, DDC SYSTEM FOR HVAC.
  - G. 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).
  - H. Flow Indicating Meters: Not Applicable.
- 2.9 STRAINERS
- A. Basket or Y Type. Tee type is acceptable for water service.
  - B. All Services: Rated 125 psig saturated steam.
    - 1. 2-1/2 inches and Larger: Flanged, iron body.
    - 2. 2 inches and Smaller: Cast iron or bronze.
  - C. 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. 3 inches and Smaller: 20 mesh for steam and 0.045-inch diameter perforations for liquids.
    - 2. 4 inches and Larger: 0.045-inch diameter perforations for steam and 0.125-inch diameter perforations for liquids.
- 2.10 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.

**2.11 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 line to permit axial movement, direct the axial pipe movement into the expansion joints only, 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.
- B. Minimum Service Requirements:
  - 1. Pressure Containment:
    - a. Steam Service 35-200 kPa (5 30 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
    - b. Steam Service 214-850 kPa (31 125 psig): Rated 1025 kPa (150 psig) at 186 degrees C (366 degrees F).
    - c. Steam Service 869-1025 kPa (126 150 psig): Rated 1375 kPa (200 psig) at 194 degrees C (382 degrees F).
    - d. Condensate Service: Rated 690 kPa (100 psig) at 154 degrees C (310 degrees F).
  - 2. Number of Full Reverse Cycles without failure: Minimum 1000.
  - 3. Movement: As shown on drawings plus recommended safety factor of manufacturer.
- C. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- D. 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.
- E. 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.

- F. Expansion Compensators: Carbon steel housing, rated 125 psig working pressure at 225 °F, bronze or steel bellows for 1-3/4 inches straight-line compression, 1/4-inch expansion. Provide threaded ends for sizes 2 inches and smaller, flanged for larger sizes.
  - 1. Permitted for condensate lines where pipe expansion is within limits of compensator.
  - 2. Corrugated bellows, externally pressurized, stainless steel or bronze.
  - 3. Internal guides and anti torque devices.
  - 4. Threaded ends.
  - 5. External shroud.
  - 6. Conform to standards of EJMA.
- G. 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.
- H. 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.

#### **2.12 GAGES, PRESSURE AND COMPOUND**

- A. ASME B40.100, Accuracy Grade 1A, (pressure, steam and water), graduated as required for service, initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 4-1/2 inches in diameter, 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. Provide brass pigtail siphon for steam gages.
- C. Range: For services not listed provide range equal to at least 130 percent of normal operating range.

Low pressure (to 15 PSIG)	0 to 30 PSIG
Medium pressure (nominal 60 PSIG)	0 to 100 PSIG
High pressure (nominal 90 to 125 PSIG)	0 to 200 PSIG

#### **2.13 PRESSURE/TEMPERATURE TEST PROVISIONS**

- A. Pete's Plug: 1/4-inch MPT by 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 Resident Engineer:
  - 1. 1/4-inch FPT by 1/8-inch diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
  - 2. 3-1/2 inch diameter, one percent accuracy, compound gage, Fed. Spec. GG-G-76D, 30 inches Hg to 100 psi range.
  - 3. 0 - 220 degree F pocket thermometer one-half degree accuracy, one inch dial, 5 inch long stainless steel stem, plastic case.

**2.14 THERMOMETERS**

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 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 9 inches, range as described below, two degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges may be slightly greater than shown to meet manufacturer's standard. Required ranges in degrees F:
  - 1. Chilled Water and Glycol-Water: 0 °F to 100 °F.
  - 2. Hot Water and Glycol-Water: 30 °F to 240 °F.

**2.15 VACUUM, AUTOMATIC AIR PURGE RELIEF VALVES/VENTS**

- A. Automatic Air Purge Valves:
  - 1. Spirotherm Spirovent shall be used for in line installation, 150 psig working pressure and 240 degrees F, stainless steel float valve, valve seat and mechanism.
  - 2. Float type, brass body with non-ferrous internals, 150 psig working pressure and 240 degrees F.
  - 3. Required at each high point in the piping system to each piece of equipment receiving hot/cold hydronic fluid where air may be trapped. Provide device equipped with ball valve for device isolation and replacement.
- B. Vacuum relief valves shall be iron body with bronze trim, and stainless steel floats.

**2.16 CLEANOUTS**

Same size as the pipe, up to 4 inches; not less than 4 inches for larger pipe. Cleanouts shall be easily accessible at each alternate change in pipe direction. Provide a minimum clearance of 24 inches for rodding.

**2.17 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.

**2.18 TRAP PRIMER**

- A. Hydraulic Device: Fifteen millimeter (1/2-inch) inlet and fifteen millimeter (1/2-inch) outlet fully automatic, all brass trap primer valve, activated by a drop in building water pressure, no adjustment required. Model for one (1) to four (4) traps with distribution unit, may be located anywhere in an active cold water line, at each floor drain, at each open trap, as indicated on the drawings or as required by code. Omit distribution unit when serving a single trap. Provide documentation that the product has been tested for compliance to ASSE Standard 1018.
- B. Electronic Device: Toro Model Vision.

**2.19 FLOOR DRAINS**

- A. ANSI A112.21.1. Provide a caulking flange for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe, and side outlet when shown. Provide membrane clamp and extensions 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, provide 1 kg (16 ounce) soft copper membrane, 600 mm (24 inches) square.

- B. Type B: Galvanized cast iron with medium duty nickel bronze grate, double drainage pattern, clamping device, without sediment bucket but with secondary strainer in bottom and 7 inch minimum diameter grate.

## 2.20 BACKFLOW PREVENTERS

Pressure Type: ASSE 1020. Provide a backflow prevention device at each point in the mechanical system where the potable water supply may encounter a potential source of contamination. Device shall be certified by the American Society of Sanitary Engineers, and be accepted (before installation) by the Boston Water & Sewer Commission.

## 2.21 EMERGENCY WASH

- A. Emergency Eye Wash: Water Saver Model EW-805.
- B. Emergency Eye and Face Wash: Corrosion-resistant Steel (CRS) receptor. Equipment with a 15 mm (1/2-inch) stay-open ball valve operated by push flag handle. Mount eye and face wash spray heads 1065 mm (42 inches) above finished floor.
- C. Receptor shall be complete with drain plug with perforated strainer, P trap and waste connection to wall with escutcheon.

## 2.22 MISCELLANEOUS DEVICES

Refer to Drawings and Mechanical Schedule.

# PART 3 – EXECUTION

## 3.1 GENERAL

- A. The contract drawings are diagrammatic only intended to show general layout of conduit, ductwork, piping, equipment, assemblies, specialties and do not identify all required accessories, components, details, fittings, pipe, offsets, equipment, etc. that may be necessary to properly complete the installation for the purpose intended. Provide all necessary accessories, components, details, fittings, pipe, offsets, equipment, etc based on field measurements and reviewed coordination drawings. Coordinate with other trades for space available and relative location of equipment and accessories to be connected at all locations. It is the intent of the drawings/specifications that the Contractor provides **all** materials, labor and coordination necessary to complete the work described or implied by the contract documents at no additional cost/time to the Government. Interferences and clearance difficulties shall be anticipated and items shall be altered where necessary to avoid the difficulties. Contractor shall determine the exact routing and location of systems prior to fabrication and installation. Accurate field measurements and coordination drawings shall be prepared to establish the locations and characteristics of the various systems (new and existing to remain). Contractor shall propose with submitted coordination drawings other solutions with the same flow characteristics where necessary to avoid interferences and clearance difficulties. Should the contract documents not agree with themselves the greater quantity of superior work and materials shall be performed.
- 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. Pipe Hangers, Supports and Accessories: Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS. Provide supports as needed at valves, strainers, in-line pumps and other heavy components. Piping layout is based on piping flexibility from sufficient offsets. Placement of supports and hangers should not restrict pipe expansion.
  - 1. Support piping securely no greater than 7 foot increments between supports.
  - 2. Seismic Bracing: Refer to Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  - 3. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
  - 4. 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 6 inches in length and be 16 Gauge steel. The shield shall be sized for the insulation.
  - 5. 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 m (20 feet) additional support shall be provided to the center of the span.
- D. Each device and piece of equipment shall be supplied with individual ball valves to isolate fluid to each device independently. These ball valves are in addition to the stop valves normally provided at the device location. Install valves with stem in horizontal position whenever possible.
  - 1. Valves shall be easily accessible. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc.
  - 2. Locate valve stems in overhead piping in horizontal position. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
  - 3. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
  - 4. Provide unions adjacent to one end of all threaded valves.
  - 5. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
  - 6. Provide hose bibbed chain capped ball valves at every low point in hydronic systems that can trap fluid during a drain down.
- E. Offset equipment/component connections and provide unions to allow service for maintenance and repair of serviceable devices with minimal removal of piping. Provide flexibility in equipment connections and branch line takeoffs with 3-elbow swing joints. Provide sufficient offsets, proper placement and type of hangers to allow pipe expansion and movement to avoid pipe stress and failure.
- F. All pipe runs shall be laid out to avoid interference with other work. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 1 inch minimum clearance between adjacent piping or other surfaces. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 1 inch in 40 feet. Provide eccentric reducers to keep bottom of sloped piping flat.
- G. Tee 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. Connect piping to equipment as shown on drawings and as recommended by the manufacturer.
  - 1. Install components furnished by others such as: Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
  - 2. Minor Piping: Generally, small diameter pipe runs from condensate, drains, and other services are not shown but shall be provided.
  - 3. Unions: Install unions and shut-off ball valves on pressure piping at connections to equipment. Provide unions at all system components to allow service for maintenance and repair of serviceable devices with minimal removal of pipe.
  - 4. Thermometer Wells: In pipes 2-1/2 inches and smaller increase the pipe size to provide free area equal to the upstream pipe area.
  - 5. Install converters and other exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.
  - 6. Provide dielectric connections where copper piping is connected to steel piping.
  - 7. Unless shown otherwise, locate piping in ceilings, walls, soffits or otherwise concealed.
  - 8. Provide automatic air vents with isolation ball valves at all piping system high points, and drain valves at all low points.
  - 9. Provide drain connections when a condensate drain system is indicated or required. Condensate drain system shall have cleanouts. 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 at each alternate change in pipe direction. Provide a minimum clearance of 600 mm (24 inches) for rodding.
  - 10. Utilize pipe freeze technology as specified by Freeze Seal Engineering (New Castle, DE) for attaching new plumbing to existing building systems in the likely event that building risers cannot be shut down.
- I. Penetrations:
  - 1. Seal Proofing: Fill openings around un-insulated pipes penetrating floors and walls. Completely seal clearances around pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
  - 2. Fire Stopping:
    - a. 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 fire stopping materials.
    - b. All temporary, concealed, framing lumber shall comply with MIL-L-19140 for fire retardant treatment, and shall bear the testing agency identification mark and performance rating.
    - c. All penetrations through fire/smoke walls are to be sleeved unless otherwise noted or directed by the VA Project Engineer. Install fire seal material at all penetrations, and troughs penetrating fire/smoke walls. All penetrations through fire/smoke walls (compartmentalization) will be sealed with appropriate fire retardant material on a daily basis, and shall maintain the same integrity as the fire barrier being sealed. The VA will be compensated through contractor contract reduction per day for each fire wall penetration not sealed with acceptable fire retardant material tested in

accordance with ASTM E814 (F rating) by the close of business the day that penetration is made.

- J. All mechanical/plumbing lines shall use shut-off ball valves. Where connections are made to existing systems, shut-off ball valves are to be installed. Valves shall be marked with labeled brass tags, and a framed directory provided describing the location and function of each valve. Provide hose bibbed chain capped ball valves at each low point that can trap fluid during draining and at each additional required drain point in the hydronic systems. Provide unions and removable pipe sections to all serviceable components in system.
- K. Install automatic trap primers at each floor drain and open traps (eg, at equipment condensate drains) according to manufactures' requirements. Connect trap primers to active water lines with unions and valves for isolation and replacement.
- L. All original building plumbing/steam pipes where originally insulated with asbestos. Work performed on these pipes shall be conducted in compliance with all applicable State & Federal requirements.
- M. Backflow prevention device shall be installed in an accessible location, 5 (five) feet above finish floor. Register all backflow preventers with the DEP and Boston Water & Sewer Commission prior to the start of construction. Contractor shall be present during initial inspection and testing, and submit all necessary documentation and as-built drawings. Contractor shall furnish the VA with one (1) additional backflow re-build kit and filter for each device installed.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ANSI B31.1.
- B. Screwed: Threads shall conform to ANSI B2.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or Rustoleum type paint for corrosion protection.
- C. Mechanical Joint: Chilled water only 2-1/2" and greater. 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.
- F. Provide unions on each side of control valves and serviceable component to accommodate replacement. Provide unions and removable pipe sections to all coils to permit replacement.

### **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 packing.

3.4 SEISMIC BRACING ABOVEGROUND PIPING

Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.5 LEAK TESTING

- A. Test system either in its entirety or in sections. Test hot systems at design maximum temperature.
- B. Tests as approved by the Resident Engineer. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. System shall be tight at all joints with no loss in test pressure.
- C. Test after installation of piping, but before piping is concealed, before covering is applied, and before mechanical equipment is connected. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.
- D. Test Methods:
  - 1. Operating Test: Fill systems with water and maintain hydrostatic pressure at 2.0 times maximum operating pressure (minimum 690 kPag - 100 psig) for 2 hours.
  - 2. Hydrostatic Test: Fill systems with water and maintain hydrostatic pressure at 1.5 times design pressure (minimum 690 kPag - 100 psig) for 2 hours. For water systems the design maximum pressure would usually be the static head or expansion tank maximum pressure plus pump head.
- E. Drain, Vent Systems: Conduct water test or air test, as directed by the Resident Engineer.
  - 1. Water Test: If entire system is tested, tightly close all openings in pipes except 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. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts.
  - 2. Air Test: Maintain air pressure of 35 kPag (5 psig) for at least 15 minutes. Use force pump and calibrated mercury column gage.
  - 3. Verifying Accuracy of Low-Pressure Gages: Using a U-tube of mercury one end of the open U-tube is connected to the gage by a tube containing a valve for the injection of air. Air pumped into the connecting tube causes the mercury to stand at different levels in each arm of the U-tube. Each 2 inches of differential between the mercury-column levels represents a pressure of approximately 1 psig. A differential of 10.17 inches of mercury should register on the gage as 5 psig. A transparent plastic tube several feet long attached to an analog gage and filled with water provides a means of an accurate check of low pressures. Each vertical foot of water in the tube above the level of the gage exerts a pressure of 0.43 psig. Thus, if the tube is held so that the water level is 5 ft above the gage, the gage should read slightly more than 2 psig.
- F. All Other Piping Tests: Fill systems with water and maintain hydrostatic pressure at 1.5 times design pressure or 2.0 times actual maximum operating conditions (minimum 690 kPag - 100 psig) for minimum 2 hour duration. For water systems the design maximum pressure would usually be the static head or expansion tank maximum pressure plus pump head.

### 3.6 FLUSHING AND CLEANING

- A. Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.
- B. Chilled/Hot Water Piping: Flush all new/existing pipes and coils. Clean systems as recommended by either the suppliers of chemicals used in the system, as recommended by the equipment manufacturer, or as specified in Section 23 25 00, HVAC WATER TREATMENT. Provide all necessary fittings to perform the required cleaning.
  - 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 that 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 6 feet per second, if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Resident Engineer.
  - 2. Cleaning: Utilizing compatible chemical products as recommended by either the chemical suppliers used in the system, as recommended by the equipment manufacturer or as specified 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 6-feet per second. Circulate each section for not less than four (4) 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.

### 3.7 WATER TREATMENT

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

### 3.8 ELECTRIC HEAT TRACING

- A. Install tracing as recommended by the manufacturer.
- B. Coordinate electrical connections.

**3.9 IDENTITY LABELING**

- A. Services: Identify systems (Examples: CHWS, CHWR, HW, CW, HWR, Steam, Steam Condensate, Drains) conforming to ANSI A13.1 in width and placement of color band, size and color of legend, unless specified otherwise, on piping, exposed, above removable ceilings, in accessible pipe spaces, interstitial spaces, and behind access panels.
  - 1. Legend shall be pressure sensitive vinyl markers or stencil applied (painted on). Legends shall be placed to be clearly visible from operating position. Use arrow to indicate direction of flow.
  - 2. Place legends 8 feet apart on straight runs of piping, where pipes pass through walls or floors, and adjacent to all operating accessories such as valves, regulators, strainers and cleanouts.
  - 3. Identify pipe contents with sufficient additional details such as temperature, pressure, and contents to identify possible hazard.
  - 4. Legend shall give name in full or in approved abbreviated form.
- B. Equipment: Shall be labeled with engraved black phenolic plates for name and source of energy utilizing the hospital nomenclature as directed by the VA Project Engineer.

**3.10 FIELD INSPECTION, OPERATING AND PERFORMANCE TESTS**

- A. Verify type, quantity, location, operation of devices. Examples: Dielectric Fittings, Unions, Valves, Measuring Devices, Strainers.
- B. Perform applicable pressure tests for each system.
- C. Verify size, type, connectivity, pitch of system sections.
- D. Verify operation of automatic air vents and trap primers.
- E. Verify that the piping system has been flushed, cleaned and filled.
- F. Verify application of the system color code and labeling requirements.
- G. Verify compliance with the pipe support/restraint and accessories requirements.
- H. Replace disposable start-up strainers after several days of operation with regular strainers.
- I. Adjust red set hand on pressure gages to normal working pressure.
- J. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

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

**SECTION 23 23 00**  
**REFRIGERANT PIPING**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the provisions for the furnishing and installing refrigerant piping for direct expansion HVAC systems. Field installed refrigerant piping and associated drain and condenser water piping for walk in refrigerators and freezers, including required pipe insulation.
- B. Terminology:
  - 1. Refrigerating system: Combination of interconnected refrigerant containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.
    - a. Low side means the parts of a refrigerating system subjected to evaporator pressure.
    - b. High side means the parts of a refrigerating system subjected to condenser pressure.
  - 2. Brazed joint: A gas tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 427 degrees C (800 degrees F) but less than the melting temperatures of the joined parts.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- B. Section 07 92 00, JOINT SEALANTS: Sealing around penetrations to prevent moisture and water migration.
- C. Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.: General mechanical requirements and items common to more than one section of Division 23.
- D. Section 23 21 13, HYDRONIC PIPING: Requirements for water and drain piping and valves.
- E. Section 23 64 00, PACKAGED WATER CHILLERS: Piping requirements for air cooled chillers and condensing units.

**1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.
- C. Comply with ASME Boiler and Pressure Vessel Code: Section IX, Welding and Brazing Qualifications.

- D. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

#### **1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

##### **A. Manufacturer's Literature and Data:**

1. Tubing and fittings
2. Valves
3. Strainers
4. Moisture liquid indicators
5. Filter driers
6. Flexible metal hose
7. Liquid suction interchanges
8. Oil separators (when specified)
9. Gages
10. Pipe and equipment supports
11. Flexible elastomeric pipe insulation
12. Refrigerant and oil
13. Pipe/conduit roof penetration cover
14. Soldering and brazing materials

##### **B. Shop Drawings:**

1. Sufficient information for components noted including valves and refrigerant piping accessories clearly presented shall be included to determine compliance with drawings and specifications.
2. Layout of refrigerant piping and accessories, including flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.

##### **C. Copies of certificates for welding procedure, performance qualification record and list of welders' names and symbols.**

##### **D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.**

##### **E. Coordination Drawings: Refer to Article, SUBMITTALS, of Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES.**

##### **F. As-Built Piping Diagrams: Provide detailed drawings for the mechanical systems such as chilled/hot water, steam/condensate system, domestic and plumbing piping.**

1. Two sets of full size (Scaled: 1/8" = 1'-0") reproducible drawings.
2. Two sets of half size reproducible drawings.

##### **G. Certifications: Prior to the next Section of mechanical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable**

manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.

#### 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. Air Conditioning and Refrigeration Institute (ARI):
  - 495.....Standard for Refrigerant Liquid Receivers
  - 710.....Standard for Liquid-line Driers
  - 750.....Thermostatic Refrigerant Expansion Valves
  - 760.....Solenoid Valves for Use with Volatile Refrigerants
- B. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):
  - 15.....Safety Code for Mechanical Refrigeration
  - 17.....Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
  - 34.....Designation and Safety Classification of Refrigerants (Including Addenda to Year 2000)
  - 63.1.....Method of Testing Liquid Line Refrigerant Driers
  - 69.....Methods of Testing Discharge line Refrigerant-Oil Separators
- C. American National Standards Institute (ANSI):
  - A13.1.....Scheme for Identification of Piping Systems
  - B16.22.....Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (and Addenda B16.22A-98)
  - B16.24.....Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500
  - B31.5.....Refrigeration Piping
  - Z535.1.....Safety Color Code
- D. American Society of Mechanical Engineers (ASME):
  - B40.200.....Thermometers, Direct Reading and Remote Reading
- E. American Society for Testing and Materials (ASTM):
  - B32.....Standard Specification for Solder Metal
  - B88.....Standard Specification for Seamless Copper Water Tube
  - B88.....Standard Specification for Seamless Copper Water Tube (Metric)
  - B280.....Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
  - B813.....Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
  - C534.....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tube Form



- F721-81 .....Standard Specification for Gage Piping Assemblies
- F. American Welding Society, Inc. (AWS):
  - A5.8 .....Standard Specification for Filler Metals for Brazing and Braze Welding
  - B2.1 .....Welding Procedure and Performance Qualifications
  - B2.2 .....Standard for Brazing Procedure and Performance
- G. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
  - SP-58.....Pipe Hangers and Supports-Materials, Design and Manufacture
  - SP-69.....Pipe Hangers and Supports-Selection and Application
- H. Military Specifications (Mil. Spec.):
  - MIL A 24179A.....Adhesive, Flexible Unicellular Plastic Thermal Insulation
  - MIL C 20079H .....Cloth, Glass, Tape, Textile Glass and Thread, Glass and Wire Reinforced Glass
- I. Underwriters Laboratories (U.L.):
  - U.L.207-93.....Standard for Refrigerant-Containing Components and Accessories, Non-electrical
  - U.L.429-99.....Standard for Electrically Operated Valves

## **PART 2 – PRODUCTS**

### **2.1 PIPING AND FITTINGS**

- A. Refrigerant Piping: Copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer.
- B. Water and Drain Piping: Copper water tube, ASTM B88, Type K, or refrigerant tube ASTM B280.
- C. Fittings, Valves and Accessories:
  - 1. Solder joints: Wrought copper fittings, ANSI B16.22.
    - a. Solder, refrigerant tubing: Cadmium free, AWS A5.8, 45 percent silver brazing alloy, Classification BAg-5.
    - b. Solder, water and drain: ASTM B32, lead free, 95 TA tin-antimony composition, Ag 95 (Silver) and Sb 5 (Antimony), Sb 5 (Antimony) HA/HB using non-corrosive lead free flux.
  - 2. Flanges and flanged fittings: ANSI B16.24.
  - 3. Refrigeration Valves:
    - a. Stop Valves: Brass or bronze alloy, packless, or packed type with gas tight cap, frost proof, backseating.
    - b. Pressure Relief Valves: Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.

- c. Solenoid Valves: ARI 760, UL-listed, two-position, direct acting or pilot-operated, moisture and vapor proof type of corrosion resisting materials, designed for intended service, and solder-end connections. Fitted with suitable NEMA 250 enclosure of type required by location and normally open, closed, holding coil.
  - d. Thermostatic Expansion Valves: Brass body with stainless-steel or non-corrosive non ferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.
  - e. Check Valves: Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.
- 4. Strainers: Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines up to 30 mm (1 1/8 inch), 60 mesh in liquid lines over 30 mm (1 1/8 inch), and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.
  - 5. Refrigerant Moisture/Liquid Indicators: Double ported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.
  - 6. Refrigerant Filter Dryers: UL listed, angle or in line type, as shown on drawings. Conform to ASHRAE Standard 63. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for service and capacity of system with connection not less than the line size in which installed. Filter driers with replaceable filters shall be furnished with one spare element of each type and size.
  - 7. Flexible Metal Hose: Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each compressor.
  - 8. Liquid Suction Heat Exchanger: Designed for counter flow and for free drainage of oil. Size shall suit system conditions and refrigerant used. Interchangers shall be ASME construction or UL listed.
  - 9. Water Piping Valves and Accessories: Refer to specification Section 23 21 13, HYDRONIC PIPING.
  - 10. Oil Separators: Provide for condensing units only in special situations, as shown. All welded steel construction with capacity to eliminate a minimum of 95 percent of the oil from the hot gas flowing through it. Provide manufacturer's published ratings for minimum and maximum refrigeration tonnage corresponding to this oil separating efficiency. Conform to ASHRAE Standard 69. Separator shall be equipped with a float valve to prevent return of the hot gas to crankcase, and shall have isolating stop valves so it can be opened and services without pumping out any other part of the system. ASME construction or UL listed.
  - 11. Receivers: Required only to accommodate pump-down charge. Conform to ARI 495, steel construction, equipped with tappings for liquid inlet and outlet valves, pressure relief valve and liquid level indicator.

## **2.2 PRESSURE TEMPERATURE GAGES**

- A. Fed. Spec. GG, Type III (freon), 65 mm (2 1/2 inch) minimum diameter, bottom connection, one percent accuracy, graduated in kPa gage (psig) and corresponding refrigerant temperature, with pressure snubber.
- B. Provide board mounted gages of the following ranges for each compressor. Provide gage shut off valve.
  - 1. Suction: 101 kPa (30 inches Hg) vacuum to 1723 kPa (gage) (250 psig).
  - 2. Discharge: 0 to 3445 kPa (gage) (0 to 500 psig).

## **2.3 THERMOMETERS AND WELLS**

Refer to specification Section 23 21 13, HYDRONIC PIPING.

## **2.4 PIPE SUPPORTS**

Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

## **2.5 HEATING TAPE**

Refer to specification Section 23 21 13, HYDRONIC PIPING. Provide for freezer unit cooler drain piping.

## **2.6 REFRIGERANTS AND OIL**

Provide required refrigerant and oil for proper system operation.

## **2.7 PIPE/CONDUIT ROOF PENETRATION COVER**

- A. Prefabricated Roof Curb: Galvanized steel or extruded aluminum 300 mm (12 inches) overall height, continuous welded corner seams, treated wood nailer, 40 mm (1 1/2 inch) thick, 48 kg (3 pound) 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.
- B. Penetration Cover: Galvanized sheet metal with flanged removable top. Provide 40 mm (1 1/2 inch) thick mineral fiber board insulation.
- C. Flashing Sleeves: Provide sheet metal sleeves for conduit and pipe penetrations of the penetration cover. Seal watertight penetrations.

## **2.8 PIPE INSULATION FOR DX HVAC SYSTEMS**

Refer to specification Section 23 07 11, HVAC – PLUMBING – BOILER PLANT INSULATION.

# **PART 3 – EXECUTION**

## **3.1 INSTALLATION**

- A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ANSI B31.5. Refrigerant piping shall be brazed with 15 percent silver solder in accordance with AWS A5.8.
  - 1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.

2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping and other surface. Unless shown otherwise, locate piping in ceilings, walls, soffits or otherwise concealed. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
  3. 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.
  4. Use copper tubing in protective conduit when installed below ground.
  5. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.
  6. Install hangers and supports per ANSI B31.5 and the refrigerant piping manufacturer's recommendations.
- B. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.
- C. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.
- D. Pipe relief valve discharge to outdoors for systems containing more than 45 kg (100 pounds) of refrigerant.
- E. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC – PLUMBING – BOILER PLANT INSULATION.
- F. Seismic Bracing: Refer to specification Section 13 05 41, SEISMIC RESTRAINTS REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS, for bracing of piping in seismic areas.
- 3.2 PIPE AND TUBING INSULATION
- A. Apply flexible cellular insulation and fabricate fittings in accordance with the manufacturer's written instructions.
- B. Use proper size material. Do not stretch or strain insulation.
- C. 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 specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- D. 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.
- E. Apply two coats of weather resistant finish as recommended by the manufacturer to insulation exposed to outdoor weather.
- 3.3 SIGNS AND IDENTIFICATION
- A. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and

address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.

- B. Systems containing more than 50 kg (110 lb) of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI Z53.1, having letters not less than 12.7 mm (0.5 inch) in height designating:
  - 1. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
  - 2. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."

### **3.4 FIELD INSPECTION, OPERATING AND PERFORMANCE TESTS**

- A. Prior to initial operation examine and inspect piping system for conformance to ASME 31.5, plans and specifications. Equipment, material, or work rejected because of defects or nonconformance with plans and specifications shall be corrected in accordance with ANSI codes for pressure piping.
- B. Perform applicable pressure tests for each system.
- C. Verify type, quantity, location, operation of devices.
- D. Verify size, type, connectivity, pitch of system sections.
- E. Verify that the piping system has been flushed, cleaned and charged.
- F. Verify application of the system color code and labeling requirements.
- G. Verify compliance with the pipe support/restraint and accessories requirements.
- H. Replace disposable start-up strainers after several days of operation with regular strainers.
- I. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- J. After completion of piping installation and prior to initial operation, conduct tests on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of the Resident Engineer. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
  - 1. Each refrigerant-containing part of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.
  - 2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding 16 mm (0.62-inch) O.D. This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.
- K. Test Medium: A suitable dry gas such as nitrogen shall be used for pressure testing. The means used to build up test pressure shall have either a pressure limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure relief device shall be set above the test pressure, but low enough to prevent permanent deformation of the system components.

### **3.5 FINAL SYSTEM TEST AND CHARGING**

- A. System Test: As recommended by the equipment manufacturer or as follows:

1. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 70 kPa (10 psig) gage. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.
  2. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Refer to Article 1.3, QUALITY ASSURANCE. Test entire system again for leaks.
- B. System Charging: Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in mPa (microns). Pull the system down to 665 mPa (500 microns) and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

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

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

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

This section specifies the provisions for the furnishing and installing ductwork and accessories.  
Refer to the plans for the scope of work details.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 07 84 00, FIRESTOPPING: Application of firestopping.
- B. Section 07 92 00, JOINT SEALANTS: Application of sealants at smoke partitions.
- C. Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS: General mechanical requirements and items common to more than one section of Division 23.
- D. Section 23 07 11, HVAC – PLUMBING – BOILER PLANT INSULATION: Ductwork insulation.

**1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- 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: All ducts shall be sealed as per SMACNA duct sealing requirements in Section 1 of SMACNA HVAC Air Duct Leakage Test Manual for actual duct pressure classes.
  - 1. Leakage and Seal classification: Leakage Class 3, Seal Class A.
  - 2. The entire ductwork system shall be pressure tested after installation to 150% of design rated static pressure (Pos & Neg), but not less than 1.0 inches WP as measured with a precision digital manometer. Tests shall be performed in accordance with the SMACNA HVAC Air Duct Leakage Test Manual.
  - 3. The permissible leakage rate shall be calculated as per Section 4 of SMACNA HVAC Air Duct Leakage Test Manual. Ductwork under Low Pressure Construction Standards shall not leak more than 3% of the system operating flow. Ductworks under High Pressure Construction Standards shall be limited to 1% of the system operating flow.
  - 4. Leakage testing procedures, test apparatus, and test reports to be submitted to the Resident Engineer. All tests shall be performed as per SMACNA HVAC Air Duct Leakage Test Manual in the presence of the Resident Engineer. The Test and Balance agency shall measure, and record duct leakage as specified, and shall identify and report unusual conditions and leakage source to the Resident Engineer.

5. If a ductwork fails to meet the permissible leakage level, the contractor shall modify all ductwork installed to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
6. Tests/re-tests and necessary repairs shall be completed prior to insulation and concealment of ducts.
- 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. Duct accessories shall not be altered by the performance of work.
- F. Duct/HVAC Cleaning Agency Qualifications: Current membership in AIAQC, ASCR, IAQA, MSHI and NADCA utilizing certified ASCS and CECS specialists meeting OSHA 1926 standards.
  1. NADCA Standards shall be followed with no modifications or deviations being allowed.
  2. Contractor shall clean the HVAC system that fails to meet the permissible cleaning level to bring it into compliance, and shall re-inspect and re-test until acceptable levels are demonstrated to the Resident Engineer.
- G. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer 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.

#### **1.4 TERMINOLOGY**

- A. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
- B. AABC: Associated Air Balance Council.
- C. AIAQC: American Indoor Air Quality Council.
- D. AIHA: American Industrial Hygiene Association.
- E. ASCR: Association of Specialists in Cleaning & Restoration.
- F. IAQA: Indoor Air Quality Association.
- G. IKECA: International Kitchen Exhaust Cleaning Association.
- H. MSHI: Mechanical Systems Hygiene Institute.
- I. NADCA: National Air Duct Cleaning Association.
- J. NEBB: National Environmental Balancing Bureau.
- K. NAIMA: North American Insulation Manufacturers Association.
- L. SMACNA Standards: As used in this specification means the HVAC Duct Construction Standards (Metal and Flexible).
- M. TAB: Testing, Adjusting and Balancing. The process of checking and adjusting HVAC systems to meet design objectives.
- N. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- O. Exposed Duct: Exposed to view in a finished room.



- P. 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.

**1.5 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data: Rectangular, round, oval duct construction details.
  - 1. Material schedule of duct systems and accessories.
  - 2. SMACNA construction alternatives for joints, sealing, gauge and reinforcement.
  - 3. Air louvers, diffusers, registers, grilles, and accessories.
  - 4. Details and design analysis of alternate or optional duct systems.
  - 5. Sound attenuators, including pressure drop and acoustic performance.
  - 6. Sealants, tape, gaskets and methods of applications.
  - 7. Hanging methods, equipment supports, seismic restraints.
  - 8. Flexible connections (restricted use).
  - 9. Equipment shown on schedule and drawings.
  - 10. Component installation instructions.
  - 11. Fire and smoke dampers, access doors.
  - 12. Volume dampers, back draft dampers.
  - 13. Instrument test fittings.
  - 14. Fire stopping material.
  - 15. Identity labels.
- B. Coordination Drawings: Refer to Article, SUBMITTALS, of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- C. Duct/HVAC Cleaning Agency Qualifications:
  - 1. Company Qualifications: Current membership in the following nationally recognized non-profit industry organizations dedicated to the cleaning of HVAC systems ... AIAQC, ASCR, IAQA, MSHI, NADCA.
  - 2. Personnel Qualifications: Shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, and shall utilize staff certified as an ASCS, CECS and CMR specialists meeting OSHA 1926 standards.
  - 3. Supervisor Qualifications: A person certified as an ASCS by NADCA shall be responsible for the total work herein specified.
  - 4. Experience: Submit information on three recently completed projects. Acceptance shall only be considered from firms which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.
  - 5. Submit list of proposed test equipment.

- D. Cleanliness Testing Agency Qualifications: Shall be performed by a registered professional Industrial Hygienist and Microbiologist (both from an independent certified testing company – independent from the duct cleaning agency).
- E. Submit one complete set of applicable American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) Booklet and Document publications for use by the Resident Engineer.
- F. Certifications: Prior to the next Section of mechanical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.

#### 1.6 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American Conference of Governmental Industrial Hygienists (ACGIH):
  - ACGIH TLV-BKLT .....Threshold Limit Values (TLV) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEI)
  - ACGIH TLV-DOC .....Documentation of Threshold Limit Values (TLV) and Biological Exposure Indices (BEI)
- B. Air Diffusion Council Test Code:
  - 1062GRD.....Certification, Rating, and Test Manual
- C. Air Moving and Conditioning Association (AMCA):
  - 500D .....Laboratory Method of Testing Dampers for Rating
  - 500L.....Laboratory Method of Testing Louvers for Rating
- D. American Society of Civil Engineers (ASCE):
  - ASCE7 .....Minimum Design Loads for Buildings and Other Structures
- E. American Society of Heating, Refrigeration & Air Conditioning Engineers (ASHRAE):
  - Standard 62 .....Ventilation for Acceptable Indoor Air Quality
- F. American Society for Testing and Materials (ASTM):
  - A167 .....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel, Steel Plate, Sheet and Strip
  - A569 .....Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality
  - A653 .....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - A1011 .....Standard Specification for Steel Sheet and Strip Hot rolled Carbon structural, High-Strength Low- Alloy and High Strength Low-Alloy with Improved Formability
  - B209 .....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

- C1071 .....Standard Specification for Thermal and Acoustical Insulation (Mineral Fiber, Duct Lining Material)
- E84 .....Standard Test Method for Surface Burning Characteristics of Building Materials
- G. National Fire Protection Association (NFPA):
  - 90A .....Standard for the Installation of Air Conditioning and Ventilating Systems
- H. National Air Duct Cleaners Association (NADCA):
  - ACR-1992 .....Assessment, Cleaning, and Restoration of HVAC Systems
  - ACR-2002 .....Assessment, Cleaning, and Restoration of HVAC Systems
  - ACR-2005 .....Assessment, Cleaning, and Restoration of HVAC Systems
  - Standard 05 .....Requirements for the Installation of Service Openings in HVAC Systems
  - HVAC Inspection – Procedures for Assessing the Cleanliness of Commercial HVAC Systems
  - Understanding Microbial Contamination in HVAC Systems
  - Introduction to HVAC System Cleaning Services
- I. Occupational Safety & Health Administrations (OSHA):
  - 29 CFR Part 1926.....Safety & Health Regulations for Construction
- J. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  - HVAC Duct Construction Standards, Metal and Flexible
  - Indoor Air Quality – Systems Approach
  - HVAC Air Duct Leakage Test Manual
- K. Underwriters Laboratories, Inc. (UL):
  - 33.....UL Standard for Safety Heat Responsive Links for Fire Protection Service
  - 181.....UL Standard for Safety Factory-Made Air Ducts and Connectors
  - 555.....UL Standard for Fire Dampers
  - 555S .....UL Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems

## **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. Duct surfaces shall be labeled by the supplier demonstrating compliance with the specified requirements.
- 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 Standards, paragraph S1.8 and S1.9.
  - 1. Sealant: Elastomeric compound, gun or brush grade. Products by Ductmate shall be used compounded specifically for sealing ductwork as recommended by the manufacturer. Conforming to the requirements of NFPA 90A and 90B with maximum 5 flame spread and 0 smoke developed (dry state). 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 by DUCTMATE or TDC SYSTEM shall be used. Use clips on all sides, bolts on all corners and sealant tape on flange mating surfaces including inside corner of bolts.

## 2.2 DUCT CONSTRUCTION AND INSTALLATION

- A. Follow SMACNA HVAC Duct Construction Standards.
  - 1. Duct Pressure Class: 500 Pa (2 inches WG, Negative/Positive). Low Pressure Systems (from -3inches WG to +3 inches WG static pressure and velocity less than 2500 fpm). The sheet metal gauge shall be selected based on the pressure classification. However, a minimum thickness of 24 gauge shall be used for duct construction.
  - 2. Seal Class: Class "A" in accordance with SMACNA HVAC Air Duct Leakage Test Manual. All ductwork shall be sealed per seal Class A irrespective of the duct pressure classifications.
  - 3. Provide only low loss fittings at each duct change in size/direction as shown in SMACNA HVAC Duct Construction Standards, Chapter 2. Use radius elbows only (vanes not permitted). No square throat or mitered elbows with/without turning vanes.
  - 4. Provide transitions, offsets and connections to ducts, dampers, coils, and other equipment in accordance with SMACNA HVAC Construction Standards, Chapter 2. Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected. Use low loss bellmouth, conical, 45° lead in, radius fittings only. Install streamline deflectors at any point where dividing ductwork around piping or other obstruction. Where such obstructions occur in insulated ducts, fill space inside streamliner and around obstructions with glass fiber insulation. Elbows and fittings shall be a minimum 2 gauge heavier than straight duct lengths of equal diameter/size.
  - 5. All ductwork shall be hard ducted. Flexible ductwork shall not be used. This requirement does not apply to vibration isolation canvas connections to the inlet and outlet connections of equipment.
  - 6. Balancing dampers shall be provided in all duct branches. Manual butterfly and splitter dampers shall be installed wherever required.
  - 7. Special Applications:
    - a. Wet Air Exhaust Ducts and Accessories: Shall be 1.3 mm (18 gage) stainless steel made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections. Where ducts are not self draining back

to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access door in side of duct at drain pockets.

- B. Duct for Negative Pressure Up to 750 Pa (3 inch W.G.): Provide for exhaust duct between HEPA filters and exhaust fan inlet.
    - 1. Round Duct: Galvanized steel, spiral lock seam construction with standard slip joints.
    - 2. Rectangular Duct: Galvanized steel, minimum 1.0 mm (20 gauge), Pittsburgh lock seam, companion angle joints 32 mm by 3.2 mm (1-1/4 by 1/8-inch) minimum at not more than 2.4 m (8 feet) spacing. DUCTMATE SYSTEM is acceptable in lieu of companion angles.
  - C. Round and Flat Oval Ducts: 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. Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints.
    - 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 bellmouth, conical, 45° lead in, reducers, radius, ogee and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards, Chapter 2. No mitered elbows with/without turning vanes permitted.
    - 3. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Resident Engineer.
    - 4. Elbows and fittings shall be a minimum 2 gauge heavier than straight duct lengths of equal diameter/size.
    - 5. Round and oval ductwork and takeoffs shall be prefabricated by United McGill or Semco. Spin-in takeoffs shall not be used on round takeoffs.
    - 6. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
      - a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
      - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
  - D. Duct Hangers and Supports: Refer to SMACNA Standards Section IV, but supports shall not be greater than 7 feet apart. Trapeze style hangers/supports shall be utilized with spot welded duct clips where necessary. Trapeze hangers for round duct shall not be used. Screws through the ductwork shall not be used to attach the hangers and supports.
  - E. Provide 1 inch thick throwaway air filters in accessible mounting frames upstream of all main duct supply and return heating/cooling hydronic/electric/steam coils. Provide retaining clips to hold filters in place.
- 2.3 DUCT ACCESS DOORS AND PANELS
- A. Provide access doors, sized and located for maintenance work, upstream and/or downstream, in the following locations:

1. Each coil and humidifier.
  2. Each fan, filter and flow measuring station.
  3. At controls or items requiring periodic inspection, adjustment, maintenance or cleaning.
  4. Each smoke detector, fire damper (link service), smoke damper and automatic damper.
  5. For duct cleaning at 20 feet intervals and at each change in direction.
  6. Where indicated, and where additionally needed by the duct cleaning agency.
- B. Provide sandwich style (clamping type) access doors only as manufacture by Ductmate Industries. 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: Construction/Airtightness shall be suitable for the pressure class.
  2. For round and flat oval duct: Access sections shall be not less than 20 gauge.
- 2.4 FIRE DAMPERS
- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70° C (160° F) fusible link, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.
1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gauge), required to provide installation equivalent to the damper manufacturer's UL test installation.
  2. Submit manufacturer's installation instructions conforming to UL rating test.
  3. Combination fire and smoke dampers: Multi louver or curtain type units meeting all requirements of both dampers shall be used where shown and may be used where applicable.
- 2.5 SMOKE DAMPERS
- A. Maximum air velocity, through free area of open damper, and pressure loss: 450 m/min (1500 fpm) for low pressure and medium pressure duct (supply, return, exhaust, outside air).
- B. Maximum static pressure loss: 32 Pa (0.13 inch W.G.) pressure differential.
- C. Maximum air leakage, closed damper: 0.32 cubic meters /min/square meter (4 CFM per square foot) at 750 Pa (3 inch W.G.) pressure differential.
- D. Minimum requirements:
1. Meet requirements of Table 6-1 of UL 555S, except the Fire Endurance and Hose Stream Test.
  2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
  3. Blades: Galvanized steel, parallel type preferably, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
  4. Shafts: Galvanized steel.

5. Bearings: Bronze sleeve or ball type.
  6. Hardware: Zinc plated.
  7. Operation: Automatic open/close with remote status indicator light. No damper that requires manual reset or link replacement after actuation is acceptable. Connect into the building/equipment fire alarm zone.
- E. Motor operator (actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage. Provide remote status indicator light.

## 2.6 FIRE DOORS

Galvanized steel, interlocking blade type, UL listing and label, 71 degrees C (160 degrees F) fusible link, 3 hour rating and approved for openings in Class A fire walls with rating up to 4 hours, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

## 2.7 FLEXIBLE CONNECTIONS

- A. Only where duct connections are made to fans 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 (1 inch) slack to insure that no vibration is transmitted. Flexible connections shall be bridged with a braided copper strip soldered to metal on each side of the connection.
- B. Factory fabricated, complying with NFPA 90A for connections not passing through floors of buildings. Flexible connections shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible connections length shall not exceed 1.5 m (5 feet). Provide insulated acoustical connections in supply air duct systems and elsewhere as required.
- C. Flexible connections shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Connections larger than 200 mm (8 inches) in diameter shall be Class 1. Connections 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.
- 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 fpm).
  3. Minimum working pressure: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.
- E. Duct Clamps: Securely fasten flexible connections to duct, fabric shall not be stressed other than by air pressure. Allow at least 25 mm (1 inch) slack to insure that no vibration is transmitted.
1. Round ducts: Stainless steel strap with cadmium plated worm gear tightening device. Apply sealant to clamps as approved for UL 181, Class 1 installation.
  2. Rectangular connections: Crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center.

## 2.8 AIR VOLUME DAMPERS

- A. General: The respective functions, types and general construction requirements of dampers shall be in accordance with the SMACNA HVCA ductwork requirements unless otherwise indicated. Dampers shall be of the flange/frame type for connection to ductwork and shall be sufficiently rigid to prevent distortion or fluttering.
1. Dampers shall provide low pressure drop and low noise regeneration characteristics.
  2. Manual dampers shall include a device for positioning and locking the damper blades. All manually and automatically operated dampers shall include a means for indicating externally the position of the blades.
  3. Unless otherwise approved, quadrants and operating handles shall be die-cast aluminum with the words 'OPEN' and 'SHUT' cast on the quadrant. Quadrants shall be securely fixed, and the damper axle/spindle shall be closely fitted in the quadrant hubs to prevent any damper movement when the damper levers are locked. Damper control/adjustment operating handles shall be provided with stand-offs to allow complete ductwork insulation coverage. The positions of all dampers 'as-set' after final adjustment shall be indelibly marked at the operating handle.
  4. For dampers installed for shut-off purposes, the maximum air leakage rate shall be tested according to SMACNA. Air leakage rates shall be tested according to SMACNA when the damper is in the closed position.
- B. Air Volume Control Dampers: Provide branch duct (not neck) air volume balancing/control dampers at each supply, return, and exhaust duct from main ducts and duct runouts to regulate and balance the system. Dampers on grilles or diffusers shall be used for fine control only.
1. Single blade, opposed blade or multi louver type as detailed in SMACNA Standards. Refer to SMACNA Details for Single Blade and for Multi-blade Volume Dampers.
  2. Blades shall be constructed from the same material as the ductwork or stainless steel with longitudinal reinforcing steel bar, mounted on a steel spindle. Bearings shall be nylon, oil impregnated bronze or stainless steel.
  3. Each air volume control damper in the ductwork shall be fitted with a non-corrodible tag stating the actual airflow in FPM when in the fully open position, its overall cross sectional area, and the degree to which the damper has been closed in order to achieve the design or actual airflow.
- C. Butterfly dampers shall each consist of two plates, edge seamed, of at least the same thickness as the material from which the associated ductwork is made, and rigidly fixed to each side of a mild steel operating spindle, the ends of which shall be turned and housed in non-ferrous bearings.
- D. Bifurcating dampers shall be of 2 mm thick sheet for sizes up to 450 mm square, for larger sizes the thickness shall be as specified. The damper blades shall be rigidly fixed to square section mild steel spindles, the ends of which shall be turned and housed in non-ferrous bearings.
- E. Each leaf of a multi-leaf damper shall consist of two plates of material of the same thickness as the associated ductwork and rigidly fixed to each side of an operation spindle, the ends of which shall be housed in brass, nylon, oil impregnated sintered metal, PTEE impregnated or ball bearings. The ends of the spindles shall be linked so that one movement of the operating handle shall move each leaf for an equal amount. The mechanism shall be located outside the air stream. For system static pressure below 1000 Pa or ductwork velocity below 12 m/s, blade of at least 50 mm wide shall be used. For static pressure at or above 1000 Pa, at least 100 mm wide blade shall be used. Central blade reinforcement bar shall be provided for damper span longer than 1500 mm. Single module of a damper shall not exceed 2000 mm width and 1000



mm height. Alternatively, multi-leaf damper blades may be of a single plate, at least 1.6 mm thick and suitably stiffened, and the blade linkages may be within the specified value.

- F. Self-closing dampers shall present a minimum resistance to air flow under running conditions and take up a stable position in operation. Maximum resistance shall be presented under reverse air flow conditions such that they will be forced to close and remain so. Resilient strips or other purpose made devices shall be provided to prevent the damper from rattling and as an aid to air sealing under reverse flow conditions. Blades shall be rigidly constructed of steel or aluminum sheet of not less than 0.8 mm (22 gauge) and shall be free of all buckles. Blades of less than 300 mm in height shall be fitted with a 3 mm (10 gauge) bright steel spindle at each end. Blades of 300 mm and over in height shall be fitted with an 8 mm bright steel spindle at each end. Spindles shall be carried by sealed ball bearings. Bearing shall be accessible for cleaning and lubrication and shall be mounted in a rigid galvanized steel frame. The maximum length of each blade without a central bearing shall be 1000 mm.
- G. Motorized shut-off dampers shall be similar to fire/smoke dampers and shall be open or close by motorized mechanism. Each of the dampers shall be in the "Open" position normally, but shall be closed in case of fire. The motorized mechanism shall be actuated by associated automatic fire detectors. Air leakage rate for motorized shut-off dampers shall be tested.

## 2.9 ROOF, FLOOR, WALL PENETRATIONS

- A. Prefabricated Roof Curbs: Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.
- B. Where ducts pass through exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Curb interior floor penetrations to prevent water from entering the areas. Provide flashing not less than 26 gage stainless steel or 16 ounce (450 g) copper.

## 2.10 EQUIPMENT SUPPORTS

- A. Refer to Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- B. Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building to withstand sustained wind velocities of 100 mph.

## 2.11 SEISMIC RESTRAINT FOR DUCTWORK

- A. Ductwork shall be supported and braced to resist all directional (transverse, longitudinal and vertical) forces equal to 50 percent of the weight of the duct system.
- B. Brace all duct branches, minimum of one brace per branch.
- C. Provide required bracing material.

## 2.12 INSTRUMENT TEST FITTINGS

- A. 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.
- B. Manufactured type with a minimum 50 mm (2 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.

## 2.13 AIR OUTLETS AND INLETS

- A. Materials:

1. Steel or aluminum except that all units installed in wet areas shall be stainless steel. Provide manufacturer's standard gasket.
  2. Air outlets, grilles and diffusers shall be easily removable for service and cleaning.
  3. Exposed Fasteners: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
  4. 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 shall be designed for quiet air distribution. Refer to Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/EQUIPMENT for NC criteria.
- C. Air Supply Outlets: Refer to plans and schedule.
1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, off-white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.
    - a. Square, louver, fully adjustable pattern: Round neck, surface mounting unless shown otherwise on the drawings. Provide equalizing or control grid and volume control damper.
    - b. Louver face type: Square or rectangular, removable core for 1, 2, 3, or 4 way directional pattern. Provide equalizing or control grid and opposed blade damper.
    - c. Perforated face type: Manual adjustment for one-, two-, three-, or four-way horizontal air distribution pattern without change of air volume or pressure. Provide equalizing or control grid and opposed blade over overlapping blade damper. Perforated face diffusers for VAV systems shall have the pattern controller on the inner face, rather than in the neck and designed to discharge air horizontally at the ceiling maintaining a Coanda effect (also known as "boundary layer attachment", is the tendency of a stream of fluid to stay attached to a convex surface, rather than follow a straight line in its original direction).
    - d. Slot diffuser/plenum: Not Applicable.
  2. Linear Grilles and Diffusers: Extruded aluminum, manufacturer's standard finish, and positive holding concealed fasteners.
    - a. Margin: Flat, 20 mm (3/4-inch) wide.
    - b. Bars: Minimum 5 mm (3/16-inch) wide by 20 mm (3/4-inch) deep, zero deflection unless otherwise shown. Reinforce bars on 450 mm (18 inch) center for sidewall units and on 150 mm (6 inch) center for units installed in floor or sills.
    - c. Provide opposed blade damper and equalizing or control grid where shown.
  3. Operating Surgery Room Air Distribution Devices: Not Applicable.
  4. Registers: Double deflection type with horizontal face bars and opposed blade damper with removable key operator.
    - a. Margin: Flat, 30 mm (1-1/4 inches) wide.
    - b. Bar spacing: 20 mm (3/4-inch) maximum.
    - c. Finish: Off white baked enamel for ceiling mounted units. Wall units shall be extruded with manufacturer's standard finish.

5. Grilles: Same as registers, but without the opposed blade damper.
  6. Styles: Refer to plans and schedule.
- D. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.
1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall be extruded aluminum with manufacturer's standard aluminum finish.
  2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin.
  3. Perforated Face Type: To match supply units.
  4. Grid Core Type: 13 mm by 13 mm (1/2-inch by 1/2-inch) core with 30 mm (1-1/4 inch) margin.
  5. Linear Type: To match supply units.
  6. Door Grilles: Are furnished with the doors.
  7. Filter Grilles: Standard face hinged to a mounting frame with space for a 25 mm (1 inch) throwaway filter. Hold face closed by a locking screw. Provide retaining clips to hold filter in place. Provide 1 inch thick fiberglass throwaway filter.
  8. Wet Rooms: Stainless steel return registers, material and finish to match supply side.
  9. Styles: Refer to plans and schedule.
- E. Supply, Return and other type Air Registers in Psychiatric Rooms: Not Applicable.
- F. Other Types: Refer to plans and schedule.
- 2.14 WIRE MESH GRILLE
- A. Fabricate grille with 2 by 2 mesh 13 mm (1/2-inch) galvanized steel or aluminum hardware cloth in a spot welded galvanized steel frame with approximately 40 mm (1-1/2 inch) margin.
  - B. Use grilles where shown and in unfinished areas such as mechanical rooms.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, particularly regarding coordination with other trades and work in existing buildings. Comply with NFPA 90A unless more stringent requirements are specified.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
  1. The drawings show or describe the general layout of ductwork, equipment, articles, assemblies, and appurtenances, but do not identify all required accessories, components, fittings, and offsets that may be necessary to complete the installation for the purpose intended such as connecting ductwork to equipment, boxes, diffusers, grilles, etc. Fabricate ductwork based on field measurements and reviewed coordination drawings. Coordinate with other trades for space available and relative location of HVAC equipment and accessories. Location of items shall be altered where necessary to avoid interference and clearance difficulties. Locations of components and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. The

Contractor shall determine the exact routing and location of systems prior to fabrication and installation. Accurate field measurements and coordination drawings shall be prepared to establish the locations and characteristics of the various systems (new and existing to remain). It is the intent of the drawings/specifications that the Contractor provides all materials, labor and coordination necessary to complete the work described or implied by the contract documents at no additional cost/time to the Government. Duct sizes on the drawings are inside dimensions. The Contractor shall propose with submitted coordination drawings other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties. Should the drawings not agree with themselves or not agree with the specifications the greater quantity of superior work and materials shall be performed.

2. Provide only low loss fittings at each duct change in size/direction as shown in SMACNA HVAC Duct Construction Standards, Chapter 2. Use radius elbows only (vanes not permitted). No square throat or mitered elbows with/without turning vanes.
  3. Provide transitions, offsets and connections to ducts, dampers, coils, and other equipment in accordance with SMACNA HVAC Construction Standards, Chapter 2. Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected. Use low loss bellmouth, conical, 45° lead in, radius fittings only. Provide streamliner sections where an obstruction cannot be relocated. Elbows and fittings shall be a minimum 2 gauge heavier than straight duct lengths of equal diameter/size.
  4. When required provide bolted construction and tie-rod reinforcement in accordance with SMACNA HVAC Construction Standards.
  5. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA HVAC Construction Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
  6. Provide 1 inch thick throwaway air filters in accessible mounting frames upstream of all main duct supply/return heating/cooling hydronic/electric/steam coils and return air registers/grilles. Provide retaining clips to hold filters in place. This work is to be performed irrespective of whether a device is indicated on the drawings or not.
  7. Provide clamping type access doors located and sized to inspect, service, and replace all serviceable components in ductwork.
  8. Penetrations. Where ducts pass through walls in exposed areas, install suitable escutcheons made of sheet metal angles as closers.
- C. Install duct hangers and supports from structure in accordance with SMACNA HVAC Construction Standards, Chapter 4, but not greater than 7 feet apart. Trapeze style hangers/supports shall be utilized with spot welded duct clips where necessary. Do not screw through the ductwork to attach hangers and supports.
- D. Provide fire/smoke dampers where shown on the drawings and where required by applicable codes for duct penetrating floors, fire walls, and smoke barriers. Fire/smoke dampers shall be enclosed in 10 gauge steel sleeves with gasketed access doors located and sized to inspect/service/replace components. Install fire dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install "Fire/Smoke Damper to Room ---" engraved label at location below the ceiling line adjacent to the damper and/or remote status indicator light.
- E. Seal all openings around duct and pipe penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A and Section 07 84 00, FIRESTOPPING.

- F. Flexible duct installation is only permitted where duct connections are made to fans and air handling units. No other flexible duct is permitted.
  - G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
  - H. Air Volume Control Damper Installation: Balancing dampers shall be provided in all duct branches. Provide branch duct (not neck) air balancing/control dampers at each supply, return, and exhaust duct from main ducts and duct runouts to regulate and balance the system. This work shall be performed irrespective of whether a device is indicated on the drawings or not.
    - 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. Damper control/adjustment operating handles shall be provided with stand-offs to allow complete ductwork insulation coverage.
    - 5. Back-flow Damper: A back-flow damper shall be provided at the fresh air supply, exhaust and discharge of outside AHU to prevent the flow of air through the idle unit. The back-flow damper shall not leak more than 3% at 2 WG differential pressure.
  - I. Clamping type access doors shall be provided adjacent to all dampers. Subject to limitations of ductwork size the dimensions of access openings shall not be less than 12 inches by 12 inches, and they shall be located to provide easy access for inspection and maintenance.
  - J. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
  - K. Duct Liners: Not Applicable.
  - L. Protection and Cleaning:
    - 1. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer.
    - 2. Adequately protect equipment and materials against physical damage and contaminants. Protect equipment and ducts during construction against entry of foreign deposits, debris or contaminants.
    - 3. Inspect and clean equipment and ducts inside and outside as specified before operation. Inspect and clean new and existing ducts as specified before operation when new duct is connected to existing duct. Verify equipment and duct system cleanliness as specified before operation allowing sufficient time for corrective actions.
- 3.2 DUCT PRESSURE & LEAKAGE TESTS AND REPAIR
- A. Perform tests required. See article, QUALITY ASSURANCE. Leak testing company shall be independent of the sheet metal company employed by General Contractor.
  - B. Testing shall be performed after all ductwork equipment and components are installed including all necessary access doors (NB: End caps shall be installed at the diffuser locations), but prior to insulation installation. Ductwork leak test shall be performed for the entire air distribution supply, return, exhaust system section by section including fans, coils, heaters, filter racks including air terminal units employed in the system where required. Ductwork shall be leak tested before enclosed in shafts or covered in other inaccessible areas.

- C. All tests shall be performed in the presence of the Resident Engineer and the TAB agency. The TAB agency shall measure and record duct leakage and identify sources with excessive leakage.
- D. Ductwork shall be pressurized and inspected at 150% of the rated pressure, but not less than 1.0 inches WP for a sustained duration of not less than 30 minutes without structural failure of the ductwork system. Seal air leaks audible at system operating conditions. Seal all visible openings in ducts particularly at notches on rectangular duct joints. Repair any structural inadequacies and failures found during testing. Testing and repair integrity verification shall include all new and existing ductwork components.
- E. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. Ductwork under Low Pressure Construction Standards shall not leak more than 3% of the system operating flow. Ductworks under High Pressure Construction Standards shall be limited to 1% of the system operating flow.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer. All tests and necessary repairs shall be completed prior to insulation and concealment of ductwork. Verify that all openings used for testing flow and temperatures by the TAB agency are sealed properly.
- G. The testing & inspecting company shall provide a written report of all the conditions occurring during testing including but not limited to the volume (CFM) of air supplied to pressurize the ductwork, the volume (CFM) and percent (%) of the system air flow loss.

### 3.3 IDENTITY MARKING

Identify designated systems conforming to ANSI A13.1 standard visibility in width and size unless specified otherwise on ductwork, exposed, above removable ceilings, in accessible spaces, and interstitial spaces.

- A. Labels shall be pressure sensitive vinyl.
- B. Place labels 8 feet apart on straight runs of ductwork, where ductwork pass through walls or floors, changes in directions and adjacent to all operating equipment.
- C. Labels shall be placed to be clearly visible after insulation installation from underside and sides of ductwork. Provide arrows to indicate direction of flow.

<u>Duct Text</u>	<u>Background Color</u>	<u>Text Color</u>
Supply	Green	White
Return	Yellow	Black
Fresh Air	Blue	White
Bypass	Green	White
Exhaust	Red	White

### 3.4 DUCTWORK EXPOSED TO WIND VELOCITY

Provide additional support and bracing to all exposed ductwork installed on roofs or outside the building to withstand wind velocity of 100 mph.

### 3.5 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS

- A. Perform applicable leakage tests.
- B. Verify application of the device labeling requirements.
- C. Inspect installation and equipment for conformance with design.

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- D. Inspect the quality of construction and installation before insulating.
- E. Verify application of the system color code and labeling requirements.
- F. Verify compliance with the support/restraint and accessories requirements.
- G. Verify quantity, size, type of access doors, air volume dampers, fire/smoke dampers.
- H. Verify size, type, connectivity of system sections, low loss fittings/transitions and air outlets/inlets.
- I. Verify size, quantity, location, operation of all flow measuring devices, controls and instrumentation.
- J. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- K. Inspect air conveyance system cleanliness to the indicated NADCA standards and VA protocols – refer to ATTACHMENT A “Air Conveyance System Cleaning”.
- L. Verify air conveyance system cleanliness to the indicated NADCA standards and VA protocols – refer to ATTACHMENT B “Air Conveyance System Cleanliness Verification”.

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

ATTACHMENT A

AIR CONVEYANCE SYSTEM CLEANING

PART 3 – EXECUTION

3.α (Alpha) BASIC METHODS AND REQUIREMENTS

- A. This section defines the minimum requirements necessary to render the air conveyance system clean in accordance with applicable Standards and requirements specified herein.
- B. Duct/HVAC Cleaning Agency Qualifications: Current membership in AIAQC, ASCR, IAQA, MSHI and NADCA utilizing certified ASCS and CECS specialists meeting OSHA 1926 standards.
  - 1. NADCA Standards shall be followed with no modifications or deviations being allowed.
  - 2. Contractor shall clean the HVAC system that fails to meet the permissible cleaning level to bring it into compliance, and shall re-inspect and re-test until acceptable levels are demonstrated to the Resident Engineer.
- C. HVAC air conveyance system includes interior surfaces of the air distribution system (new and existing) for conditioned spaces and/or occupied zones within the project boundary. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. Services to be provided including, but not limited to:
  - 1. The return air grilles, return air ducts to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers and dehumidifiers, supply air ducts, fans, fan housing, fan blades, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system.
  - 2. The HVAC system may also include other components such as dedicated exhaust, ventilation components, and air make-up systems.
- D. Initial Cleanliness Inspection: Visual inspection of the complete (all new and existing) air conveyance system within the construction boundary shall be performed before mechanical cleaning by competent qualified personnel to determine the need for cleaning. Access doors shall be installed where necessary to facilitate visual inspection.
  - 1. New Work – Visual inspection shall be performed to ensure that no visible deposits, debris or contaminants are present, and if cleaning is prudent.
  - 2. Existing Work – Visual inspection shall be performed to ensure that no visible deposits, debris or contaminants are present, and the extent of cleaning that may be prudent.
  - 3. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean.
  - 4. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be cleaned, and subjected to re-inspection.
  - 5. Cleanliness verification shall be performed and certified by an Industrial Hygienist (from an independent certified testing laboratory – independent from the duct cleaning agency).
- E. Component Inspections: Contractor shall inspect and document the condition of the HVAC system. This information shall be reported prior to the start of cleaning work.



1. A visual inspection of the HVAC system shall be performed to determine appropriate methods, tools, and equipment required to satisfactorily inspect and clean the system. Refer to Article, Source Removal Cleaning Methods.
    - a. Method 1: Wet Clean in Place
    - b. Method 2: Remove, Wet Clean & Replace
    - c. Method 3: Air Wash in Place
  2. Inspector Qualifications: Qualified personnel with membership in AIAQC, ASCR, IAQA, MSHI and NADCA shall perform the HVAC inspection. At minimum, such personnel shall have an understanding of HVAC system design, applicable industry standards, current industry HVAC cleaning procedures, and experience in utilizing accepted indoor environmental sampling practices.
  3. Inspection shall include air handling units and representative areas of the HVAC system components and ductwork. In HVAC systems that include multiple air handling units, a representative sample of the units shall be inspected.
  4. System component inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures should be implemented.
  5. Damaged system components found during the inspection shall be documented and brought to the attention of the Resident Engineer.
  6. Air Volume Control Devices: Dampers and any air directional mechanical devices inside the HVAC system shall have their position marked prior to cleaning and, upon completion, shall be restored to their marked position.
- F. HVAC cleaning agency shall be responsible for the removal of visible surface deposits and contaminants (mold/fungus, mycotoxins, bacteria and particulates) from within the HVAC system (all new and existing components) in strict accordance with these specifications ... refer to ATTACHMENT B "Air Conveyance System Cleanliness Verification" for additional requirements. Cleaning shall be performed after installation of all components in a manner not to alter TAB settings made to the system. Services to be provided include, but are not limited to:
1. Access and Clean Air Supply/Return & Make-up Ductwork
  2. Remove, Clean and Replace:
    - Supply Registers
    - Return Air Grills
  3. Access and Clean Air Supply/Return & Make-up Plenums
  4. Remove, Clean and Reinstall Blower Motors & Assembly
  5. Clean air stream side of Heat Exchangers
  6. Clean Secondary Heat Exchangers
  7. Clean Evaporator Coil, Drain and Pan
  8. Replace air filters
  9. Wash air cleaners

- G. Site Evaluation and Preparations: HVAC cleaning agency shall conduct a site evaluation, and establish a specific, coordinated plan detailing the method each area of the building will be protected during the various phases of the work.
- H. Health and Safety Standards: HVAC cleaning agency shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.
  - 1. Containment Requirements: Debris removed during cleaning shall be collected and precautions must be taken to ensure that debris is not otherwise dispersed outside the HVAC system during the cleaning process.
  - 2. Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.
  - 3. Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.
  - 4. Particulate Collection: Where the Particulate Collection equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection equipment is exhausting outside the building, mechanical cleaning operations shall be undertaken only with Particulate Collection equipment in place, including adequate filtration to contain debris removed from the HVAC system. When the Particulate Collection equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.
  - 5. Debris Disposal: All debris removed from the HVAC system shall be disposed of in accordance with applicable federal, state and local requirements.
- I. Service Openings: Contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.
  - 1. Contractor shall utilize existing service openings already installed in the HVAC system where possible.
  - 2. Other openings shall be created where needed for present and future cleaning of the new and existing air conveyance system within the construction boundary, and shall be closed and/or sealed in accordance with Article, DUCT ACCESS DOORS AND PANELS.
  - 3. Openings must not compromise the structural integrity of the system.
  - 4. Closures must not significantly hinder, restrict, or alter the airflow within the system.
  - 5. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces.
  - 6. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.
  - 7. Cutting service openings into flexible duct is not permitted. Flexible duct shall be disconnected at the ends as needed for proper cleaning and inspection.

8. Rigid fiberglass duct systems shall be resealed in accordance with NAIMA recommended practices. Only closure techniques that comply with UL Standard 181 or UL Standard 181a are suitable for fiberglass duct system closures.
  9. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location documented in project report documents.
  10. Ceiling Tiles: Contractor may remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.
- J. Source Removal Cleaning Methods: The air conveyance system cleaning including use of biocidal agents and application of biocidal coatings shall be performed by a member of AIAQC, ASCR, IAQA, MSHI and NADCA utilizing certified ASCS, CECS and CMR specialists.
1. HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that shall render the HVAC system visibly clean and capable of passing verification methods, Cleaning Verification Inspections/Tests and other recommended tests (see NADCA Standards). No cleaning method or combination of methods shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.
  2. All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device shall be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.
  3. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.
  4. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes or regulations.
  5. All methods require mechanical agitation devices to dislodge debris adhered to interior surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods shall include those which shall not potentially damage the integrity of system components, ductwork or porous materials inside the ductwork.
- K. Cleaning Components: Cleaning methods employed shall render all HVAC system components visibly clean as defined in applicable NADCA Standards and be capable of passing Cleaning Verification Inspections/Tests. Upon completion, all components shall be returned to the settings recorded prior to the cleaning operations.
- L. Cleaning Air Handling Units, Terminal Units (VAV, Dual duct boxes, etc.), Blowers and Fans: Contractor shall insure that supply, return, and exhaust fans and blowers are thoroughly cleaned. Areas to be cleaned include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and

drive assemblies. All visible surface deposits and contamination shall be removed in accordance with NADCA Standards and be capable of passing Cleaning Verification Inspections/Tests. Contractor shall:

1. Clean all air handling units (AHU) internal surfaces, components and condensate collectors and drains.
2. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.
3. Clean all coils and related components, including evaporator fins.

M. Cleaning Coils:

1. Any cleaning method may be used which will render the coil visibly clean and capable of passing Coil Cleaning Verification in accordance with applicable NADCA Standards. Coil condensate drain pans shall be subject to Non-Porous Surfaces Cleaning Verification and the condensate pan drain operation shall be verified including trap primers. Cleaning methods shall not cause any damage to, displacement of, erosion, or inhibit heat transfer of the coil surface or fins, and shall conform to coil manufacturer recommendations. Coils shall be thoroughly rinsed with clean water to remove any latent residues.
2. Coil Cleaning Verification: Cleaning shall restore the coil pressure drop to within 5 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not available, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection in accordance with applicable NADCA Standards and capable of passing Cleaning Verification Inspections/Tests.

N. Cleaning Duct Systems:

1. Contractor shall create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
2. Contractor shall mechanically clean all duct systems to remove all visible deposits and contaminants, such that the systems are capable of passing Cleaning Verification Inspections/Tests.

O. Cleaning Fibrous Glass Insulated Components:

1. Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure in accordance with applicable NADCA and NAIMA standards and recommendations.
2. Cleaning methods used on fibrous glass components shall not cause damage and not be permitted to get wet.
3. Damaged Fibrous Glass Material: Shall be replaced if there is any evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture such that the materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating.
4. Damaged Fibrous Glass Replacement: Contractor shall be capable of remediating exposed damaged insulation in air handlers and/or ductwork requiring replacement. In the event fiber glass materials must be replaced, all materials shall conform to applicable industry codes and standards, including those of UL and SMACNA.

P. Antimicrobial Agents and Coatings:

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1. Application of antimicrobial agents to control the growth of fungal or bacteriological contaminants shall be performed only after removal of surface deposits and debris.
  2. Antimicrobial agents shall be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.
  3. Antimicrobial treatments and coatings shall be applied in strict accordance with the manufacturer's written instructions, recommendations and EPA registration listing. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than "fogged" downstream onto surfaces.
  4. Air conveyance system cleanliness, inspection and application of biocidal coatings shall be performed in compliance with NADCA (ACR-1992, 2002, 2005) standards on the complete (all new and existing components) air conveyance system within the construction boundary.
- Q. Certifications: Submit to the Resident Engineer 4 copies of the testing/inspection report & tabulated records documenting that the air conveyance system cleaning has been performed in accordance with all applicable codes, contract requirements, verified through visual inspection and testing, and certified by a registered professional Industrial Hygienist (from an independent certified testing company).

ATTACHMENT A

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ATTACHMENT B

AIR CONVEYANCE SYSTEM CLEANLINESS VERIFICATION

PART 3 – EXECUTION

3.β (*Beta*) BASIC METHODS AND REQUIREMENTS

- A. Description: This section defines the minimum requirements necessary to verify the HVAC components cleanliness through inspection and testing in accordance with applicable Standards and requirements specified herein.
- B. Cleanliness Verification: Visual inspection of the complete (all new and existing) air conveyance system within the construction boundary shall be performed before/after mechanical cleaning by a registered professional Industrial Hygienist and Microbiologist (both from an independent certified testing laboratory – independent from the duct cleaning agency) to determine appropriate methods, tools, and equipment required to satisfactorily inspect and test the system.
  - 1. HVAC system cleanliness shall be verified and certified by the Industrial Hygienist before the application of any substance, including biocidal agents or coatings that ensure no contaminants (mold/fungus, mycotoxins, bacteria and particulates) are present. Air conveyance system cleanliness, inspection and application of biocidal coatings shall be performed in compliance with NADCA (ACR-1992, 2002, 2005) standards.
  - 2. Visual inspection of the complete (all new and existing) HVAC system shall be performed after mechanical cleaning to ensure that no visible deposits, debris or contaminants are present and certified for cleanliness by the Industrial Hygienist.
    - a. If no contaminants are evident through visual inspection, the HVAC system shall be considered initially clean and certified for cleanliness by the Industrial Hygienist.
    - b. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned, subjected to re-inspection and certification for cleanliness by the Industrial Hygienist.
  - 3. HVAC system cleanliness shall next be verified through surface comparison, particulate air samples and NADCA vacuum tests demonstrating compliance with NADCA hygiene protocols, and ASHRAE Standard 62 requirements. Testing and analysis shall be performed by a qualified party experienced in the methods.
    - a. New Work – Tested after cleaning if determined prudent.
    - b. Existing Work – Tested initially before cleaning and, if determined prudent, shall be tested after cleaning.
  - 4. If deemed prudent, the HVAC system cleanliness shall be finally verified through EPA Mold Technology, Quantitative PCR (polymerase chain reaction), Microbial Volatile Organic Compound (MVOC), microbiological, bioaerosol and gravimetric analyses, and particulate air sample testing as applicable. Testing and analysis shall be performed by a qualified party experienced in the methods.
- C. Sampling Protocols: Before sampling is performed, a plan shall be developed by the Industrial Hygienist and Microbiologist (approved by ASHREA, EPA, NADCA) indicating likely sources, how the organisms shall be located and quantified, and when and where samples shall be collected.
  - 1. Collect samples of background/exterior air for comparison with each test.

2. Collect total airborne fungi samples via Air-O-Cell cassette and Malt Extract Agar (MEA) from representative area(s).
  3. Collect microbial surface vacuum test samples from representative locations of each system.
  4. Collect representative Mycotoxin air samples and bacterial swab samples from representative locations of each system.
  5. Collect airborne dust concentrations using a portable aerosol monitor at representative locations.
  6. A summary report shall be furnished following the completion of cleaning activities including sample analysis and interpretation of collected remedial data. The summary report shall include cleaning sampling methodology, sample results, sample locations, data summaries and conclusions.
  7. Contractor shall not be permitted to remove any isolation barriers until all satisfactory airborne clearance criteria sample results have been reviewed.
- D. For general guidance refer to SMACNA, Indoor Air Quality – Systems Approach.
1. EPA Mold Technology, Quantitative PCR (polymerase chain reaction), Microbial Volatile Organic Compound (MVOC), microbiological, bioaerosol and gravimetric analyses, and particulate air sample testing may be necessary.  
*MVOC analysis provides a way to detect HVAC system contamination when neither visible mold growth nor measurable bioaerosols (spores, etc.) are present.*
  2. There are no standard methods for gathering information on airborne microorganisms. Assessment of only viable microorganisms may reveal as little as 1% of the total microbial airborne load. *Reference: Brian Flannigan ... "Guidelines for Evaluation of Airborne Microbial Contamination of Buildings".*
  3. There are many kinds of volumetric air samplers, among which the Reuter Centrifugal Sampler (RCS) or the Anderson Single Stage Sampler which draw in air from the room and discharge it with the bioaerosols onto a filter or sticky surfaces or agar plates.
  4. Air samples can be used to get a count of "colony-forming units" (CFU, which are bacteria and fungi that start growing on the culture media) per cubic meter of air. If the colonies are easy to identify, the counts can be related to individual species. The CFU of mixed species may also be used as a broad index of microbial growth. However, when species are mixed one or more species may be suppressed on the culture plate by competitors.
  5. A well-known but unreliable way of taking bioaerosol samples in an area is to set out culture plates and let the spores and other bioaerosols settle on them. This method is unreliable because some organisms do not send out many spores, or have spores that are too light to settle out, or that die soon after they leave the colony.
  6. Many facts and observations have to be recorded and samples have to be taken by several different methods in order to collect reliable data. Individual species finding matching conditions for colonization and reproduction have in vitro various physiologic demands, it is therefore recommended when examining the samples to use various kinds of culture media.
- E. Testing shall include analysis for the following:

1. Aspergillus, Eurotium, Fusarium, Penicillium, Trichoderma and Memnoniella molds
  2. Aspergillus fumigatus, A. flavus, A. versicolor, A. parasiticus (aflatoxins), A. terreus
  3. Fusarium graminearum (DON), F. sporotrichioides (T-2), F. moniliforme (fumonisin)
  4. Penicillium expansum (citrinin), P. chrysogenum (roquefortine C), P. brevicompactum (mycophenolic acid)
  5. Stachybotrys chartarum (atra) (satratoxins), Phoma
  6. Alternaria, Blastomyces, Coccidioides, Cryptococcus, Cladosporium, Fusarium, Helminthosporium, Histoplasma, Mesophilic and Thermophilic fungi
  7. Legionella bacterium
- F. Airborne Clearance Criteria:
1. Biological parameters shall not exceed the following levels:
    - a. Fungal Bioaerosols (culturable): 300 CFU/m<sup>3</sup> total  
50 CFU/m<sup>3</sup> individual (except Cladosporium)  
Glucans: 1 ng/m<sup>3</sup>  
Mold Hazard Class A: 0
    - b. Bacterial Bioaerosols (culturable): 500 CFU/m<sup>3</sup> total  
Pathogenic Bacteria: 0  
Viruses: 0
    - c. Actinomycete Spores: 0
  2. Particulate shall not to exceed the following levels:
    - a. HVAC System Particulate: 1.0 mg/100 cm<sup>2</sup>.
    - b. Respirable Particulate: 50 mg/m<sup>3</sup>.
  3. Human Carcinogens: Air stream shall not contain any confirmed or suspected human carcinogens ... ACGIH-BKLT and ACGHI-DOC.
- G. Certifications: Submit to the Resident Engineer 4 copies of the testing/inspection report & tabulated records documenting that the air conveyance system cleaning has been performed in accordance with all applicable codes, contract requirements, verified through visual inspection and testing as applicable, and certified by a registered professional Industrial Hygienist (from an independent certified testing company).

ATTACHMENT B

--- E N D ---



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

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the provisions for heating, ventilating and air conditioning fans.
- B. Terminology: In accordance with AMCA Publication 99, Standard 1 – 66.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

**1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.
- B. Fans and power ventilators shall be listed in the current edition of AMCA 26I, and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
  - 1. Testing and Rating: AMCA 210.
  - 2. Sound Rating: AMCA 300.
- E. Vibration Tolerance for Fans and Power Ventilators: Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/EQUIPMENT.
- F. Performance Criteria:
  - 1. The fan schedule shows CFM and design static pressure. Scheduled fan motors, 1/2 horsepower and larger, are sized for design CFM at 110 percent design static pressure, but not to exceed 3/4-inch additional pressure.
  - 2. Provide fans and motors capable of stable operation at design conditions and at 110 percent pressure as stated above.
  - 3. Lower than design pressure drop of approved individual components may allow use of a smaller fan motor and still provide the safety factor. When submitted as a deviation a smaller motor may be approved in the interest of energy conservation.
  - 4. Select fan operating point as follows:
    - a. Forward curved and axial fans: Right hand side of peak pressure point.
    - b. Backward inclined or tubular: Near the peak of static efficiency.
- G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge exposed to operating and maintenance personnel.
- H. Corrosion Protection:
  - 1. All steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint.

2. Manufacturer's paint and paint system shall meet the minimum specifications of ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G23 weathermeter.

#### 1.4 SUBMITTALS

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data:
  1. Fan sections, motors and drives.
  2. Centrifugal fans, motors, drives, accessories and coatings.
  3. Prefabricated roof curbs.
  4. Equipment shown on schedule drawing.
- B. Certified Sound power levels for each fan.
- C. Motor ratings types, electrical characteristics and accessories.
- D. Roof curbs.
- E. Belt guards.
- F. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
- G. Fan curves for each fan showing CFM versus static pressure, efficiency, and horsepower for design point of operation and at 110 percent of design static pressure. Include product application data to indicate the effect of capacity control devices such as inlet vane dampers on flow, pressure and horsepower.
- H. Certifications: Prior to the next Section of mechanical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a mechanical system specialist, and testing shall be performed by a qualified technician.

#### 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. Anti Friction Bearing Manufacturers Association, Inc. (AFBMA):
  - 9..... Load Ratings and Fatigue Life for Ball Bearings
- B. Air Moving and Control Association (AMCA):
  - 99..... Standards Handbook
  - 210..... Laboratory Methods of Testing Fans for Rating Purposes
  - 261..... Directory of Products Licensed to Bear the AMCA Certified Ratings Seal - Published Annually
  - 300..... Reverberant Room Method for Sound Testing of Fans
- C. American Society for Testing and Materials (ASTM):
  - B117 ..... Standard Method of Salt Spray (Fog) Testing

- D1735 ..... Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
- D3359 ..... Standard Test Method for Measuring Adhesion by Tape Test
- G23 ..... Standard Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) with and without Water for Exposure of Non-Metallic Materials
- G152 ..... Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
- G153 ..... Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
- D. National Fire Protection Association (NFPA):
  - 96 ..... Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment
- E. National Sanitation Foundation (NSF):
  - 37-R85 ..... Air Curtains for Entrance Ways in Food Establishments
- F. Underwriters Laboratories, Inc. (UL):
  - 181 ..... Factory Made Air Ducts and Air Connectors

## PART 2 – PRODUCTS

### 2.1 GENERAL

- A. Refer to plans and schedules for specification and performance.
- B. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the equipment.

### 2.2 CENTRIFUGAL FANS

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the fan or furnish to the Contractor.
- B. Fan arrangement, unless noted or approved otherwise:
  - 1. DWDI fans: Arrangement 3.
  - 2. SWSI fans: Arrangement I, 3, 9 or IO, except for fume hood exhaust fans Arrangement 3 shall not be acceptable.
- 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 1/2-inch 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 40,000 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. Furnish one additional complete set of belts for each belt-driven fan.
  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, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, for specifications. Provide protective sheet metal enclosure for fans located outdoors.
  9. Furnish variable speed fan motor controllers where shown on the drawings. Refer to Section 26 29 11, LOW VOLTAGE MOTOR STARTERS. Refer to Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS, for controller/motor combination requirements.
- D. In line Centrifugal Fans: In addition to the requirements of paragraphs A and C, provide inlet and outlet flanges, bolted access door and arrangement I, 4 or 9 supports as required.
- E. Industrial Fans: Use where scheduled or in lieu of centrifugal fans for low volume high static service. Construction specifications paragraphs A and C for centrifugal fans shall apply. Provide air handling type wheel.
- F. Utility Fans, Vent Sets and Small Capacity Fans: Class I 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.
- G. Explosion Proof Fans: 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.

## **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.

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

- A. Grease bearings.
- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.

### **3.3 FIELD INSPECTION, OPERATING AND PERFORMANCE TESTS**

- A. Schedule and perform all required inspections and tests for each piece of equipment as required by the manufacturers and specified in the contract documents in the presence of the Resident Engineer. Performance shall include all new and existing to be reused components. Performance shall include running the equipment and controls as applicable through their complete operational cycles with all components installed and system balancing complete.

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- B. Check vibration and correct as necessary for air balancing TAB work.
- C. Verify proper operation of motor, drive system and fan wheel.
- D. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/EQUIPMENT.
- E. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate that all equipment and components meet the manufacturer's requirements and are installed properly, complete and ready for use for the purpose intended.
- F. Refer to PART 3 of Section 23 05 11, REQUIREMENTS FOR MECHANICAL INSTALLATIONS.

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

**SECTION 23 82 00**  
**CONVECTION HEATING AND COOLING UNITS**

PART 1 - GENERAL

1.1 DESCRIPTION

Induction units, fan-coil units, radiant ceiling panels (for bathrooms), unit heaters, cabinet unit heaters, convectors and finned-tube radiation

1.2 RELATED WORK

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for equipment.
- 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 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Noise requirements.
- D. Section 23 21 13, HYDRONIC PIPING: Heating hot water and chilled water piping.
- E. Section 23 31 00, HVAC DUCTS and CASINGS: Ducts and flexible connectors.
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.
- G. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Flow rates adjusting and balancing.
- H. Section 23 82 16, AIR COILS: Additional coil requirements.
- I. Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- J. Section 01 09 00 – GENERAL COMMISSIONING REQUIREMENTS

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. Fan-Coil units.
  - 2. Finned-tube radiation.
- C. Certificates:
  - 1. Compliance with paragraph, QUALITY ASSURANCE.
  - 2. Compliance with specified standards.
- D. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute / Air Conditioning, Heating and Refrigeration Institute (ANSI/AHRI):
  - 440-08 ..... Performance Rating of Room Fan Coils
  - National Fire Protection Association (NFPA):
    - 90A-09 ..... Standard for the Installation of Air Conditioning and Ventilating Systems
    - 70-11 ..... National Electrical Code
- C. Underwriters Laboratories, Inc. (UL):
  - 181-08 ..... Standard for Factory-Made Air Ducts and Air Connectors
  - 1995-05 ..... Heating and Cooling Equipment

**1.6 GUARANTY**

In accordance with FAR clause 52.246-21

**PART 2 - PRODUCTS**

**2.1 ROOM FAN-COIL UNITS**

- A. Capacity Certification: AHRI 440.
- B. Safety Compliance: NEC compliant and UL listed.
- C. Noise Levels: Operating at full cooling capacity, sound power level shall not exceed by more than 5 dB the numerical value of sound pressure levels associated with noise criteria specified in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Select units at intermediate speed, for compliance with the noise criteria.
- D. Chassis: Galvanized steel, acoustically and thermally insulated to attenuate noise and prevent condensation.
- E. Cabinet: Minimum 1.3 mm (18 gage) steel reinforced and braced. Arrange components and provide adequate space for installation of piping package and control valves. Finish shall be factory-baked enamel in manufacturer's standard color on all exposed surfaces.
  - 1. Horizontal Unit: Provide Recessed type as shown. Provide supports and vibration isolators for horizontal units as recommended by the manufacturer.
    - a. Concealed Units: Provide fully enclosed cabinet with inlet and outlet duct collars.
- F. Fans: Centrifugal, forward curved, double width type wheels, galvanized steel or polyester resin construction, statically and dynamically balanced, direct driven.
  - 1. Motors: Premium efficiency, 3-speed permanent split capacitor type with integral thermal overload protection, for operation at not more than 1200 RPM.
  - 2. Provide a fan speed selector switch, with off, low, medium, and high positions. Switch shall have a set of auxiliary contacts which are open when the switch is in the "off" position and closed when the switch in any of the other positions. On vertical units, mount switch in a junction box in the cabinet of each unit. On ceiling-suspended horizontal and concealed units, switch shall be wall mounted.
- G. Cooling and Heating Coils:

1. Hydronic: Copper tubes, 10 mm (three-eighths inch) minimum inside diameter, not less than 4.3 mm (0.017 inch) thick with copper or aluminum fins. Coils shall be pressure tested for bursting and strength in accordance with Underwriters Laboratories, Inc., requirements for pressure tested coils, and shall be designed to provide adequate heat transfer capacity. Provide manual air vent at high point of each coil and drain at each low point.
  2. Electrical heating coils: Spiral sheath or finned-tube construction with Cal-rod resistance elements in aluminum tubes. Units shall be UL listed and factory wired with unit mounted heat switch, magnetic contactors, high temperature cutout safety control, and fan override thermostat. Heating coils shall be shipped separate for duct install.
- H. Piping Package: Factory furnished with unit by the manufacturer or field-installed by the contractor to fit control valves provided by the controls supplier. Submit manufacturer's detailed drawings of the piping in the end compartments for approval prior to fabrication of the piping packages. Provide ball stop valves on the supply and return pipes and balancing fittings on the return pipes.
- I. Drain pans: Furnish galvanized steel with solderless drain connections and molded polystyrene foam insulating liner.
- J. Air Filter: Manufacturer's standard throwaway type, not less than 25 mm (1 inch) thick, MERV 7, supported to be concealed from sight and be tight fitting to prevent air by-pass. Filters shall have slide out frames and be easily replaced without removing enclosure or any part thereof.
- K. Control valves and remote wall mounted space thermostats// or unit mounted return air thermostats, where shown or specified //are to be field installed. Provide two-way modulating control valves unless shown or specified otherwise.
- 2.2 FINNED-TUBE RADIATION
- A. Ratings: Certified under the I=B=R program of the Gas Appliance Manufacturer's Association.
- B. Enclosures: 1.6 mm (16 gage) steel, sloping top, designed for wall mounting. Provide baked enamel finish in standard manufacturer's colors as selected by the Architect. End plates and corner pieces shall be die-formed with round edges and fit flush with enclosure surface. Where continuous wall-to-wall installations are shown on the drawings provide all fillers, corner fittings, sleeves, end caps and other accessories, which shall have the same profile as the basic unit. Provide access panels or extensions where required for access to valves, or traps shown on the drawings.
- C. Hydronic/Steam Heating Elements: Steel pipe or nonferrous tubing with fins mechanically bonded by mechanical expansion of the tube. Elements shall be positively positioned front-to-back with provisions for silent horizontal expansion and contraction.
- D. Electric Heating Elements: Cal-rod electric resistance type inside aluminum tubes, mechanically expanded into fins and suspended between junction boxes. Provide capillary type automatic reset thermal cutout for immediate overheat protection. Front panel temperature shall not exceed 54 degrees C (130 degrees F). Units shall be UL approved. VA Comment – Steam is generally not used.



**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. Install fiberglass blanket insulation with a minimum R value of 8 above hydronic radiant panels.

**3.2 OPERATIONAL TEST**

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

**3.3 STARTUP AND TESTING**

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

**3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

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

**SECTION 23 82 16**  
**AIR COILS**

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Heating and cooling coils for air handling unit and cut applications

1.2 RELATED WORK

- A. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. Section 23 31 00, HVAC DUCTS AND CASINGS
- D. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS
- E. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- F. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS

1.3 QUALITY ASSURANCE

- A. Refer to paragraph, QUALITY ASSURANCE, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Unless specifically exempted by these specifications, heating and cooling coil shall be tested, rated, and certified in accordance with AHRI Standard 410 and shall bear the AHRI certification label.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data for Heating and Cooling Coils: Submit type, size, arrangements and performance details. Present application ratings in the form of tables, charts or curves.
- C. Provide installation, operating and maintenance instructions.
- D. Certification Compliance: Evidence of listing in current ARI Directory of Certified Applied Air Conditioning Products.
- E. Coils may be submitted with Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning and Refrigeration Institute (AHRI):

Directory of Certified Applied Air Conditioning Products

AHRI 410-01 ..... Forced-Circulation Air-Cooling and Air-Heating Coils

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

B75/75M-02 ..... Standard Specifications for Seamless Copper Tube

D. National Fire Protection Association (NFPA):

70-11 ..... National Electric Code

E. National Electric Manufacturers Association (NEMA):

250-11 ..... Enclosures for Electrical Equipment (1,000 Volts Maximum)

F. Underwriters Laboratories, Inc. (UL):

1996-09 ..... Electric Duct Heaters

**PART 2 – PRODUCTS**

**2.1 HEATING AND COOLING COILS**

A. Conform to ASTM B75 and AHRI 410.

1. The coating process shall such that uniform coating thickness is maintained at the fin edges. The quality control shall be maintained by ensuring compliance to the applicable ASTM Standards for the following:

- a. Salt Spray Resistance (Minimum 6,000 Hours)
- b. Humidity Resistance (Minimum 1,000 Hours)
- c. Water Immersion (Minimum 260 Hours)
- d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)
- e. Impact Resistance (Up to 160 Inch/Pound)

B. Tubes: Minimum 16 mm (0.625 inch) tube diameter; Seamless copper tubing.

C. Fins: 0.1397 mm (0.0055 inch) aluminum or 0.1143 mm (0.0045 inch) copper mechanically bonded or soldered or helically wound around tubing.

D. Headers: Copper, welded steel or cast iron. Provide seamless copper tubing or resistance welded steel tube for volatile refrigerant coils.

E. "U" Bends, Where Used: Machine die-formed, silver brazed to tube ends.

F. Coil Casing: 1.6 mm (16 gage) galvanized steel with tube supports at 1200 mm (48 inch) maximum spacing. Construct casing to eliminate air bypass and moisture carry-over. Provide duct connection flanges.

G. Pressures kPa (PSIG):

Pressure	Water Coil	Steam Coil	Refrigerant Coil
Test	2070 (300)	1725 (250)	2070 (300)
Working	1380 (200)	520 (75)	1725 (250)

- H. Protection: Unless protected by the coil casing, provide cardboard, plywood, or plastic material at the factory to protect tube and finned surfaces during shipping and construction activities.
- I. Vents and Drain: Coils that are not vented or drainable by the piping system shall have capped vent/drain connections extended through coil casing.

## **2.2 REFRIGERANT COILS**

- A. Continuous circuit, straight tubes, dry expansion type equipped with multi-port distribution header, less expansion valve.
- B. Minimum 16 mm (5/8-inch) tube diameter.
- C. Designed for R22 or other EPA approved refrigerants.

## **2.3 ELECTRIC HEATING COILS**

- A. Standards: ARI 410 is not applicable. Electric coils shall meet the requirements of the National Electric Code (NEC) and UL 1996.
- B. General: Aluminized steel frame, spot welded. Duct mounted units may be flanged or slip-in design with built-in terminal box completely factory wired to terminals. Control panels for coils in air handling units may be built-in or remote in NEMA 1 enclosure.
- C. Coils: Open type, 80 percent nickel, 20 percent chromium resistance wire, insulated by floating ceramic bushings and supported in aluminized steel brackets spaced on 100 mm (4-inch) maximum centers. Coils shall be mechanically crimped in stainless steel terminals which are insulated from the frame with high temperature molded phenolic bushings.
- D. Over Temperature Protection:
  - 1. Primary system: Automatic reset thermal cutout.
  - 2. Secondary system: Load-carrying manual reset thermal cutout factory wired in series with each heater stage.
- E. Overcurrent Protection: Comply with UL and NEC.
- F. Contactors: Disconnecting magnetic type, (when required), except for duct mounted reheat coils contractors shall be disconnecting mercury type.
- G. Airflow Interlock: Diaphragm operated differential airflow pressure switch.
- H. Leaving air temperature control for electric coils mounted in ductwork shall be 3 step control driven by a unit mounted modulating thermostat.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Follow coil manufacturer's instructions for handling, cleaning, installation and piping connections.
- B. Comb fins, if damaged. Eliminate air bypass or leakage at coil sections.

### **3.2 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedule with Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

**3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

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

**SECTION 26 05 11**  
**REQUIREMENTS FOR ELECTRICAL INSTALLATIONS**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. Basic methods and requirements for Division 26, ELECTRICAL, apply to all sections of Division 26, 27, 28.
- B. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings.
- C. Verify in advance of performing any work the availability, type, capacity, location of electrical systems necessary to perform the work.
- D. Ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.
- E. Definitions:
  - 1. Exposed: Items exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method offered in documents.
  - 3. Shall: Mandatory.
  - 4. May: Optional.

**1.2 RELATED WORK – MINIMUM WORK PERFORMANCE REQUIREMENTS**

No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Verify all dimensions, clearances, information and assumptions on existing conditions. All work shall be performed within approved tolerances, meet the requirements of the manufacturer and be neat, straight, plumb, level, smooth. Contractor is responsible for reviewing all contract documents for discrepancies prior to commencing any and all work. Contractor shall notify the Project Engineer of any variances with adequate time so that alternate solutions can be established without disrupting the established construction schedule. Data and information furnished or referred to in the construction documents is for the Contractor's use. The Government assumes no responsibility for any interpretation of or conclusion drawn from the data or information made by the contractor based on the information made available by the Government. Nor does the Government assume responsibility for any understanding reached or representation made concerning conditions that can affect the work by any of its officers or agents before the execution of this contract, unless that understanding or representation is expressly stated in the contract.
- B. Division 01, GENERAL REQUIREMENTS: Work performance.
- C. References to the APPLICABLE PUBLICATIONS are a minimum requirement standard. Except where a specific date is given, the issue in effect including amendments, addenda, revisions, supplements, and errata on the date of Invitation for Bids shall be applicable. Drawings and specification sections shall govern in those instances where contract document requirements are greater than those specified in the APPLICABLE PUBLICATIONS.

### 1.3 COORDINATION

Coordinate work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended.

- A. Coordinate the location of all work, equipment and components with other trades and equipment installers to prevent interferences, and maintain proper use and access to all items and spaces. Refer to the **"Coordination Drawing Checklist"** for further details. General Contractor is responsible for coordinating all equipment and components being installed with the placement location and dimension requirements. Prior to job execution each trade shall submit "complete" coordinated shop drawings indicating all equipment and material layouts with locations from walls/columns, bottom/top elevations, vibration isolators, supports, dimensions, utility requirements and equipment submittal numbers. Each trade shall maintain a set of working drawings to document as-built information as the work progresses and submit to the Project Engineer monthly for review.
- B. All work shall be coordinated with other trades to avoid conflicts and to obtain a neat competent installation that will afford maximum accessibility for easy and proper operation, maintenance, service and headroom. All work shall be installed in a manner that permits easy accessibility and proper removal of system components requiring periodic service. Any items determined to be in non-compliance shall be corrected by the Contractor at no additional expense to the Government.
- C. The drawings show or describe the general arrangement of equipment, articles, assemblies, appurtenances but do not show all required fittings, drains, air vents, supports and may not identify all required accessories, components, fittings, and offsets that are necessary to properly complete the installation for the purpose intended. The contract drawings are diagrammatic only intended to show general layout of conduit, ductwork, piping, equipment, terminals, specialties and not intended to show all required offsets, details, accessories and equipment to be connected. Provide all necessary fittings, offsets and pipe runs based on field measurements and reviewed coordination drawings. Coordinate with other trades for space available and relative location of equipment and accessories to be connected at all locations. The Contractor shall alter locations of items where necessary to avoid interference and clearance difficulties. Locations of components and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. The Contractor shall determine the exact routing and location of systems prior to fabrication and installation. Accurate field measurements and coordination drawings shall be prepared to establish the locations and characteristics of the various systems which are existing to remain. It is the intent of the drawings/specifications that the Contractor provides **all** materials, labor and coordination necessary to complete the work described or implied by the contract documents at no additional cost/time to the Government. The Contractor shall propose with submitted coordination drawings other dimensions with similar characteristics where necessary to avoid interferences and clearance difficulties. **Should the contract documents not agree with themselves the greater quantity of superior work and materials shall be performed.**
- D. Coordinate all mechanical, electrical, plumbing utility service, fire protection sprinkler system shutdowns and space access three (3) weeks in advance with the Project Engineer. Due to facility scheduling and access difficulties, some shutdowns and the performance of certain work will need to be performed during prime-time by the Contractor. Arrange phases and perform work to insure utility services for other buildings and areas at all times as required.
- E. Before placement and installation of work subject to tests the Contractor shall coordinate and notify the Resident Engineer in sufficient time to enable testing personnel to be present at the site in time for proper testing and field inspection. Such prior notice shall be not less than two (2) weeks unless otherwise designated by the Resident Engineer.

- F. For further details and requirements refer to Section 01 45 99, QUALITY CONTROL – INSPECTION – TESTING SERVICES.

**1.4 QUALITY ASSURANCE**

- A. Independent Electrical System Inspection/Testing Organization:
1. Agency that is financially independent of equipment manufacturer, supplier, and installer. Inspection/Testing of the entire electrical system shall be performed by an independent agency regularly involved in the specified work.
  2. Certification: Documentation upon completion of inspection/testing to include results, names of independent agency individuals performing work, detailed procedures followed for inspection/testing, and certification that all results were within the limits specified.
- B. When Factory Testing Is Specified:
1. The Government shall have the option of witnessing factory tests. Contractor shall notify the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
  2. Four (4) copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
  3. When equipment fails to meet factory test and re-inspection is required, the Contractor shall be liable for all additional expenses, including expenses of the Government.
- C. Products 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. All construction firms and personnel shall be experienced and qualified specialists in the applicable industrial and institutional construction.
- D. Product Criteria:
1. Materials, equipment and associated systems shall be comprised of high quality industrial-class and institutional-class products of current production by manufacturers that are experienced specialists in the required products.
  2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly. Asbestos products, or equipment or materials containing asbestos shall not be used.
  3. Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located reasonably close to the site.
  4. When more than one unit of the same class of product is required, such units shall be the products of a single manufacturer.
  5. Brand Names: Certain items may be identified by brand name make and model. Identification of these items by a “brand name” description is intended to indicate the quality and salient physical, functional, or performance characteristics of products that will be satisfactory and is not intended to be restrictive. Unless clearly indicated in the offer that an “equal” product is offered, the offer shall be considered as offering a referenced brand name product. Offers of “equal” products or items will be considered for this award if such product or item is clearly identified in the offer and is determined by the Government to fully meet the salient physical, functional, or performance characteristics of the product or item named. The Government’s determination as to the acceptability of the “equal” product shall be based on information furnished or otherwise identified in the offer, as well as other information reasonably available to the Government. If the item cited is no longer available, the manufacturer’s currently available item that replaces the cited model shall be provided.



- E. Assemblies and Components:
  - 1. Manufacturers of assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  - 2. Components shall be compatible with each other and with the total assembly for the intended service.
  - 3. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
  - 4. Components of an assembled unit need not be products of the same manufacturer.
  - 5. Constituent parts that are similar shall be the product of a single manufacturer.
- 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 Resident Engineer 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. Guaranty: In accordance with WARRANTY OF CONSTRUCTION (FAR 52.246-21).
- H. For further details and requirements refer to Section 01 45 99, QUALITY CONTROL – INSPECTION – TESTING SERVICES.

#### **1.5 QUALIFICATIONS OF PRODUCTS AND SERVICES**

Approval by Contracting Officer is required of product and services of proposed manufacturers, suppliers, installers and will be based upon submission by Contractor of certification that:

- A. Installer Qualifications: The installer has technical qualifications, licenses and specialized experience in installing products similar in material, design, and extent to those indicated with a record of successful in-service performance. Submit list of acceptable installations.
- B. Manufacturer Qualifications: The manufacturer is regularly engaged in manufacturing the specified material as a principal product with a minimum of five (5) years experience.
- C. Product Qualifications: The design, model and size of each item shall have been in satisfactory and efficient operation on at least three (3) installations for three (3) years. Submit list of acceptable product installations.
- D. Source Limitations: Each product type shall be the same and the product of a single manufacturer.
- E. Service Qualifications: There shall be a permanent service organization maintained that will render satisfactory service to restore operations within four (4) hours of receipt of notification in event of an emergency or within 24 hours in a non-emergency. Submit name and address of service organizations.

#### **1.6 EQUIPMENT REQUIREMENTS**

- A. The contract drawings are diagrammatic only intending to show general runs and locations of systems and equipment, and not intended to show all required details and accessories. All work shall be accurately laid out and coordinated with other Trades to avoid conflicts and afford maximum accessibility for easy of operation, service, maintenance and headroom. All work shall be installed in a manner permitting removal of components requiring periodic replacement and maintenance without damage to other parts of equipment and system components.
- B. Where variations from the contract requirements are necessary in accordance with Section 01 45 99, QUALITY CONTROL – INSPECTION – TESTING SERVICES, and requested in accordance Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, the installation methods, connecting work and related components shall be included, not limited to

additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels at no additional cost to the Government.

#### **1.7 EQUIPMENT INSTALLATION REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than specified in the NEC for all voltages specified.
- C. Inaccessible Equipment:
  - 1. Equipment shall be installed at conveniently accessible locations viewable in a direct line of sight parallel and/or perpendicular to the building lines as determined by the Government. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
  - 2. "Conveniently accessible" is defined as being capable of being reached and serviced without the use of ladders, or without reaching or climbing or crawling under or over or behind obstacles such as motors, fans, pumps, pipes, belt guards, high voltage lines, transformers, and ductwork.
- D. Certifications: Submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

#### **1.8 EQUIPMENT IDENTIFICATION**

- A. In addition to the requirements of the NEC, install an identification sign that will clearly indicate information required for use and maintenance of items such as cabinets, separately enclosed circuit breakers, control devices and other significant equipment. All installed equipment shall be labeled with name and source of energy utilizing the hospital nomenclature as directed by the Project Engineer. Systems shall be color code labeled with contents and flow direction in 8 foot intervals.
- B. Nameplates: 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.
- C. Equipment Identification: Other labels shall be either black or red laminated phenolic resin with a white core, engraved lettering shall be a minimum of 3/16-inch high. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

#### **1.9 SINGULAR NUMBER**

Where any device or part of equipment is referred to in these specifications in the singular number e.g., "the switch", this reference shall be deemed to apply to as many such devices as are necessary to complete the installation shown on the drawings and recommended by the manufacturer for the purpose intended.

#### **1.10 TEST STANDARDS**

- A. All material and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and material which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no

nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

- B. Contractor shall engage independent testing companies specialized and certified in the required testing of all installed equipment and components not performed by the manufacturer. The testing firms shall be professionally independent of the manufacturers, suppliers, installers of the equipment and systems evaluated. The testing firms shall meet the criteria for full membership of the International Electrical Testing Association. The site personnel shall consist of an independent licensed electrician and a certified electrical technician. Testing and inspection shall be performed during a minimum of two periods (rough and final phases) of electrical construction.
- C. Definitions:
  - 1. Listed; equipment or device of a kind mentioned which:
    - a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.
    - b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
  - 2. Labeled; equipment or device is when:
    - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.
    - b. The laboratory makes periodic inspections of the production of such equipment.
    - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
  - 3. Certified; equipment or product is which:
    - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
    - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
    - c. Bears a label, tag, or other record of certification.

#### **1.11 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, furnish the following:

- A. Manufacturer's Literature and Data: Submit under the pertinent specification section.
  - 1. Equipment, components and materials shown on drawings and/or identified.
  - 2. Submit all starters that are part of the electrical package.
  - 3. Hangers, inserts, supports and bracing.
  - 4. Fire-stopping materials.
- B. Coordination Drawings: Provide complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to SUBCONTRACTS AND WORK COORDINATION (VAAR 852.236-80), and Section 01 45 99, QUALITY CONTROL – INSPECTION – TESTING SERVICES. In addition, provide details of the following:
  - 1. All equipment and component layouts with submittal & drawing tag, utility requirements, dimensions, locations off walls & column lines, top and bottom elevations.

2. Electrical space layout details including above all the ceiling areas throughout the project showing all existing/new equipment, piping, ductwork, major raceways/conduit, etc.
- C. Manuals: Submitted in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
  1. Maintenance and Operation Manual, 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 words on the cover: "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. 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 manual 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 startup, 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. Lubrication schedule including type, grade, temperature range, and frequency.
    - j. 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.
    - k. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- D. 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.
- E. 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. Submittals shall be assembled using the Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, sample Cover Sheet Attachment A and Checklist Table Attachment B forms.
  2. Submittals shall contain the list of items being used, applicable specification paragraph numbers and/or drawing numbers (and other information required for exact identification

of location for each item); manufacturer and brand, referenced Publication and such additional information as may be required by specifications for particular item.

3. Submit each section separately.
- F. 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. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- G. 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 that has not had prior approval will not be permitted at the job site.
  1. Approvals will be based on complete submission of manuals together with shop drawings.
  2. Provide copies of approved Electrical submittals to the Testing subcontractor.
- H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
  1. Each type of receptacle, toggle switch, outlet box, device plate, engraved nameplate, wire and cable splicing and terminating material and molded case circuit breaker.
  2. A 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.
  3. Each type of conduit coupling, bushing and termination fitting.
  4. Conduit hangers, clamps and supports.
- I. Visual/Electrical Inspections & Tests: Submit tentative schedules for the Division 26, 27, 28 required inspections and tests. Refer to the Electrical System Inspecting & Testing Checklist (Attachment A) for the minimum requirements and details.
- J. As-Built System Line Diagrams: Provide detailed drawings for the electrical systems.
  1. AUTOCAD and PDF file drawings on CD (Version as required by the VA).
  2. Two sets of full size (Scaled: 1/8" = 1'-0") reproducible drawings.
  3. Two sets of half size reproducible drawings.
- K. Certifications: After completion of each Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.
- L. 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.

**1.12 PRODUCT DELIVERY, STORAGE AND HANDLING**

**VAMC Providence Respiratory Services**  
**VA Project No. 650-10-022**  
**PAI Project No. 35919.00**

- A. Delivery: 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.
- B. Protection: Equipment and material shall be protected during shipment and storage against physical damage, dirt, moisture, rain and cold.
  - 1. Equipment and material placed on the job site shall remain in the custody of the Contractor until 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. Painted surfaces shall be protected with factory installed removable heavy craft paper, sheet vinyl or equal. 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.
  - 3. Damaged equipment shall be replaced or repaired to original operating condition as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the Government.
  - 4. Existing equipment and systems being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected against any damage.
- C. Cleaning:
  - 1. 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, operating and painting.
  - 2. Prior to final inspection and acceptance of the facilities and areas for beneficial use by the Government, the equipment and systems shall be thoroughly cleaned and painted.
  - 3. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.
  - 4. In addition, the following special conditions apply:
    - a. Cleaning shall be thorough. Use 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.
    - b. Control and instrument panels shall be cleaned; damaged surfaces repaired, and touched-up with matching paint obtained from panel manufacturer.
    - c. 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 proper finish.

**1.13 APPLICABLE PUBLICATIONS**

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. Except where a specific date is provided the issue in effect on the date of Bids/Proposals shall be applicable. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. Publications listed in each Division 26, 27, 28 specification section form a part of this specification to the extent referenced.
- B. American Society for Testing and Materials (ASTM):  
A36/A36M ..... Carbon Structural Steel

- A575 ..... Steel Bars, Carbon, Merchant Quality, M-Grades
- E84 ..... Surface Burning Characteristics of Building Materials
- E119 ..... Fire Tests of Building Construction and Materials
- C. Federal Specifications (Fed. Spec.):
  - FF-S-325..... Shield, Expansion; Nail, Expansion; and Nail, Drive Screw  
(Devices, Anchoring, Masonry)
- D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
  - SP-58..... Pipe Hangers and Supports – Materials, Design and Manufacture
  - SP-69..... Pipe Hangers and Supports – Selection and Application
  - SP-127..... Bracing for Piping Systems, Seismic – Wind – Dynamic, Design,  
Selection, Application
- E. National Electrical Manufacturers Association (NEMA):
  - MG-1 ..... Motors and Generators
- F. National Fire Protection Association (NFPA):
  - 70..... National Electric Code (NEC)
  - 101..... Life Safety Code
- G. Occupational Safety and Health Administration (OSHA):
  - Part 1910 ..... Occupational Safety and Health Standards

## **PART 2 – PRODUCTS**

### **2.1 ASSEMBLED PRODUCTS**

- A. Provide maximum standardization of components to reduce spare part requirements. 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.
- B. 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.
- C. 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.
- D. 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.

## **2.2 ELECTRIC MOTORS**

- A. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient motors where 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 may be split phase or permanent split capacitor (PSC).
- C. Poly Phase Motors: NEMA Design B, squirrel cage, induction type.
- 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.
    - b. Other wiring 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, MG-1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- 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 specified, 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 mega ohm between stator conductors and frame, to be determined at the time of final inspection.

## **2.3 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 29 11, LOW VOLTAGE MOTOR STARTERS.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.



- C. Motors shall be energy efficient type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- 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.

#### **2.4 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and maintenance manuals. 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. 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 sensors, controllers and control devices. Identify and label each item as they appear on the control diagrams.

#### **2.5 PIPE AND EQUIPMENT SUPPORTS/RESTRAINTS**

- A. Vibration Isolators: Refer to Section 23 05 41, NOISE & VIBRATION CONTROL FOR HVAC PIPING/EQUIPMENT.
- B. Attachment to Concrete Construction:
  - 1. Concrete insert: Type 18, MSS SP-58.
  - 2. Self-drilling expansion shields and machine bolt expansion anchors: Fed. Spec. FF-S-325, permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-325.
  - 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than four inches thick when approved by the Resident Engineer for each job condition. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-325.
- C. 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 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- D. Multiple Trapeze Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-1/2 inches by 1-1/2 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts.
  - 1. Allowable hanger load: Manufacturers rating less 200 pounds.
  - 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod.
- E. Seismic Restraint of Equipment and Piping: Seismic restraint of equipment, ductwork and piping is required for projects in seismic areas where peak horizontal ground acceleration A max is 0.10g or greater. The A max values are listed in VA Handbook H-08-8, titled "Earthquake Resistant Design Requirements for VA Hospital Facilities".

1. Seismic force design criteria:
  - a. Piping resiliently supported: 120 percent of the weight of the system components and contents.
  - b. Piping not resiliently supported: 60 percent of the weight of the system components and contents.
  - c. Except as noted above; meet the more severe requirements of the Local Code and the latest Uniform Building Code for determining seismic force  $F_p$ .
2. Provide one of the following as applicable:
  - a. Design and installation shall meet the most current requirements of the National Uniform Seismic Installation Guidelines (NUSIG). Contractor shall submit all design tables and information for the design force levels, stamped and signed by a professional engineer registered in the State where the project is located.
  - b. Where NUSIG requirements are not met completely, submit proposed alternate details and calculations to completely address seismic bracing requirements. Such designs shall use the more severe of the Local Code and the Uniform Building Code requirements for determining seismic forces, and be performed, stamped and signed by a professional engineer registered in the State where the project is located. Revise if necessary any details shown on the contract drawings for vertical support and lateral bracing, and submit for the approval of the Resident Engineer to meet the required design criteria.

## **2.6 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent liquid spills from passing to a lower level provide the following as applicable:
  1. At sleeves: Extend sleeve 1 inch above finished floor and provide sealant for watertight joint.
  2. At blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
  3. At drilled penetrations: Provide 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 from the Resident Engineer.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel Pipe 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 firestopping 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.
- 2.7 TOOLS AND LUBRICANTS
- A. Tools: Furnish the Resident Engineer, special tools not readily available commercially, that are required for disassembly or adjustment of equipment furnished.
  - B. Lubricants: A minimum of one quart of oil, and 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.

### PART 3 – EXECUTION

#### 3.1 GENERAL

- A. Proper precautions shall be taken so that adjacent occupied areas shall not be disturbed or contaminated during construction. The VA Project Engineer shall be consulted three (3) weeks in advance for approval of work schedules in occupied areas. Due to hospital scheduling and access difficulties some work will likely require prime-time performance by the Contractor. Work above ceilings in areas beyond the construction boundary shall be cleaned and closed with matching undamaged materials by the close of each day.
- B. Verify in advance of performing any work the availability, type, capacity, location of energy systems eg, Mechanical, Electrical, Plumbing necessary to perform the work. Provide all necessary labor, material and coordination to complete the work described or implied by the construction documents for equipment to operate in the manner intended at no additional cost or time to the Government. In the event that the characteristics of any equipment do not agree with the characteristics of the available system, make the necessary modifications. All appurtenances, assemblies, articles, equipment, components, and materials furnished shall be new and free from defects, and be of the most suitable grade, size and capacity for the purpose intended, unless otherwise specified or approved by the VA Project Engineer. **Should the contract documents not agree with themselves the greater quantity of superior quality materials and work shall be used.**
- C. All appurtenances, assemblies, articles, equipment, components, and materials installed shall be complete for operation, service and maintenance for the purpose intended not limited to the details and information provided. All appurtenances, assemblies, articles, equipment, components, materials and execution shall be in conformance with the contract documents, manufacturer's written procedures and recommendations, latest editions of all applicable Federal/State/City codes, regulations, ordinances, and the jurisdiction having authority JHA as applicable. Except where specific dates are given, the issue (including amendments, addenda, revisions, supplements, and errata) in effect on the date of Invitation for Bids shall be applicable. **In the event that criteria requirements conflict, the most stringent requirement (the greater quantity of superior quality materials and work) shall be met.**
- D. Construction shall not block proper access to new/existing appurtenances, assemblies, articles, equipment, components, and materials requiring operation, service and maintenance whether detailed on the drawings or not. Access must be conveniently placed as determined by the VA Project Engineer.

- E. Properly relocate any existing systems considered interfering with the installation of new construction at no additional expense to the Government, and after confirming plans with the VA Project Engineer. This will include the relocation and/or reinstallation of items within the construction boundaries to perform and complete all necessary work as required.
- F. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to original condition. Care shall be used during removal and installation to avoid damaging the surrounding surfaces. Damaged surfaces and items within the contract limits shall be patched, repaired, refinished, painted and/or replaced as necessary with materials comparable to the surrounding material and surface equal to new conditions unless otherwise noted or directed by the VA Project Engineer. Finished surfaces shall be indistinguishable from the surrounding area.
- G. All installed equipment shall be labeled with name and source of energy utilizing the facility nomenclature as directed by the VA Project Engineer. Energy systems eg, Mechanical, Electrical, Plumbing shall be color code labeled with contents and flow direction in 8 foot intervals.
- H. Work shall be accomplished with all affected systems or equipment de-energized where possible. Work shall comply with the requirements of OSHA Part 1910. When an outage for the required work cannot be accomplished in this manner, the following requirements are mandatory:
  - 1. Electricians shall use full protective equipment 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. Electricians shall wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
  - 3. Before initiating work, a job specific work plan shall be developed by the Contractor with a peer review by the Resident Engineer and Medical Center staff. The work plan shall include procedures to be used on and near the live systems and equipment, barriers to be installed, safety equipment to be used and exit pathways.
  - 4. Work on energized systems or equipment cannot begin until prior written approval is obtained.

### **3.2 DEMOLITION AND MAINTAINING UTILITY SERVICES**

- A. During the execution of work, deactivation, relocation, rerouting, removal of existing equipment and systems shall be performed by the contractor as required by the job conditions to facilitate the installation of the new systems.
- B. Continuous operation of existing systems is required during demolition, tie-ins, relocation, rerouting and removal work. Outages required for construction purposes shall be scheduled in a manner that shall afford the shortest possible duration. Shutdowns shall be scheduled with the facility for specified mutually agreeable periods. After each period, the interruption shall cease and the service restored to normal operation and the process repeated until the work is completed. Due to the hospital schedules and access difficulties, some shutdowns and the performance of certain work shall be performed during prime time by the contractor.
- C. Maintain and restore all utilities servicing undisturbed regions which pass through the renovated areas. Contractor shall utilize deep scan metal detectors prior to coring/drilling holes in existing structure, and ground detecting core/drill equipment during operation to avoid damaging active existing systems buried in the existing structures.
- D. Devices that are not scheduled for deactivation and are loop fed from devices being removed shall be fed from the extended existing circuits unless otherwise specified. Where existing fixtures are removed from continuous lengths due to architectural modifications, the remaining fixtures shall be reconnected to the system with branch circuit wiring and switches as required

by the job conditions. Re-hang unsupported existing to remain appurtenances as required by the job conditions with suitable supports in compliance with applicable codes.

- E. Remove electrical appurtenances in affected areas. Remove all abandoned materials, equipment, components, articles, assemblies, appurtenances within the construction area including but not limited to ducts, pipes, utilities, hangers, suspension systems, fixtures, surface mounted device boxes, switches, receptacles, wires, conduits back to the termination point where they originate eg, panel, riser. When utility feeds other active devices, components shall be removed back to the nearest termination point. All removed components shall be terminated properly. Other existing items not compatible with the new construction shall be removed unless otherwise directed by the Project Engineer.
- F. Care shall be used during removal and installation to avoid damaging the surrounding surfaces. Damaged surfaces and items within the contract limits shall be patched, repaired, refinished, painted and/or replaced as necessary with materials to match the existing surrounding material and surface unless otherwise noted or directed by the Project Engineer. Where existing items are removed, ceiling/wall/floor areas shall be patched to match surrounding material and surface. Finished surfaces shall be indistinguishable from the surrounding area.
- G. Where device installation into existing walls is necessary the installation shall include all modifications required by the job conditions to recess the device.
- H. For further details refer to Section 02 41 00, DEMOLITION.

### 3.3 INSTALLATION

- A. In the event that criteria requirements conflict, the most stringent requirement shall be met.
- B. Coordinate location of equipment, components, materials and articles with other trades. Locate equipment, components, materials and articles clear of proper operation and service to other equipment, components, materials and articles eg, windows, doors, openings, lights, outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- C. Construction shall not block proper access to new/existing materials, equipment, components, articles, assemblies, appurtenances requiring operation, service and maintenance **whether detailed on the drawings or not**. Access must be conveniently placed as determined by the VA Project Engineer.
- D. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to original condition.
- E. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer shall be replaced.
  - 2. Protect all finished parts of equipment from rust prior to operation by means of protective coating and wrapping. Close openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemicals, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- F. Install devices with due regard for ease in reading or operating and maintaining said devices. Locate and position devices to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or work.
- G. Work in Existing Building:

1. Perform as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, Article, RESTORATION, alterations, relocation and restoration of existing systems and equipment.
  2. Arrange, phase and perform alterations to existing utility services to assure the least interference with normal operations of the facility.
- H. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- I. Electrical and Pneumatic Interconnection of Controls and Instruments: 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.
- J. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and communication switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.
- K. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- L. Minor Piping: Generally, small diameter pipe runs are not shown but must be provided.
- M. Install piping expansion joints as per manufacturer's recommendations.
- N. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- O. Cut required openings through existing masonry and reinforced concrete using diamond core rotary drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation. All openings must be patched.
- 3.4 TEMPORARY PIPING AND EQUIPMENT
- A. Continuity of operation of existing utilities shall generally require temporary installation or relocation of equipment and piping.
- B. Contractor shall provide all required utilities. 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.
- C. Temporary utilities shall be completely removed and any openings in structures sealed upon completion of permanent work. Provide necessary blind flanges and caps to seal open piping remaining in service.
- 3.5 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 shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to Resident Engineer for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

### **3.6 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. Only drill or burn holes in structural steel with the prior approval of the Resident Engineer.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 1/2-inch clearance between pipe or piping covering and adjacent work.
- D. Overhead Supports: 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.
- E. 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 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 2 inch excess on all edges. Foundations shall have horizontal dimensions that exceed base frame dimensions by at least 6 inches on all sides. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
  - 3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
  - 4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. Provide additional equipment and pipe supports/restraints as necessary to meet the requirements of PART 2. Re-hang unsupported existing fixtures and utility service lines above ceiling where affected by work with suitable support devices in compliance with applicable codes. All pipes, ducts, conduits, fixtures, equipment, utility and service lines are to be independently supported from the concrete slab not exceeding 8 foot intervals between supports. Light fixtures shall be supported to the building structure with two (2) safety chains in trapeze style at all four (4) corners.

**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. Equip all devices with required lubrication fittings or devices. Lubricate all devices requiring lubrication prior to initial operation. Field check all devices for proper lubrication.
- B. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

**3.9 INSPECTIONS, OPERATING AND PERFORMANCE TESTS**

- A. Schedule and perform all required inspections and tests for each system as required by the manufacturers and specified in the contract documents. Conduct inspections and tests required in various Sections of specifications in presence of an authorized representative of the Contracting Officer scheduled two (2) weeks in advance.
- B. Within one (1) week after completion of each phase of work in each applicable Section, submit to the Resident Engineer 4 copies of each inspection/testing report tabulating the results, analysis, recommendations documenting that all work performed including material/installation is in compliance with all the applicable manufacturers' requirements, codes and contract requirements. Inspections, tests or similar services shall be performed and certified by qualified electrical system specialists from an independent agency.
- C. Inspections and Tests shall be performed during a minimum of two (2) periods (rough and final). Performance shall include all new and existing to be reused components. Performance shall include running the equipment and controls as applicable through their complete operational cycles with all components installed and system balancing complete. Additional periods may be necessary due to project phasing and construction coordination. Inspection and Tests require documentation reports. The electrical system shall be considered ready for rough Inspections and Tests once the conduit system is complete and all the cables have been pulled.
- D. Test instruments, materials, labor to be supplied by the testing agency furnished by the Contractor.
- E. Verify that all installed and existing equipment, lighting, devices, components are clean and free of debris.
- F. Verify compliance of all material, workmanship and installation with approved Submittals, applicable Codes, and contract requirements. Verify nameplate data with drawings and specifications.
- G. Inspect all installed and reused equipment, lighting, devices and components for physical integrity, anchorage, alignment, grounding, required clearances & mechanical condition for proper operation within manufacturer's tolerances and applicable requirements.
- H. Obtain either equipment vendor approval or perform all test procedures recommended by manufacturers and demonstrate that all equipment and components meet the manufacturer's requirements and are installed properly, complete and ready for use for the purpose intended.
- I. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values. Document all inspections and tests with detailed results. Provide a startup and checkout report indicating the performance of the systems with documentation demonstrating that all requirements were successfully completed for each task.



- J. 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. All systems must be completely operational meeting the requirements of the contract documents without defective installation/materials at the time of beneficial occupancy. Contractor is responsible for all VA costs associated with the delinquent execution of this effort.
  - K. When completion of certain work or system occurs at a time when final settings and adjustments cannot be properly made to make performance tests due to seasonal conditions, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.
  - L. Make tests under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
  - M. Pre-test equipment and systems and make corrections required for proper operation of such systems before requesting final tests. Final test will not be conducted unless pre-tested.
  - N. Systems shall be balanced, controlled and coordinated. A system is defined as the entire complex that must be coordinated to work together during normal operation to produce results for which the system is designed. For example, air conditioning supply air is only one part of entire system that provides comfort conditions for a building. Other related components are return air, exhaust air, steam, chilled water, refrigerant, hot water, controls and electricity, etc. Another example of a complex that involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate and other related components.
  - O. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonably short period of time during which operating and environmental conditions remain reasonably constant.
  - P. Individual test result of any component, where required, will only be accepted when submitted with the test results of related components and of the entire system.
  - Q. Testing shall be performed with calibrated precision digital meters/instruments. Test instruments, materials, labor shall be supplied by a full member company of the International Electrical Testing Association utilizing an independent licensed electrician and a certified electrical technician furnished by the Contractor.
  - R. Inspections and Tests shall be performed in accordance with NETA "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" and as indicated in the contract documents (drawings and individual specification sections). Provide recommendations and corrective actions required.
  - S. Minimum Tests required:
    - 1. Refer to ATTACHMENT A "Electrical System Inspecting & Testing Checklist".
    - 2. Refer to ATTACHMENT C "NEC Compliance Checklist".
    - 3. Perform other tests and inspections as required in other parts of the contract documents.
    - 4. Upon completion, submit written certification with documentation to the Project Engineer demonstrating that the requirements were successfully completed for each task.
- 3.10 INSTRUCTIONS TO GOVERNMENT PERSONNEL
- A. Each applicable trade shall provide qualified, factory-trained representatives to furnish detailed instructions to Department of Veterans Affairs assigned personnel in the operation and complete maintenance for each system and piece of equipment. Instructions for different items of

equipment that are component parts of a complete system shall be given in an integrated, progressive manner. All instructors for every piece of component equipment in a system shall be available until instructions for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. The first 2 hour session shall be presented after submittal approval and equipment delivery, but before installation of any equipment. The second 2 hour session shall be accomplished two weeks prior to the final inspection. All instruction periods shall be at such times as scheduled by the Resident Engineer and shall be considered concluded only when the Resident Engineer is satisfied in regard to complete and thorough coverage of information.

- B. Instructional services of competent instructors shall be provided for a minimum of 4 hours of onsite training to designated Government employees covering the overall installation, operational methods, adjustments, care and periodic maintenance requirements for their systems.
- C. Each instructor shall be familiar with all parts of their respective system and shall be trained in operating theory as well as practical operation and maintenance practices. Factory trained instructors shall be employed wherever practical and available. The Department of Veterans affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the Resident Engineer, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.
- D. Utilize the maintenance manual for the system or equipment as a text for instruction. **Instruction shall include a full and extensive review of the maintenance and operation manual.** Failure to execute this task shall require additional training sessions when this information is made available.
- E. Unless otherwise required or approved, the instruction shall be given during the regular work week after the equipment has been accepted and turned over to the Government for regular operation. Where significant changes or modifications in equipment are made under the terms of the guarantee, additional instruction shall be provided as may be necessary to acquaint the operating personnel of the changes or modifications. When more than four man-days (32 hours) of instruction are specified in other sections, approximately half of the time shall be classroom instruction and the other half at the site of the system or equipment.
- F. Upon completion, submit written acknowledgment with documentation to the Project Engineer demonstrating that the required instructions were successfully completed for each discipline.

--- E N D ---

**SECTION 26 05 21**  
**LOW VOLTAGE ELECTRICAL CONDUCTORS & CABLES**  
**(600 VOLTS & BELOW)**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation, and connection of wiring for the following . . .

- A. Low voltage power and lighting
- B. Communication
- C. Control
- D. Signal

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.

**1.3 QUALITY ASSURANCE**

Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data: Showing each cable type and rating.
- B. Certificates: Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

**1.5 APPLICABLE PUBLICATIONS**

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. ANSI/EIA/TIA Publications:

568B ..... Commercial Building Telecommunications Wiring Standard

569B ..... Commercial Building Standard for Telecommunications  
Pathways and Spaces

- 606A .....Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- 607A .....Grounding and Bonding Requirements for Telecommunications in Commercial Buildings
- 758.....Grounding and Bonding Requirements for Telecommunications in Commercial Buildings
- B. American Society of Testing Material (ASTM):
  - D2301 .....Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- C. Federal Specifications (Fed. Spec.):
  - A-A-59544.....Cable and Wire, Electrical (Power, Fixed Installation)
  - J-C-30B.....Cable and Wire Electrical (Power, Fixed Installation)
  - HH-I-595C.....Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic
  - W-F-406E .....Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible
- D. National Fire Protection Association (NFPA):
  - 70.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  - 4.....Armored Cable
  - 44.....Thermoset-Insulated Wires and Cables
  - 83.....Thermoplastic-Insulated Wires
  - 467 .....Electrical Grounding and Bonding Equipment
  - 486A .....Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - 486C .....Splicing Wire Connectors
  - 486D .....Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
  - 486E .....Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
  - 493.....Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
  - 514B .....Fittings for Cables and Conduit
  - 1479.....Fire Tests of Through-Penetration Fire Stops
  - 1581.....Reference Standard for Electrical Wires, Cables, and Flexible Cords

## PART 2 – PRODUCTS

### 2.1 CABLE AND WIRE (POWER AND LIGHTING)

- A. Cable and Wire: Fed. Spec. A-A-59544, except as hereinafter specified.

B. Single Conductor:

1. Annealed copper.
2. Stranded for sizes No. 8 AWG and larger.
3. Solid for sizes No. 10 AWG and smaller unless otherwise indicated.
4. Minimum size No. 12 AWG, except where smaller sizes are allowed.

C. Insulation:

1. General wire: Dual rated THHN-THWN conforming to UL 83.
2. Direct burial: UF or USE in accordance with UL 493.
3. Isolated power wire: Type XHHW with a dielectric constant of 3.5 or less.

D. Color Code:

1. Feeder and Branch circuit conductors:

Secondary Service System —

<u>208/120 Volt</u>	<u>Phase</u>	<u>480/227 Volt</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray or White with colored tracer except other than Green

Isolated Power System —

Conductor 1	Orange
Conductor 2	Brown
Conductor 3	Yellow

2. The lighting circuit "switch legs" and 3-way switch "traveling wires" shall have color coding unique and distinct (i.e. pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate final color coding with the Resident Engineer.
3. Use solid color compound or solid color coating for No. 12 and No. 10 AWG branch circuit conductors and neutral sizes.
4. No. 8 AWG and larger Phase conductors using one of the following:
  - a. Solid color compound or solid color coating.
  - b. Stripes, bands, or hash marks of color specified above.
  - c. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points, and in junction boxes, pull boxes, and troughs. 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.
5. For modifications and additions to existing wiring shall conform to the existing wiring system unless otherwise specified.
6. For isolated power wiring in accordance with the NEC.

7. For Nurse Call wiring shall conform to the existing hospital wiring system.

## **2.2 ARMORED CABLE**

- A. HCF Type Armored Cable (AC): Fed. Spec. A-A-59544 and J-C-30B, NEC and UL 4, 83, 1479, 1581 for the assembly.
  1. Conductors color code shall comply with the appropriate section specified.
  2. Armor color code manufactured green for identification of cable type with additional color bands to identify circuit/phase conductor colors throughout its entire length. Comparable to either AFC's ColorSpec or Kaf-Tech's Color-Trak ID system (800- 757-6996) by Tyco.
- B. Where permitted by the NEC and UL, may only be used for whip/tap connections to suspended and recessed (requires approval) interior lighting fixtures with lengths limited to six (6) feet extending from a junction box to the fixture. Not permitted for normal, emergency or essential electrical system circuits.
- C. Assembly shall include an insulated green equipment grounding conductor, sized in accordance with the NEC in addition to an internal bonding strip of copper or aluminum in intimate contact with the armor for its entire length. Minimum size bonding strip shall be No. 16 AWG. The outer metal armor or sheath of the assembly shall be approved and identified as an acceptable grounding return path.
- D. Fittings:
  1. Shall meet the requirements of Fed. Spec. W-F-406E and UL 514B.
  2. Only steel or malleable iron material is acceptable.
  3. Clamp type with insulating throat.
- E. Supports:
  1. Parts and hardware: Zinc-coated or equivalent corrosion protection.
  2. Individual hangers: Straps, hangers or similar fittings shall be used and installed at intervals so as not to damage the cable. Staples are not permitted to be used for supports.

## **2.3 SPLICES AND JOINTS**

- A. In accordance with UL 486A, C, D, E and NEC.
- B. Branch circuits (No. 10 AWG and smaller):
  1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C. with integral insulation, approved for copper and aluminum conductors.
  2. The integral insulator shall have a skirt to completely cover the stripped wires.
  3. The number, size, and combination of conductors, as listed on the manufacturers packaging shall be strictly complied with.
- C. Feeder Circuits:
  1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material.
  2. Field installed compression connectors for cable sizes 250 MCM and larger shall have not less than two clamping elements or compression indents per wire.
  3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulate with not less than that of the conductor level that is being joined.

4. Plastic electrical insulating tape: Fed Spec. HH-I-595 shall apply, flame retardant, cold and weather resistant.

#### **2.4 COMMUNICATION WIRING (Telephone/Data)**

- A. Telephone/Data wiring shall be plenum rated enhanced Category 6 voice/data quality 4 pair 24 AWG unshielded twisted pair (UTP) cables as manufactured by Berk-Tek.
- B. Each 4 pair conductor shall be color coded ... Jack A – Yellow; Jack B – Blue; Jack C – White, Jack D – Green.

#### **2.5 CONTROL WIRING**

- A. Unless otherwise specified in other sections of these specifications, size control wiring as specified for power and lighting wiring, except the minimum size shall be not less than No. 14.
- B. Control wiring shall be sized large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

#### **2.6 FIRE ALARM, MEDICAL GAS ALARM AND SIGNAL WIRING**

- A. Shall conform to the recommendations of the manufacturers of the communication and signal systems, and VA Engineering requirements.
- B. Provide wiring as required for the systems and components being furnished to provide a completely operating system.
- C. Multi-conductor cables shall have the conductors color-coded.

#### **2.7 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.

#### **2.8 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 arcproof 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 7 mils thick and 3/4-inch wide.

### **PART 3 – EXECUTION**

#### **3.1 CABLE AND WIRE INSTALLATION**

- A. Install in accordance with NEC, and as required by the contract documents.
- B. Install all wiring in raceway systems, except where direct burial or HCF Type AC cables are used.
- C. Each circuit shall have its own individual neutral. Do not share neutral wires with other circuits.
- D. Splice cables and wires only in outlet boxes, junction boxes or pull boxes.

- E. Wires of different systems i.e. 120V, 277V shall not be installed in the same conduit or junction box system.
- F. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type that firmly clamps each individual cable and tightens due to cable weight.
- G. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.
- H. Seal cable and wire between the wire and conduit, where the cable exits the conduit, with a non-hardening approved compound.
- I. No more than three (3) single-phase branch circuits shall be installed in any one conduit.
- J. The wires shall be de-rated in accordance with NEC Article 310. Neutral wires, under conditions defined by the NEC, shall be considered current-carrying conductors.
- K. 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.
- L. Wire Pulling:
  - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
  - 2. Use ropes for pulling feeders made of nonmetallic material.
  - 3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Resident Engineer.
  - 4. Pull in together multiple cables in a single conduit.

### **3.2 ARMORED CABLE INSTALLATION**

- A. Installation: Where permitted by the NEC and UL, may only be used for whip/tap connections to suspended and recessed interior lighting fixtures with lengths limited to six (6) feet extending from a junction box to the fixture. Not permitted for normal, emergency or essential electrical system circuits.
- B. Install HCF Type AC cable as follows:
  - 1. Flattened, dented, deformed, or opened armor is not permitted. If damaged during installation, damaged cables shall be replaced with new undamaged material.
  - 2. Assure that cable installation does not encroach into the ceiling height head room, walkways, or doorways.
  - 3. Cut square with manufacturer's armor stripping tool and remove burrs.
  - 4. Remove enough armor from cable to permit sufficient conductor to extend into the enclosure.
  - 5. Cable shall be mechanically and electrically continuous.
  - 6. Secure cable to cabinets, junction boxes, and outlet boxes with fittings approved for grounding.
  - 7. Cables shall be run parallel or perpendicular to the building lines.
- C. Bends: Bends shall be made so that the cable is not damaged. The radius of the curve of the inner edge of any bend shall not be less than five times the diameter of the cable.
- D. Concealed Work: Cables installed above suspended ceilings shall be supported as specified.



- E. Exposed Work: Cables may be run exposed only in unfinished areas such as electrical closets or mechanical rooms and be supported as specified.
- F. HCF Type AC cable shall not be installed embedded in concrete.
- G. Cable Identification: Armor color code manufactured green for identification of cable type with additional color bands to identify circuit/phase conductor colors throughout its entire length.
- H. Cable Supports:
  - 1. The cable shall be secured by approved straps, hangers, or similar fittings designed and installed as to not damage the cable.
  - 2. Independently support the cable or install in cable trays. Do not use other supports i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.
  - 3. Support within one (1) foot of each outlet box, junction box, cabinet, or fitting.
  - 4. Through Metal Framing: Not permitted for this use.
  - 5. Fished Cables: Not permitted for this use.
- I. Penetrations:
  - 1. Cutting holes in concrete and masonry in new and existing structures not permitted for this use.
  - 2. Where HCF Type AC cable passes through fire partitions, fire walls or smoke partitions, install a fire stop that provides an effective barrier against the spread of fire, smoke and gasses as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between cables and openings with the fire stop material. Penetrations shall meet the requirements of UL 1479.

### **3.3 SPLICE INSTALLATION**

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices using approved methods at no additional cost to the Government.

### **3.4 COMMUNICATION WIRING (Telephone/Data)**

- A. Unless otherwise specified, install wiring and connect from each faceplate jack (4 jacks for each outlet box) to the communication closet patch panel for a complete operating system. Provide plenum rated enhanced Category 6 voice/data quality 4 pair 24 AWG unshielded twisted pair (UTP) cables, faceplates, jacks and patch panels. Each 4 pair conductor shall be color coded ... Jack A – Yellow; Jack B – Blue; Jack C – White, Jack D – Green. Provide blank covers for unused locations.
- B. Furnish and pull wire in all communication conduits/sleeves. Cabling shall be installed in conduit in wall spaces to corridors. Route cables to the appropriate telecommunications closet to that section of the building in either the corridor raceway system or supported using a facility approved method. Seal all penetrations through fire rated barriers.
- C. Cable installation precautions shall be observed, including the elimination of cable stress caused by cable tension. Cables should not be routed in tightly cinched bundles. Cable bending radius shall not be less than 1/4-inch or 2 times the cable diameter. Cables shall be neatly bundled and routed without strain, protected and supported per NEC requirements. All cabling in walls shall be in conduit with seven (7) cables maximum in 1 inch conduit. Pairs shall not be untwisted any more than 1/4-inch for termination at patch panel and wall jacks. Do not split pairs. Cable shall be neatly bundled on supports and on the 19 inch racks.

- D. Install a permanent wire marker on each cable at each of the termination point ends designating the Building – Floor – Jack number. Label the patch panel with the corresponding jack number. Provide labeling in accordance with ANSI/EIA/TIA 606-A. All lettering for voice and data circuits shall be stenciled using either laser printers or thermal ink transfer process. Handwritten labels are not acceptable. Wire markers shall retain their markings after cleaning.
    - 1. Cable and Wires: Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA 606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams".
    - 2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
    - 3. Conduit, Cable Duct, and/or Cable Tray: Label conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 10 feet. In addition, each enclosure shall be labeled according to this standard.
    - 4. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA 606-A and the "Record Wiring Diagrams".
    - 5. Provide the Project Engineer a list of the tagged cables with room numbers indicated.
  - E. Existing communication cables that are not being reused shall be tagged with the Building – Floor – Jack number then coiled and hung above the ceiling line in the corridor before removal. Provide the Project Engineer with a list of the tagged cables not being reused for assessment.
  - F. All telecommunications cables must be placed so as to avoid electrical interference caused by inductive loads such as fluorescent light ballast, electric motors, generators, etc.
  - G. All cables must be placed within 295 cable-feet of the patch panel in which the jack wiring terminates, per ANSI/EIA/TIA requirements.
  - H. Before acceptance of the work, test each system, station and wall jack to demonstrate compliance with the contract requirement. Each system shall be subjected to complete functional and operational tests including tests in place of each jack with a telecommunications wiring and equipment analyzer for testing of transmission quality. Tested parameters must equal or exceed acceptable criteria. Malfunctioning components shall be replaced and retested.
    - 1. Interim Inspection: Inspection shall verify cabling terminations in telecommunications rooms and at workstations adhere to color code for T568B – T568A pin assignments and cabling connections are in compliance with ANSI/EIA/TIA standards. Visually confirm Category 6 marking of outlets, faceplates, outlet/connectors and patch cords.
    - 2. Performance Testing: Perform Category 6 tests in accordance with ANSI/EIA/TIA 568-B.1 and ANSI/EIA/TIA 568-B.2. Test shall include wire map, length, impedance, attenuation, resistance, capacitance, insertion loss, return loss, propagation delay, delay skew, NEXT, PSNEXT, ELFEXT, PSELFEXT.
    - 3. Voice Testing: Connect to the network interface device at the demarcation point. Go off-hook and receive dial tone from the LEC. If a test number is available, place and receive a local, long distance, and FTS telephone call.
    - 4. Certification: Once any necessary corrections are made and testing has been completed, submit inspection/testing report tabulating the results for each cable with wire marker designation to the Project Engineer.
- 3.5 CONTROL, FIRE ALARM, MEDICAL GAS ALARM AND SIGNAL WIRING
- A. Unless otherwise specified in other sections of these specifications, install wiring and connect to perform the functions required for a completely operating system.

- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.
- C. Where power supply circuits are not shown for systems, connect them to the nearest panelboards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.
- D. Install a lockable 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.
- E. System voltages shall not exceed 120 volts and shall be lower voltages where shown on the drawings or required by the NEC.
- F. Install a permanent wire marker on each wire at each termination. Wire markers shall retain their markings after cleaning.
- G. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- H. In each manhole and handhole, install embossed brass tags to identify the system served and function.

### **3.6 DIRECT BURIAL CABLE INSTALLATION**

Not Applicable.

### **3.7 FEEDER IDENTIFICATION**

- A. In each interior, pullbox and junction box, install plastic tags on each circuit cables and wires to clearly designate their circuit identification and voltage.
- B. In manholes and handholes, provide tags of the embossed brass type, and also show the cable type and voltage rating. Attach the tags to the cables with slip free plastic cable lacing units.

### **3.8 FIELD INSPECTIONS AND TESTS**

- A. Inspections (visual/mechanical) and Tests shall be performed during a minimum of two periods (rough and final). Due to project phasing and construction coordination additional periods may be necessary. The electrical system shall be considered ready for the rough Inspections and Tests once the conduit system is complete and all the cables have been pulled. Inspection and Tests requires witness of the VA scheduled 2 weeks in advance, and documentation reports.
- B. Testing shall be performed with calibrated precision digital meters/instruments. Test instruments, materials, labor shall be supplied by an independent agency utilizing a qualified system specialist furnished by the Contractor.
- C. Verify compliance of all material, workmanship and installation with approved Submittals, Contract Documents, and applicable Codes. Verify nameplate data with drawings and specifications.
- D. Inspect all installed and reused devices and components for physical integrity, anchorage, alignment, grounding, required clearances & mechanical condition for proper operation within manufacturer's tolerances and applicable requirements.
- E. Verify circuit and voltage tag designation at each manhole, handhole, disconnect, pull and junction box.
- F. Verify sections of cables and connections in accordance with single-line diagrams.
- G. Verify cable size and quantity in accordance with NEC and contract requirements.
- H. Verify application of the cable color code and labeling requirements.
- I. Verify that no neutral wires are shared between circuits.

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- J. Inspect exposed sections of cables for damage.
- K. All feeders and branch circuits (new, modified, existing) shall be tested after installation. Perform testing and verify installation in accordance with NFPA 70/99. Testing shall include, but is not limited to:
  - 1. Verify uniform resistance of parallel conductors.
  - 2. Measure insulation-resistance ie, "megger" on each conductor before connection to devices eg, fixtures, appliances, solid-state components with respect to ground phase-to-ground and adjacent conductors phase-to-phase with an applied potential of 1,000 Volts DC for one (1) minute. Test all motors after installation but before start-up. All conductors shall test free from short-circuits & grounds and the megger value shall exceed 50 megaOhms. Test shall utilize a calibrated precision digital multivoltage multirange insulation tester ie, megger meter.
- L. Refer to PART 3 of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- M. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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

**SECTION 26 05 26**  
**GROUNDING & BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies general grounding and bonding requirements of electrical and telecommunication installations for personnel safety, equipment operations and to provide a low impedance path for possible ground fault currents.
- B. Terminology:
  - 1. The terms “connect” and “bond” is used interchangeably in this specification and has the same meaning.
  - 2. “Grounding electrode system” refers to all electrodes required by NEC, as well as including made, supplementary, lightning protection system and telecommunications system grounding electrodes.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.

**1.3 QUALITY ASSURANCE**

Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data as applicable.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included 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.
  - 3. Include details involving grounding for patient equipment and areas on plans.
- C. Test Reports: Provide certified test reports of ground impedance.
- D. Certifications: Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

## 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American Society for Testing and Materials (ASTM):
  - B1 ..... Standard Specification for Hard-Drawn Copper Wire
  - B8 ..... Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 81 ..... Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
  - 70 ..... National Electrical Code (NEC)
  - 99 ..... Health Care Facilities
- D. Telecommunications Industry Association (TIA):
  - J-STO-607-A ..... Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- E. Underwriters Laboratories, Inc. (UL):
  - 44 ..... Rubber-Insulated Wires and Cables
  - 83 ..... Thermoplastic-Insulated Wires and Cables
  - 467 ..... Grounding and Bonding Equipment
  - 486A ..... Wire Connectors and Soldering Lugs for Use with Copper Conductors

## PART 2 – PRODUCTS

### 2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 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 10 AWG and smaller shall be ASTM B1 solid bare copper wire.
- C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.
- D. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 1/0 AWG insulated stranded copper grounding conductor unless indicated otherwise.
- E. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

**2.2 GROUND RODS**

- A. Copper clad steel, 3/4-inch diameter by 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**

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

**2.4 TELECOMMUNICATION SYSTEM GROUND BUSBARS**

- A. Provide solid copper bus bar, pre-drilled from two-hole lug connections with a minimum thickness of 1/4-inch for wall and backboard mounting using standard insulators sized as follows:
  - 1. Room Signal Grounding: 12 inches by 4 inch.
  - 2. Master Signal Ground: 24 inches by 4 inch.

**2.5 GROUND CONNECTIONS**

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
  - 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
  - 2. Ground Bus Bars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
  - 3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.
- C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

**2.6 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 3/8-inch by 3/4-inch.

**2.7 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.

**2.8 SPLICE CASE GROUND ACCESSORIES**

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

**2.9 COMPUTER ROOM GROUND**

- A. Provide 1/0 AWG bare copper grounding conductors bolted at mesh intersections to form an equipotential grounding grid. The equipotential grounding grid shall form a 24 inch)mesh pattern. The grid shall be bonded to each of the access floor pedestals.

### **PART 3 – EXECUTION**

#### **3.1 GENERAL REQUIREMENTS**

- A. Ground in accordance with the NEC, and as required by the contract documents.
- B. System Grounding:
  - 1. Secondary service neutrals ground at the supply side of the secondary disconnecting means and at the related transformers.
  - 2. Ground the secondary neutral in separately derived systems.
  - 3. All circuits shall include a grounding/bonding conductor. Conduit shall not be used as the only grounding path.
  - 4. Isolation transformers and isolated power systems shall not be system grounded.
- C. Equipment Grounding: Metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Special Grounding: For patient care area electrical power system grounding, conform to NFPA 99, "Safe Use of Electricity in Patient Care Areas of Hospitals" and Article 517, "Health Care Facilities" of NFPA 70.
- E. Make grounding connections which are buried or otherwise normally inaccessible, except connections for which periodic testing access is required, by exothermic weld.

#### **3.2 INACCESSIBLE GROUNDING CONNECTIONS**

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

#### **3.3 SECONDARY EQUIPMENT AND CIRCUITS**

- A. Main Bonding Jumper: Connect the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode:
  - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Provide jumpers at insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
  - 2. Provide a supplemental ground electrode and bond to the grounding electrode system or connect to the service equipment ground bus.
- C. Service Disconnect: Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.
- D. Switchgear, Switchboards, and Unit Substations:
  - 1. Connect the various feeder green grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
  - 2. For service entrance equipment, connect the grounding electrode conductor to the ground bus.
  - 3. Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.
  - 4. Connect the neutral to the ground bus.



- E. Transformers:
  - 1. Exterior: Exterior transformers supplying interior service equipment shall also have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
  - 2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment. Size the grounding electrode conductor in accordance with NEC 250-66.
- F. Conduit Systems:
  - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
  - 2. Non metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
  - 3. Conduit containing only a grounding conductor which is provided for mechanical protection of the conductor shall be bonded to that conductor at the entrance and exit from the conduit.
- G. Feeders and Branch Circuits: Install green equipment grounding conductors as follows:
  - 1. All feeders and power/lighting branch circuits.
  - 2. Receptacle outlets.
  - 3. Motors and motor controllers.
  - 4. Fixed equipment and appliances.
  - 5. Items of equipment where the final connection is made with flexible metal conduit.
  - 6. Additional locations and systems as shown.
- H. Boxes, Cabinets, Enclosures, and Panelboards:
  - 1. Bond the grounding wires to each pullbox, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass.
  - 2. Provide lugs in each box and enclosure for ground wire termination.
  - 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- I. Motors and Starters:
  - 1. Provide lugs in motor terminal box and starter housing to terminate equipment grounding conductors.
  - 2. In motor control center compartments make ground wire connections to ground bus.
- J. Receptacles are not approved for grounding through their mounting screws. Ground with a green jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
- K. Ground lighting fixtures to the green equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. 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.

- L. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the green equipment grounding conductor.
- M. Raised Floors: Provide bonding of all raised floor components.
- N. Panelboard Bonding: The equipment grounding terminal buses of the normal and essential branch circuit panelboards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than 10 AWG. These conductors shall be installed in rigid metal conduit.

#### **3.4 CORROSION INHIBITORS**

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.

#### **3.5 CONDUCTIVE PIPING**

- A. Bond all conductive piping systems in the building to the electrical system ground. Bonding connections shall be made as close as practical to the water pipe ground or service equipment ground bus.
- B. In operating rooms, procedure rooms and intensive care beds, bond the medical gas and vacuum piping, at the outlets, directly to either the room or patient ground bus.

#### **3.6 LIGHTNING PROTECTION SYSTEM**

Bond the lightning protection system to the electrical system grounding electrode.

#### **3.7 TELECOMMUNICATIONS SYSTEM**

- A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.
- B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
- D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milliohms or less.
- E. Below-Grade Grounding 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 the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Resident Engineer prior to backfilling any ground connections.
- F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- G. Bonding Jumpers:
  - 1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 6 AWG insulated copper wire.
  - 2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.

3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.

H. Bonding Jumper Fasteners:

1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lock washers.
2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lock washers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
3. Ground Plates and Bus Bars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lock washers, and nuts.
4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lock washers.

3.8 COMMUNICATIONS CABLE GROUNDING

- A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
1. At terminal points install a cable shield bonding connector. Provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
  2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.9 COMMUNICATIONS SYSTEM CABLE TRAY

- A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout these cable tray systems as follows:
1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one splice plate connection in the presence of the Contractor.
  2. Install a 6 AWG bonding jumper across each cable tray splice or junction where splice plates cannot be used.
  3. When cable tray terminations to cable rack, install 6 AWG bonding jumper between cable tray and cable rack pan.

3.10 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 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.

2. Install insulated 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 6 AWG bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.
- B. Use insulated AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 45 feet.
- 3.11 COMMUNICATIONS RACEWAY GROUNDING
- A. Conduit: Use insulated 6 AWG bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
  - B. Wireway: Use insulated 6 AWG bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.
  - C. Cable Tray Systems: Use insulated 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates at each end and approximately every 48 feet.
- 3.12 GROUND RESISTANCE
- A. Services at power company interface points shall comply with the power company ground resistance requirements.
  - B. Below-grade connections shall be visually inspected by the Resident Engineer prior to backfilling. The Contractor shall notify the Resident Engineer 24 hours before the connections are ready for inspection.
- 3.13 GROUND ROD INSTALLATION
- As applicable to the type of construction being performed:
- A. Drive each rod vertically in the earth for not less than ten 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 grounding electrodes in horizontal trenches to achieve the specified resistance.
- 3.14 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS
- A. Inspections (visual/mechanical) and Tests shall be performed during a minimum of two periods (rough and final). Due to project phasing and construction coordination additional periods may be necessary. The electrical system shall be considered ready for the rough Inspections and Tests once the conduit system is complete and all the cables have been pulled. Inspection and Tests requires witness of the VA scheduled 2 weeks in advance, and documentation reports.
  - B. Testing shall be performed with calibrated precision digital meters/instruments. Test instruments, materials, labor shall be supplied by an independent agency utilizing a qualified system specialist furnished by the Contractor.
  - C. Verify compliance of all material, workmanship and installation with approved Submittals, Contract Documents, and applicable Codes. Verify nameplate data with drawings and specifications.
  - D. Inspect all installed and reused devices and components for physical integrity, anchorage, alignment, grounding, required clearances & mechanical condition for proper operation within manufacturer's tolerances and applicable requirements.
  - E. Perform applicable tests indicated in NETA ATS.

- F. Perform electrical system interground voltage test. Voltage shall not exceed 20 millivolts between receptacle ground reference point and the ground of each receptacle. Testing shall be performed with a precision digital volt meter capable of accurately reading in this range.
- G. Perform grounding system impedance test. Test resistance equal potential grounding, all devices on same circuit outlet to outlet and outlet to local ground. Test each receptacle with no loads plugged into other receptacles sharing the same equipment ground conductor. Impedance shall not exceed 0.10 ohms. Testing shall be performed with either a Woodhead Model 7040 G.L.I.T. or a Hampden Model MVO-60Hz-IT Impedance Tester.
- H. Perform ground system resistance test. Resistance shall not exceed 5 ohms between main ground electrode and ground, and 0.5 ohms point to point equipment frames, system neutrals, derived neutral points. Testing shall be performed with a Hampden Model MVO-1-PB Ground Integrity Tester.
- I. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE Standard 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less 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.
- J. Perform ground system leakage current test. Connect one probe to a ground reference point, touch the other probe to all exposed conducting surfaces that could be reached by patient/personnel. Demonstrate compliance with NFPA 70 (Art 250), NFPA 99 (Ch 3) and IEC 60601-1 (Table I). Testing shall be performed with an ammeter capable of accurate reading over 10 – 500 microAmps range with a biomedical grade 1,000 ohm test load (Neurodyne Dempsey 431 Safety Analyzer or Biotek Model 170 Safety Analyzer or Instrutek LR 200A).
- K. Refer to PART 3 of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- L. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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

**SECTION 26 05 33**  
**RACEWAY & BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section includes 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 except for the use of hospital grade MC cable whips limited in length to light fixtures.
- B. Terminology: Conduit, as used in this specification, shall mean any or all of the raceway types specified.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- B. Section 07 92 00, JOINT SEALANTS: Sealing around penetrations to prevent moisture and water migration.
- 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 common to more than one section of Division 26.
- E. Section 26 05 26, GROUNDING & 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 specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Manufacturer & Product Qualifications: Each product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly engaged in manufacturing items of the type specified. Additional or better features, not specifically prohibited by the specifications, but which are parts of the manufacturer's standard commercial product shall be included in the product.
- C. Source Limitations: Each product type shall be the same and the product of a single manufacturer.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data as applicable.
- B. Shop Drawings:
  - 1. Size and location of main feeders.

2. Size and location of conduit, panelboards, junction boxes, disconnects, fixtures and components.
3. Layout of required conduit penetrations through structural elements.
4. The specific item proposed and its area of application shall be marked on the catalog cuts.

- C. Certifications: Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

#### **1.5 APPLICABLE PUBLICATIONS**

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

A. Federal Specifications (Fed. Spec.):

- W-C-586C.....Conduit Outlet Boxes, Bodies and Entrance Caps, Electrical; Cast Metal
- W-F-406E .....Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible
- W-F-408D .....Fittings for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall (EMT) Type)
- W-J-800E.....Junction Box; Extension Junction Box; Cover Junction Box Steel, Cadmium or Zinc-coated
- FF-S-760A(2).....Strap, Retaining (Metal For Conduit, Pipe, And Cable)
- FFF-S-325 .....Shield, Expansion, Nail, Expansion and Nail, Drive
- INT AMD 3.....Screw (Devices, Anchoring, Masonry)
- WW-C-566C .....Conduit, Metal, Flexible

B. National Fire Protection Association (NFPA):

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

C. National Electrical Manufacturers Association (NEMA):

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

D. Underwriters Laboratories, Inc. (UL):

- 1 .....Flexible Metal Electrical Conduit
- 5.....Surface Metal Electrical Raceway and Fittings
- 6.....Rigid Metal Conduit
- 50.....Electrical Cabinets and Boxes
- 360.....Liquid-Tight Flexible Steel Conduit
- 467.....Electrical Grounding and Bonding Equipment
- 514A .....Metallic Outlet Boxes

514B .....	Fittings for Conduit and Outlet Boxes
514C .....	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
797 .....	Electrical Metallic Tubing
1242 .....	Intermediate Metal Conduit

## PART 2 – PRODUCTS

### 2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 3/4-inch unless otherwise shown. Where permitted by the NEC, 1/2-inch flexible conduit may be used for tap connections to recessed lighting fixtures only.
- B. Conduit:
  - 1. Rigid galvanized steel: Shall conform to UL 6 and ANSI C80.1.
  - 2. Rigid intermediate steel conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.
  - 3. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 inch. Permitted only with cable rated 600 volts or less.
  - 4. Flexible steel conduit (Hospital Grade – commercial Greenfield): Shall conform to UL 1 and Fed. Spec. WW-C-566C. Where permitted by the NEC and UL, may only be used for whip/tap connections to suspended and recessed (requires approval) interior lighting fixtures with lengths limited to six (6) feet extending from a junction box to the fixture.
  - 5. Liquid-tight flexible metal conduit: Shall conform to UL 360. Flexible galvanized steel tubing covered with extruded liquid-tight jacket of polyvinyl chloride (PVC). Provide conduit with a continuous copper bonding conductor wound spirally between the convolutions. Where permitted by the NEC and UL for use on all rotating equipment, motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission with lengths limited to six (6) feet.
  - 6. Surface metal raceway: Shall conform to UL 5.
- C. Conduit Fittings:
  - 1. Rigid galvanized steel and intermediate steel conduit (IMC) fittings:
    - a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
    - b. Standard threaded couplings, locknuts, bushings, and elbows conforming to UL 514B, Fed. Spec. WF 408 and only material of steel or malleable iron is acceptable. Integral retractable type IMC couplings are acceptable also.
    - 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 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 coverplates having the same finishes as that of other electrical plates in the room.
- 2. Electrical metallic tubing (EMT) fittings:
  - a. Fittings shall meet the requirements of UL 514B, ANSI/NEMA FB1.
  - b. Only material of steel or malleable iron is acceptable. Diecast or pressure cast zinc alloy fittings or fittings made of "pot metal" are prohibited.
  - c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats.  
  
For conduit sizes 2 inches and smaller: Use gland and ring compression type couplings and connectors.  
  
For conduit sizes over 2 inches: Use set screw type couplings with four (4) set screws each. 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.
- 3. Flexible steel conduit Hospital Grade – fittings:
  - a. Fittings shall meet the requirements of UL 514B, Fed. Spec. WF 406E.
  - b. Only material of steel or malleable iron is acceptable.
  - c. Clamp type, with insulated throat.
- 4. Liquid-tight flexible metal conduit fittings:
  - a. Fittings shall meet the requirements of UL 514B and ANSI/NEMA FB1.
  - b. Only material of steel or malleable iron is acceptable.
  - c. Fittings shall 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.
- 6. Expansion and deflection couplings:
  - a. UL 467 and UL 514B.
  - b. Accommodate 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 fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
  - d. Jacket: Flexible, corrosion resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
  - e. Watertight, seismically qualified, corrosion resistant, threaded for and compatible with rigid or intermediate metal conduit.
- D. Conduit Supports:
  - 1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
  - 2. Pipe Straps: Shall conform to Fed. Spec. FF-S-760, Type I, Style A or B.

3. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
  4. Multiple Conduit (trapeze) Hangers: Not less than 1-1/2 by 1-1/2 inch, 12 gage steel, cold formed, lipped channels; with not less than 3/8-inch diameter steel hanger rods.
  5. Solid Masonry and Concrete Anchors: Fed. Spec. FF-S-325; Group III self-drilling expansion shields, or machine bolt expansion anchors Group II, Type 2 or 4, or Group VIII.
- E. Outlet, Junction, and Pull Boxes:
1. Shall conform to UL 50, UL 514A, Fed Spec. W-C-586 and Fed. Spec. W-J-800.
  2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
  3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
  4. 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.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.
- G. Warning Tape: Standard, 4 mil thick polyethylene 3 inch wide tape detectable type, red with black letters, and imprinted with "CAUTION BURIED ELECTRIC LINE BELOW".

### PART 3 – EXECUTION

#### 3.1 PENETRATIONS

- A. Cutting or Holes:
1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Resident Engineer prior to drilling through structural sections.
  2. Cut holes through concrete and masonry in existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Resident Engineer as required by limited working space.
- B. Fire Stop: Where conduits, wireways, other electrical raceways and boxes 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 fire stop material. **Comply with NEC Article 300.21 in rated walls, floors, ceilings in such a manner that the installation does not contribute to the spread of fire or the products of combustion.**
- C. Waterproofing: At floor, and exterior wall conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

#### 3.2 GENERAL REQUIREMENTS

- A. Installation: In accordance with UL, NEC, manufacturer's recommendations, as shown on the drawings and as required by the contract documents. Boxes shall not be installed either above or behind other systems to assure accessibility as determined by the VA.

- B. Essential raceway systems: Install entirely independent of other raceway systems, except where specifically "accepted" by NEC Article 517. Essential raceway systems shall be two (2) hour rated eg, MI cable.
- C. 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 and electrically continuous.
  - 6. Independently support conduit at 8 feet on center. Do not use other supports i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.
  - 7. Support within one (1) foot of changes in direction, and within one (1) foot 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. 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.
  - 10. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.
- 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.
  - 2. Contractor shall determine the exact routing and location of systems prior to fabrication and installation.
- F. Deviations: Locations of conduit, boxes and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted to and have been approved by the Resident Engineer.
- G. Fire Alarm: 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 & ALARM.

### **3.3 CONCEALED WORK INSTALLATION**

- A. In Concrete:
  - 1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.

2. Align and run conduit in direct lines.
  3. Install conduit through concrete beams only when the following occurs:
    - a. Where shown on the structural drawings.
    - b. As approved by the Resident Engineer 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 3 inches 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 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. In Furred or Suspended Ceilings and Walls: All wiring and raceways shall be concealed above furred or suspended ceilings, and recessed in new and/or existing walls unless otherwise noted.
1. Conduit for conductors above 600 volts: Rigid steel.
  2. Conduit for conductors 600 volts and below: Rigid steel, IMC, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
  3. Align and run conduit parallel or perpendicular to the building lines.
  4. Tightening set screws with pliers is prohibited.
  5. Flexible metal conduit is not permitted for normal, emergency or essential electrical system circuits. Where permitted by the NEC and UL:
    - a. Flexible metal conduit may only be used for whip/tap connections to suspended and recessed (requires approval) interior lighting fixtures with lengths limited to six (6) feet extending from a junction box to the fixture.
    - b. Liquid-tight flexible metal conduit shall be used for whip/tap connections to all rotating equipment, motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission with lengths limited to six (6) feet extending from a junction box to the equipment.

### **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 above 600 volts: Rigid steel.
- C. Conduit for conductors 600 volts and below: Rigid steel, IMC, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.
- D. Liquid-tight flexible metal conduit shall be used for whip/tap connections to all rotating equipment, motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission with lengths limited to six (6) feet.
- E. Align and run conduit parallel or perpendicular to the building lines.
- F. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- G. Support horizontal or vertical runs at not over eight (8) foot intervals.

- H. Surface metal raceways: Use only where shown.
- I. Painting: Paint exposed conduit indicated on the drawings. Refer to Section 09 91 00, PAINTING, for preparation, paint type, and color.

### **3.5 DIRECT BURIAL INSTALLATION**

Not Applicable.

### **3.6 HAZARDOUS LOCATIONS**

- A. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.
- B. Install UL approved sealing fittings, that prevent passage of explosive vapors, in hazardous areas equipped with explosive proof lighting fixtures, switches, and receptacles, as required by the NEC.

### **3.7 WET OR DAMP LOCATIONS**

- A. Unless otherwise shown, use conduits of rigid steel or IMC.
- 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) or similar spaces.
- C. Unless otherwise shown, use rigid steel or IMC conduit within 5 feet of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall include an outer factory coating of 20 mil bonded PVC or field coat with asphalt before installation. After installation, completely coat damaged areas of coating.

### **3.8 MOTORS AND VIBRATING EQUIPMENT**

- A. Use liquid-tight 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, and locations subject to seepage or dripping of oil, grease or water. Provide a green ground wire with flexible metal conduit.

### **3.9 EXPANSION JOINTS**

- A. Conduits three (3) inch and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings.
- B. Conduits smaller than three (3) inch couplings, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. In lieu of expansion fittings and with the Resident Engineers approval, provide conduits smaller than three (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 five (5) inches vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed.
- C. Install expansion and deflection couplings where shown and required in accordance with the manufacturer's recommendations.
- D. Seismic Supports: Provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15 inches of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

**3.10 CONDUIT SUPPORTS**

- 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 eight (8) feet on center. Support within one (1) foot of changes in direction, and within one (1) foot of each enclosure to which connected.
- 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 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 1/4-inch bolt size and not less than 1-1/8 inch embedment.
    - b. Power set fasteners not less than 1/4-inch diameter with depth of penetration not less than three inches.
    - c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted. Bolts supported only by plaster are not acceptable.
- G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking. Bolts supported only by plaster or gypsum wallboard are prohibited.
- I. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- J. Spring steel type supports or fasteners are prohibited.
- K. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

**3.11 BOX INSTALLATION**

- A. Boxes for Concealed Conduits:
  - 1. Mount flush. Recess into existing structure where necessary.
  - 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 operations.
- C. Boxes shall be installed at conveniently accessible locations viewable in a direct line of site parallel and/or perpendicular to the building lines as determined by the Government. Where the Government determines that the Contractor has installed boxes not conveniently accessible for operation and maintenance, the boxes shall be removed and reinstalled as directed at no cost to the Government.

- D. 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.
- E. Outlet boxes in the same wall mounted back-to-back are prohibited. Gaps between outlet boxes and wall/ceiling material shall be less than 1/8-inch as measured from the edge of the outlet box.
- F. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.
- G. Stencil or install phenolic nameplates on box covers with panel and circuit designation.
- H. Paint boxes and covers to match color code of conduit service.

**3.12 COMMUNICATION CONDUIT (Telephone/Data)**

- A. Install the communication, conduit at each designated location in 1 inch EMT conduit from a recessed double duplex outlet box with duplex single gang trim piece to the corridor suspended ceiling area.
- B. Conduit runs shall contain no more than four-quarter turns and no junction/pull boxes.
- C. The communication system shall be provided with sleeves through each wall above the ceiling line to the communication closet.
- D. Conduit/Sleeve ends shall terminate with an insulated bushing and a fire seal plug. All conduit/sleeves shall be sealed after voice/data cables are installed with non-hardening fire resistant sealant to prevent the entrance of moisture, gases, and meet fire resistance requirements.
- E. Vertical conduits/sleeves through closet floors shall terminate not less than 3 inches below the floor, and not less than 3 inches below the ceiling of the floor below. Where coring/drilling is necessary for vertical conduits, locate holes so as not to impair structural section members such as ribs or beams.
- F. Each communication run shall be piped with EMT conduit not less than the sizes shown on the drawings. Minimum radius of voice/data conduit bends shall be as follows (special long radius):

<u>Conduit Size</u> (Inches)	<u>Conduit Bend Radius</u> (Inches)
1 minimum	6 minimum
1	9
1-1/4	14
1-1/2	17
2	21
2-1/2	25
3	31

- G. Furnish and pull wire in all communication conduits/sleeves. Cables from the communication closet to the point of termination outlet boxes shall be installed in either the corridor raceway system or supported using a facility approved method.
- H. Provide nylon pull cords in all empty conduit runs from the corridor to the point of termination outlet box. Provide blank covers for unused locations.
- I. Existing communication cables that are not being reused shall be tagged with the Building – Floor – Jack number then coiled and hung above the ceiling line in the corridor before removal. Provide the Project Engineer with a list of the tagged cables not being reused for assessment.

### 3.13 IDENTITY LABELING

- A. Identify systems, unless specified otherwise, on conduit and boxes, concealed, exposed, above removable ceilings, in accessible spaces, interstitial spaces, and behind access panels. Legends shall be placed to be clearly visible from all positions.
- B. Place a color coded 6 inch wide band 360° surround label every 4 feet on center of conduit run.
- C. Paint boxes and covers to match color code of conduit service. Stencil or install phenolic nameplates on box covers with panel and circuit designation.
- D. Conduit containing high voltage over 600 volts: Paint entire length Federal Safety Orange. In addition, conduits carrying high voltage require labels in compliance with OSHA requirements. Provide labels designating conductor voltage Class Rating (5000, 15000, or 25000 as applicable) and not exact voltage. Labels shall use 50 mm (2 inch) high black numbers and letters with yellow background and black border. Labels shall contain the words "Danger High Voltage Class 5000 or 15000 or 25000". Labels shall be placed at maximum 8 foot intervals, and where conduits pass through walls and floors.
- E. Refer to Section 09 91 00, PAINTING, for preparation and paint type.
- F. All conduits and boxes (new, modified, relocated, rewired) shall be labeled.
- G. Painting or using vinyl tape according to the following schedule:

<u>COLOR</u>	<u>APPLICATION</u>
Red	Fire Alarm
Orange	Emergency
Blue	Normal 480/277V
Brown	Normal 120/208V
Black	ECC System (under 120V)
Yellow	Medical Gas Alarms
White	Nurse Call System
Orange/Red	Life Safety
Orange/Blue	Critical
Orange/Brown	Equipment (Critical type)

### 3.14 FIELD INSPECTIONS AND TESTS

- A. Inspections and Tests shall be performed during a minimum of two periods. Due to project phasing and construction coordination additional periods may be necessary. The electrical system shall be considered ready for the rough Inspections and Tests once the conduit system is complete and all the cables have been pulled. Inspection and Tests requires witness of the VA scheduled 2 weeks in advance, and documentation reports.
- B. Testing shall be performed with calibrated precision digital meters/instruments. Test instruments, materials, labor shall be supplied by an independent agency utilizing a qualified system specialist furnished by the Contractor.
- C. Verify compliance of all material, workmanship and installation with approved Submittals, Contract Documents, and applicable Codes. Verify nameplate data with drawings and specifications.
- D. Inspect all installed and reused devices and components for physical integrity, anchorage, alignment, grounding, required clearances & mechanical condition for proper operation within manufacturer's tolerances and applicable requirements.



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- E. Verify size, quantity, location of conduits, boxes, disconnects in accordance with NEC.
- F. Verify the conduit and box supports in accordance with contract requirements.
- G. Verify pull, junction, disconnect box accessibility.
- H. Verify length and use of flexible conduit.
- I. Verify application of the conduit system color code and labeling requirements.
- J. Verify tightness of accessible bolted connections in accordance with published data.
- K. Verify tightness of compression-applied connectors in accordance with published data.
- L. Verify circuit and voltage tag designation on cables at each manhole, handhole, disconnect, pull and junction box.
- M. Refer to PART 3 of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- N. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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

**SECTION 26 09 23**  
**LIGHTING CONTROLS**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

**1.3 QUALITY ASSURANCE**

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

**1.4 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product Data: For each type of lighting control, submit the following information.
  - 1. Manufacturer's catalog data.
  - 2. Wiring schematic and connection diagram.
  - 3. Installation details.
- C. Manuals:
  - 1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
  - 2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Resident Engineer.
- D. Certifications:
  - 1. Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:
    - a. Certification by the Contractor that the equipment has 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. Green Seal (GS):
  - GC-12 ..... Occupancy Sensors
- C. Illuminating Engineering Society of North America (IESNA):
  - IESNA LM-48..... Guide for Calibration of Photoelectric Control Devices
- D. National Electrical Manufacturer's Association (NEMA)
  - C136.10 ..... American National Standard for Roadway Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing
  - ICS-1..... Standard for Industrial Control and Systems General Requirements
  - ICS-2..... Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
  - ICS-6..... Standard for Industrial Controls and Systems Enclosures
- E. Underwriters Laboratories, Inc. (UL):
  - 20..... Standard for General-Use Snap Switches
  - 773..... Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
  - 773A ..... Nonindustrial Photoelectric Switches for Lighting Control
  - 98..... Enclosed and Dead-Front Switches
  - 917..... Clock Operated Switches

## **PART 2 – PRODUCTS**

### **2.1 INDOOR OCCUPANCY SENSORS**

- A. Wall- or ceiling-mounting, solid-state units with a power supply and relay unit, suitable for the environmental conditions in which installed.
  - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a 1 to 15 minute adjustable time delay for turning lights off.
  - 2. Sensor Output: Contacts rated to operate the connected relay. Sensor shall be powered from the relay unit.
  - 3. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V, for 13A tungsten at 120V, and for 1 hp at 120V.
  - 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 2 to 200 fc [21.5 to 2152 lx]; 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 6-inch [150mm] minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. [232 sq. cm], and detect a person of average size and weight moving not less than 12 inches [305 mm] in either a horizontal or a vertical manner at an approximate speed of 12 inches/s [305 mm/s].
  3. Detection Coverage: as scheduled on drawings.

### **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 photocell switch according to manufacturer's recommendations. Set adjustable window slide for 1 footcandle photocell 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 //5// //10// //15// minutes.
- E. Locate light level sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the scheduled light level at the typical work plane for that area.
- F. Label time switches and contactors with a unique designation.

#### **3.2 ACCEPTANCE CHECKS AND TESTS**

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

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

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of wiring devices.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.
- B. Section 26 05 21, LOW VOLTAGE ELECTRICAL CONDUCTORS & CABLES (600 Volts & Below): Cables and wiring.
- C. Section 26 05 26, GROUNDING & BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and providing a low impedance path for possible ground fault currents.

**1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Manufacturer & Product Qualifications: Each product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly engaged in manufacturing items of the type specified. Additional or better features, not specifically prohibited by the specifications, but which are parts of the manufacturer's standard commercial product shall be included in the product.
- C. Source Limitations: Each product type shall be the same and the product of a single manufacturer.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data as applicable.
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.
- C. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS. Complete operating and maintenance manuals shall be provided including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver copies to the Resident Engineer not less than 4 weeks prior to final inspection.

- D. Certifications: Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

## 1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. Federal Specifications (Fed. Spec.):  
W-C-596 ..... Electric Power Connector, Plugs, Receptacles and Cable Outlets  
W-S-896 ..... Flush Mounted Toggle and Lock Switches
- B. National Fire Protection Association (NFPA):  
70 ..... National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):  
WD 1 ..... General Requirements for Wiring Devices  
WD 3 ..... A/C General-Use Snap Switches  
WD 5 ..... Specific-Purpose Wiring Devices  
WD 6 ..... Wiring Devices – Dimensional Requirements
- D. Underwriter's Laboratories, Inc. (UL):  
5 ..... Surface Metal Raceways and Fittings  
20 ..... General-Use Snap Switches  
231 ..... Power Outlets, Electrical  
467 ..... Grounding and Bonding Equipment  
498 ..... Attachment Plugs and Receptacles  
514 ..... Outlet Boxes and Fittings  
943 ..... Ground Fault Circuit Interrupters  
1010 ..... Receptacle - Plug Combinations, Electrical, For Use In Hazardous Locations  
1054 ..... Switches, Special Use

## PART 2 – PRODUCTS

### 2.1 RECEPTACLES

- A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., as hospital grade and conform to NEMA WD1.
1. Mounting straps shall be plated steel, with beak-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 (4 minimum) and side wiring from four captively held binding screws.

- B. Duplex receptacles shall be single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA 5-20R configuration in NEMA WD6. The duplex type shall have break-off feature for two circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
  - 1. Bodies shall be Ivory in color.
  - 2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The remaining receptacle shall be un-switched.
  - 3. Duplex receptacle on emergency circuits:
    - a. Bodies shall be red in color. Wall plates shall be red with the word "Emergency" engraved 1/4-inch white or black letters on cover.
    - b. In rooms without emergency powered general lighting, the emergency receptacles shall be of self-illuminating type.
  - 4. Duplex receptacles with ground fault interrupter: Shall be an integral unit suitable for mounting in a standard outlet box.
    - a. Ground fault interrupter, shall be hospital grade with indicator light and consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. It shall be rated for operation on a 60 Hz, 120 volt, 20 ampere branch circuit.
    - b. Device shall have nominal sensitivity to ground leakage current of 5 milliamperes and shall function to interrupt the current supply for any value of ground leakage current above 5 milliamperes on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second. Devices shall meet UL 943.
  - 5. Safety Type Duplex Receptacles: Not Applicable.
  - 6. Isolated Ground Type Duplex Receptacles:
    - a. Bodies shall be orange in color.
    - b. Shall be hospital grade and UL listed as "Isolated Ground".
- C. Receptacles 20, 30 and 50 Ampere, 250 Volt: Shall be complete with appropriate cord grip plug. Devices shall meet UL 231.
- 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.

## 2.2 SWITCHES AND DIMMERS

- A. Toggle switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable.
  - 1. 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.
  - 2. Switches installed in hazardous areas shall be explosion proof type in accordance with the NEC and as shown on the drawings.



3. Shall be color coded for current rating, listed by Underwriters Laboratories, Inc., and meeting the requirements of NEMA WD1, Heavy-Duty and UL 20.
  4. Ratings:
    - a. 120 volt circuits: 20 ampere at 125 volts AC.
    - b. 277 volt circuits: 20 ampere at 277 volts AC.
  5. Incorporate barriers between switches with multigang outlet boxes where required by the NEC.
  6. Light switches shall be mounted on the striker plate side of doors.
  7. Switches connected to isolated type electrical power system shall be double pole.
  8. All toggle switches shall be of the same manufacturer.
- B. Incandescent modular dimmers: Shall be encapsulated electronic type with bodies of phenolic compound. Toggle pads shall be ivory in color unless otherwise specified.
1. Incandescent dimming system shall be 2000 watt modular type, with capability for "slaving" larger loads from the "Master". System shall have capability of adding additional "Slaves", controlled from the original basic dimmer "Master". All units shall track with "Master". Control units shall be single-phase manual control or three-phase manual motorized control as shown on the drawings. Dimmers shall have low and intensity adjustment and built-in transient voltage protection and fused on the load side. All remote mounted units shall be completely enclosed in integral metal housing. "Master", "Slaves" and controls shall be of the same manufacturer.
    - a. Leviton MDI10-1 or equal with LED brightness level display incandescent rated for 1000 watts.
    - b. Lutron 11001-P micro-dim or equal with LED level display incandescent rated for 1000 watts with Lutron 10000-P or equal for multi-point control shall be utilized where applicable.
  2. Ratings: Shall be color coded for current rating, listed by Underwriters Laboratories, Inc., and meet the requirements of NEMA WD1.
    - a. 120 volt circuits: 20 ampere at 125 volts AC.
    - b. 277 volt circuits: 20 ampere at 277 volts AC.
  3. The switches shall be mounted on the striker plate side of doors.
  4. All dimming switches shall be of the same manufacturer.
- C. Fluorescent lamp dimmers: Shall be totally enclosed tumbler type with bodies of phenolic compound. Control knob shall be ivory in color unless otherwise specified.
1. Switches shall be specification grade and shall be capable of raising and lowering the lighting from completely off at extreme counter-clockwise rotation, to full intensity. Switches shall include an "OFF" position.
    - a. Leviton IP710-DLZ or equal with LED display electronic low-voltage rated for 1200 VA.
  2. Switches shall have low end intensity adjustment and maintain full load rating even when two or more units are installed adjacent to one another. Dimming ballast shall be provided for each F32 rapid start lamp or pair of lamps.
  3. Switches shall have adequate capacity for the load served and the environment in which installed, shall be color coded for current rating, listed by Underwriters Laboratories, Inc., and meet the requirements of NEMA WD1.

4. All switches shall be of the same manufacturer.
5. All dimmers shall be of the same manufacturer.

### 2.3 OCCUPANT SENSOR CONTROL FOR INDOOR LIGHTING SYSTEMS

- A. General: An active or passive sensor shall be utilized to control the "On/Off" actuation of fluorescent or incandescent lighting loads. It shall provide control of an isolated set of contacts on exposure to a perceived change in environmental conditions indicating the presence or absence of one or more persons. It shall maintain the contacts closed in the presence of continued changes at similar intensity and rate. It shall open the contacts at a nominal time after the changes cease.
- B. Passive Sensor System: Sensor(s) shall react to changes of radiated infrared energy, indicating the activity of one or more human bodies in the area covered:
  1. Range of detection: The sensor(s) shall provide effective coverage of a room, sensing the presence of one or more people in the room in order to turn the lights on. The ceiling mounted sensor's area of coverage shall be approximately a 14 feet diameter circle at 6 feet away. Provide sufficient units to give full coverage as measured 30 inches above the floor. A field of view adjustment feature shall be provided to allow orientation to various room operating conditions.
  2. Sensor placement: Locate the sensor(s) in accordance with the manufacturer's recommendations to maximize energy savings by avoiding nuisance activation due to sudden temperature or air flow changes. Locate the units within 6 feet horizontally of work stations or major points of activity, including the center of room entrance doors.
- C. Active Sensor System: Sensor(s) shall react to reflective changes to generated ultrasonic radiation, indicating the activity of one or more persons in the area covered.
  1. Range of detection: On ceilings below twelve feet in height, a single direction sensor shall cover approximately 30 feet by 30 feet area; a two directional unit a 60 feet by 30 feet area; and a two way corridor unit a total distance of 90 feet. The sensors shall be equipped with a concealed but accessible sensitivity control to tune the unit to specific room conditions.
  2. Sensor placement: Locate the sensors in accordance with the manufacturer's recommendations to maximize energy savings by avoiding nuisance activation due to predictable non human motion activities. Give particular attention to work station or major areas of activity and the coverage of room entrance doors.
- D. Timing/Function: Shall not be user adjustable. Lighting shall remain on with one or more persons within the covered area. The system shall be factory set to maintain lights on for a minimum of 8 minutes and not longer than 12 minutes after the area of coverage is vacated. For testing purposes, there shall be a means to change the pre-set time delay to 30 seconds or less.
- E. Control Unit: The system shall have a switching relay(s) capable of switching the fluorescent or incandescent loads as required. Contacts shall be rated at a minimum of 15 Amps at voltages to 277, with expected cycles of operation in excess of 100K. Power derived from a current limiting 24 volt transformer shall power the system and the unit must be packaged for installation on a standard 4 inch by 4 inch NEMA box enclosure. The unit shall be wired through a conventional wall switch to provide an over ride system "Off" and active "Off On" functioning.
- F. Field Wiring: The wiring between the control unit and sensor(s) shall be an insulated multi-conductor, Number 22 gauge Poly Vinyl Chloride (PVC) jacketed cable.

## 2.4 WALL PLATES

- A. Wall plates for switches and receptacles shall be mid-size high impact self-extinguishing smooth nylon thermoplastic. Oversize plates will not be acceptable.
- B. Normal power plates shall be ivory. Emergency power plates shall be red. Emergency plates shall also be engraved with "EMERGENCY" in addition to the panel and circuit number.
- C. Standard NEMA design so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD1.
- D. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- E. All receptacle and light switch cover plates shall have the electrical panel number and circuit number engraved in block utilizing the hospital numbering system. New cover plates on existing devices shall match the new work being performed.

## 2.5 SURFACE MULTIPLE-OUTLET ASSEMBLIES

- A. Assemblies shall conform to the requirements of NFPA 70 and UL 5.
- B. Shall have the following features:
  - 1. Enclosures:
    - a. Thickness of steel shall be not less than 0.040 inch steel for base and cover. Nominal dimension shall be 1-1/2 by 2-3/4 inches with inside cross sectional area not less than 3.5 square inches. The enclosures shall be thoroughly cleaned, phosphatized and painted at the factory with primer and the manufacturer's standard baked enamel or lacquer 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, spacing of the receptacles along the strip shall be 6 inches on centers.
  - 4. Wires within the assemblies shall be not less than No. 12 AWG copper, with 600 volt ratings.
  - 5. Installation fittings shall be designed for the strips being installed including bends, offsets, device brackets, inside couplings, wire clips, and elbows.
  - 6. Bond the strips to the conduit systems for their branch supply circuits.

## 2.6 COMMUNICATION DEVICES (Telephone/Data)

- A. The 4-port single gang Ortronics faceplate standard shall be used at each designated location. Provide blank covers for unused locations.
- B. Voice/Data 4-port single gang ivory faceplates manufactured by Ortronics with Model Clarity Category 6 TracJack T568A/B workstation modules using matching color-coded voice/data icons ... Jack A – Yellow; Jack B – Blue; Jack C – White, Jack D – Green.
- C. Patch panels manufactured by Ortronics Model Clarity Category 6 supporting T568A/B wiring schemes with 8-port groupings using matching color-coded voice/data icons ... Jack A – Yellow; Jack B – Blue; Jack C – White, Jack D – Green. Patch panel quantity/capacity/size shall be suitable for the system being installed and compatible with the facility communication racks ... CPI Chatsworth Products – 73 inch length, 15 inch depth, 95 inch height with horizontal tray.

## **2.7 CARD ACCESS**

- A. Card Access system shall interface with and match the existing in the facility. Program each device into the facility system. Card Access system installation shall be performed in accordance with the requirements of the facility service company of record.
- B. Card Access system shall consist of a card reader mounted next to the door it serves, door contact to monitor the door position and an electrically operated mortise lockset Best Lockset Model 45HW7DEU15J626RH-RQE with an 8 wire transfer hinge – Stanley Part #CEFBB179-58. Wiring and conduit shall be installed from the door frame for connection of the card reader, door contact and lockset to an M – 8 interface panel provided by the Contractor and mounted on a 3/4-inch fire rated plywood panel. Location of the interface panel which interconnects with the facility master system shall be approved by the Project Engineer. Contractor is responsible for all wiring, conduit, devices, labeling and programming for a fully functional system. Contractor shall utilize the facility service company of record as a subcontractor to provide a complete and fully functional system.
- C. Verify with the facility service company of record for the extent of work required to connect into the system. JP – Barry Security Sys (Red Hawk) (1-800-273-1423) of Lawrence, MA

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, and as required by the contract documents.
- B. Each circuit shall have its own neutral. Do not combine neutral wires with other circuits.
- C. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and connected to the green equipment grounding conductor.
- D. Light switches shall be mounted on the striker plate side of door/room openings and shall be horizontally placed within 18 inches of the opening.
- E. All switch and receptacle plates within the construction boundary shall be engraved with the circuit and panel number feeding the device utilizing the hospital nomenclature. Contractor shall verify existing quantities and type of device plates required to be replaced. Contractor shall trace all circuits (including existing) to verify proper labeling and load distribution.
- F. Install communication system faceplates and jacks at each designated location. Install patch panels in the communication closet. Connect devices to the communication cable system. Install a permanent label on each faceplate designating the Building – Floor – Jack number. Label the patch panel with the corresponding jack number. Provide the Project Engineer a list of the labeled faceplates with room numbers indicated.
- G. At the final inspection, a factory certified representative of the Duress, Code Blue/Green, Card Access systems shall perform the tests specified herein under Article, FIELD QUALITY ASSURANCE. The representative shall demonstrate that the system functions properly in every respect in the presence of a qualified VA representative.

### **3.2 FIELD QUALITY ASSURANCE**

- A. Acceptance Testing: Contractor shall notify the Resident Engineer in writing seven (7) days after the pretest has been completed and 30 days prior to the date acceptance testing is expected to begin. The system shall be tested in the presence of the Resident Engineer. Contractor shall verify that the total system meets all of the requirements of the specification and complies with all appropriate standards.

- B. Communication Device systems shall interface with the facility existing systems where applicable. Communication Device system installation shall be performed in accordance with the requirements of the facility. Contractor shall provide all labeling, termination, testing at both ends of the cables. Final connections and programming of the Communication Devices to the facility system shall be performed by the facility.
- C. Card Access system shall interface with the facility existing system. Card Access system installation shall be performed in accordance with the requirements of the facility service company of record. Final connections and programming of the Card Access components shall be performed by the facility service company of record
  - 1. Verify with the facility service company of record for the extent of work required to connect into the system.
  - 2. Card Access at JP is located in the Bldg 1 first floor security/police office – Vendor: Barry Security Sys (Red Hawk) of Lawrence, MA.

### **3.3 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS**

- A. Inspections (visual/mechanical) and Tests shall be performed during a minimum of two periods (rough and final). Due to project phasing and construction coordination additional periods may be necessary. The electrical system shall be considered ready for the rough Inspections and Tests once the conduit system is complete and all the cables have been pulled. Inspection and Tests requires witness of the VA scheduled 2 weeks in advance, and documentation reports.
- B. Testing shall be performed with calibrated precision digital meters/instruments. Test instruments, materials, labor shall be supplied by an independent agency utilizing a qualified system specialist furnished by the Contractor.
- C. Verify compliance of all material, workmanship and installation with approved Submittals, Contract Documents, and applicable Codes. Verify nameplate data with drawings and specifications.
- D. Inspect all installed and reused devices and components for physical integrity, anchorage, alignment, grounding, required clearances & mechanical condition for proper operation within manufacturer's tolerances and applicable requirements.
- E. Verify tightness of accessible bolted connections with published data.
- F. Verify application of the device and cover plate color code and labeling requirements.
- G. Verify circuit continuity, hot/neutral polarity, operating voltage, voltage/current ratings.
- H. Verify that all wiring is connected properly, clear of ground faults, shorts, open circuit defects.
- I. Verify blade & ground retention forces of each receptacle are not less than 20 oz. & 10 oz. respectively.
- J. Verify that fuse sizes & types are in accordance with the drawings, short-circuit studies, and coordination study.
- K. Verify voltage difference between the neutral conductor and the equipment ground (ground contacts of the receptacle) is 4.5 volts (3 volts feeder and 1.5 volts branch circuit).
- L. Refer to PART 3 of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- M. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

### **3.4 INSTRUCTIONS TO GOVERNMENT PERSONNEL**

- A. Refer to PART 3 of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

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- B. Furnish the services of a competent instructor for not less than four 2-hour periods for instructing personnel in the operation and maintenance of the system, on the dates requested by the Resident Engineer.
- C. Furnish the services of a representative of the Duress, Code Blue/Green and Card Access systems familiar with the functions and operation of the equipment to train staff personnel where devices are provided. Instruction shall include corrective and preventive maintenance of the equipment. **Training shall be accomplished before VA can accept the devices.**

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

ATTACHMENTS FOLLOW

ATTACHMENT A: Electrical Cover Plates – Engraved Labeling Sample ... 1 Page

**SECTION 26 29 11**  
**LOW VOLTAGE MOTOR STARTERS**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of motor starters and motor control stations (whether furnished with the equipment specified in other sections or otherwise).

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.
- B. Section 26 05 26, GROUNDING & BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

**1.3 QUALITY ASSURANCE**

Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.
- B. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
  - 1. Complete operating and maintenance manuals shall be provided including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver copies to the Resident Engineer not less than 4 weeks prior to final inspection.
  - 2. Wiring diagrams shall have their terminals identified to facilitate installation, operation, and maintenance.
  - 3. Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
  - 4. Elementary schematic diagrams shall be provided for clarity of operation.
- C. Certifications: Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including

records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

1. Certification by the manufacturer that the controllers have passed the factory 24 hour operational tests. (NB: This certification must be furnished to the Resident Engineer prior to shipping the controller to the job site.)
2. Certification by the manufacturer that high voltage motor controller(s) conforms to the requirements of the drawings and specifications.
3. Certification that the equipment has been properly installed, adjusted, and tested.

#### **1.5 APPLICABLE PUBLICATIONS**

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. American National Standards Institute, Inc. (ANSI):  
C37.90.1 ..... Guide for Surge Withstand Capability
- B. Institute of Electrical and Electronic Engineers (IEEE):  
519..... Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems  
C37.90.1 ..... Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
- C. National Electrical Manufacturers Association (NEMA):  
ICS-1..... General Standards for Industrial Control and Systems  
ICS-1.1..... Safety Guidelines for the Application, Installation and Maintenance of Solid State Control  
ICS-2..... Industrial Control Devices, Controllers and Assemblies  
ICS-6..... Enclosures for Industrial Control and Systems  
ICS 7 ..... Industrial Control and Systems Adjustable-Speed Drives  
ICS 7.1..... Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems
- D. National Fire Protection Association (NFPA):  
70..... National Electrical Code (NEC)
- E. Underwriters' Laboratories, Inc. (UL):  
508..... Electric Industrial Control Equipment

## **PART 2 – PRODUCTS**

### **2.1 GENERAL**

- A. Motor starters shall be in accordance with the requirements of the IEEE, NEC, NEMA (ICS 1, ICS 1.1, ICS 2, ICS 6, ICS 7 and ICS 7.1) and UL.



- B. Shall have the following features:
1. Separately enclosed unless part of another assembly.
  2. Circuit breakers and safety switches within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
  3. Motor control circuits:
    - a. Shall operate at not more than 120 volts.
    - b. Shall be grounded except as follows:
      - 1) Where isolated control circuits as shown.
      - 2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.
    - c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.
    - d. Incorporate phase loss protection for each starter with contacts to de-energize the starter upon loss of any phase.
    - e. Incorporate overcurrent protection for control power transformers in accordance with the NEC.
    - f. See paragraph, MOTOR CONTROL STATIONS, in this section.
  4. Overload current protective devices:
    - a. Thermal or induction type.
    - b. One for each pole.
    - c. Manual reset on the door of each motor controller enclosure.
    - d. Correctly sized for the associated motor's rated full load current.
    - e. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
    - f. Deliver four copies of a summarized list to the Resident Engineer which indicates and adequately identifies every motor controller installed; include the catalog numbers for the correct sizes of protective devices for the motor controllers.
  5. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular starter.
  6. Incorporate into each control circuit a 120-volt, solid state 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 also not required.
  7. Auxiliary contacts, pilot lights, pushbuttons and other devices and accessories as shown on the drawings or otherwise required.
  8. Enclosures:
    - a. Shall be the NEMA types shown on the drawings for the motor controllers.
    - b. Where the types of motor controller enclosures are not indicated, they shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.
    - c. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open.

- d. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- C. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.
- D. For motor controllers being installed in existing motor control centers or panelboards, coordinate with the existing centers or panelboards.
- E. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.
- F. Provide a disconnect safety switch nearby and within sight of each motor.

## 2.2 MANUAL MOTOR STARTERS

- A. Shall be in accordance with applicable requirements of Par 2.1 above.
- B. Manual motor starters.
  - 1. Starters shall be AC, general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
  - 2. Units shall include overload and low voltage protection, red pilot light, NO – NC – auxiliary contact and toggle operator.
- C. Fractional horsepower manual motor starters.
  - 1. Starters shall be AC, general-purpose Class A, manually operated with full voltage controller for fractional horsepower induction motors.
  - 2. Units shall include thermal overload protection, red pilot light and toggle operator.
- D. Motor starting switches.
  - 1. Switches shall be AC, general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
  - 2. Units shall include thermal overload and low voltage protection, red pilot light, NO – NC – auxiliary contact and toggle operator.

## 2.3 SOLID STATE MOTOR STARTERS

- A. Shall be in accordance with applicable requirements of Par 2.1 above.
- B. Drive shall be rated at a minimum of 22kAIC.
- C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.
- D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.
- E. Solid-State Overload Relay:
  - 1. Provide a solid-state overload relay for protection of the motors. The relay shall be Cutler-Hammer type CEP7 or approved equal.
  - 2. The overload relay shall provide high accuracy through the use of state-of-the-art microelectronic packaging technology. The relay shall be suitable for application with NEMA Size 1 through Size 7 motor starters.
  - 3. The overload relay shall be modular in design, be an integral part of a family of relays to provide a choice of levels of protection, be designed to directly replace existing electromechanical overload relays, and be listed under UL Standard 508.
  - 4. The overload relay shall have the following properties:

- a. Self powered.
- b. Class 10 or 20 fixed tripping characteristics.
- c. Manual or automatic reset.
- d. Phase loss protection. The relay shall trip in 2 seconds or less under phase loss condition when applied to fully loaded motor.
- e. Visible trip indication.
- f. One NO and one NC isolated auxiliary contact.
- g. Test button that operates the normally closed contact.
- h. Test trip function that trips both the NO and NC contacts.
- i. A current adjustment range of 3.2:1 or greater.
- j. Ambient temperature compensated.
- k. Ground fault protection. Relay shall trip at 50% of full load ampere setting.
- l. Jam/Stall protection. Relay shall trip at 400% of full load ampere setting, after inrush.

#### 2.4 MAGNETIC MOTOR STARTERS

- A. Shall be in accordance with applicable requirements of Par 2.1 above.
- B. Starters shall be AC, general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum size 0.
- C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.
- D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

#### 2.5 VARIABLE SPEED MOTOR CONTROLLERS

- A. Shall be in accordance with applicable portions of Par 2.1 above.
- B. Shall be solid state, micro processor-based with adjustable frequency and voltage, three phase output capable of driving standard NEMA B design, three phase alternating current induction motors at full rated speed. The drives shall utilize a full wave bridge design incorporating diode rectifier circuitry with pulse width modulation (PWM). Other control techniques are not acceptable. Silicon controlled rectifiers (SCR) shall not be used in the rectifying circuitry. The drives shall be designed to be used on 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.
- C. Shall be rated for input power of 460 volts, three phase, 60 Hz. Unit shall be capable of operating within voltage parameters of plus 10 to minus 10 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- D. Each controller shall be factory tested at maximum watts (HP), rated full load current and at an ambient temperature of 40 degrees C for a period of not less than 24 hours. If a component fails, it shall be replaced and the test restarted for the full time period. A certified copy of the factory Test Report shall be furnished to the VA COTR prior to shipping the controller to the job site.
- E. Controllers shall have the following features:
  - 1. Isolated power for control circuits.
  - 2. Manually re-settable motor overload protection for each phase.

3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 30 seconds. Set timers to the equipment manufacturer's recommended time in the above range.
5. Provide 4 to 20 ma current follower circuitry for interface with mechanical sensor devices.
6. Automatic frequency adjustment from 20 Hz to 60 Hz including adjustable carrier frequency.
7. Provide circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The controller shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected:
  - a. Incorrect phase sequence.
  - b. Single phasing.
  - c. Over voltage in excess of 10 percent.
  - d. Under voltage in excess of 10 percent.
  - e. Running over current above 110 percent shall not automatically reset for this condition.
  - f. Instantaneous overcurrent above 150 percent shall not automatically reset for this condition.
  - g. Surge voltage in excess of 1000 volts.
  - h. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations).
8. Provide factory installed keypad for programming the drive.
9. Provide factory installed, plug-in LONworks serial communication card.
- F. Minimum efficiency shall be 95 percent at 100 percent speed and 85percent at 50 percent speed.
- G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.
- H. Controllers shall include a door interlocked circuit breaker switch which will disconnect all input power.
- I. Include a by pass starter with circuitry to protect and isolate the variable speed controller. When the variable speed controller is in the by pass mode, the solid state components shall be isolated from the power supply on both the line and motor side.
- J. The following accessories are to be door mounted:
  1. AC Power on light.
  2. Ammeter (RMS motor current).
  3. HAND OFF AUTOMATIC switch.
  4. Manual speed control in HAND mode.
  5. System protection lights indicating that the system has shutdown and will not automatically restart.
  6. System protection light indicating that the system has shutdown but will restart when conditions return to normal.

7. Manual variable speed controller by pass switch.
8. Diagnostic shutdown indicator lights for each shutdown condition.
9. Provide two N.O. and two N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
  - a. System shutdown with auto restart.
  - b. System shutdown without auto restart.
  - c. System running.
10. Incorporate into each control circuit a 120 volt, time delay relay (ON delay), adjustable from 0.3 10 minutes, with transient protection. Provide transformer/s for the control circuit/s.
11. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall transients from other devices on the AC power distribution system affect the controller. Controllers shall be protected to comply with IEEE C37.90.1 and UL 508. Line noise and harmonic voltage distortion shall not exceed the values allowed by IEEE 519. Include Harmonic filter within the enclosure of the VFD.

## 2.6 MOTOR CONTROL STATIONS

### A. Shall have the following features:

1. Designed for suitably fulfilling the specific control functions for which each station is being installed.
2. Coordinate the use of momentary contacts and maintained contacts with the complete motor control systems to insure safety for people and equipment.
3. Each station shall have two pilot lights behind red and green jewels and a circuit to its motor controller. Connect the lamps so they will be energized as follows:
  - a. Red while the motor is running.
  - b. Green while the motor is stopped.
4. Where two or more stations are mounted adjacent to each other, install a common wall plate, except where the designs of the stations make such common plates impracticable.
5. Identify each station with a permanently attached individual nameplate: Normal power shall be laminated black phenolic resin with a white core and engraved lettering not less than 6 mm (1/4 inch) high. Emergency power shall be laminated red phenolic resin with a white core and engraved lettering not less than 6 mm (1/4 inch) high. Identify the motor by its number or other designation and indicate the function fulfilled by the motor.

### B. Components of Motor Control Circuits:

1. Shall also be designed and arranged so that accidental faulting or grounding of the control conductors will not be able to start the motors.
2. Use of locking type STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, will not be permitted.

## 2.7 PROVIDE INTERNALLY INTEGRATED SURGE PROTECTIVE DEVICES FOR EACH CONTROLLER

- ### A.
- SPD (Surge Protective Devices) shall be Component Recognized and listed in accordance with UL 1449 Second Edition to include Section 37.3 highest fault category testing on devices intended for service entrance use. SPD shall also be UL 1283 listed.

- B. SPD shall be UL 67 listed, installed by and shipped from the electrical distribution equipment manufacturer's factory.
- C. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, in WYE systems, and L-L, L-G in DELTA systems.
- D. SPD shall be modular in design. Each mode shall be fused with a 200kAIC; UL recognized surge rated fuse and incorporate a thermal cutout device.
- E. SPD shall be integrally mounted to the bus bars of the switchboard.
- F. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided as well.
- G. SPD shall meet or exceed the following criteria:
  - 1. Maximum surge current capability (single pulse rated) per phase shall be:
    - a. Service Entrance Switchboard 250 kA
    - b. Distribution Panelboards 160 kA
    - c. Branch Panelboards 160 kA
    - d. Service Entrance MCC 240 kA specified
    - e. Distribution Class MCC 160 kA
  - 2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings (SVR's) for Service Entrance and Distribution Location equipment shall not exceed the following Voltage Let-Thru values for Solidly Grounded Systems:
    - a. 208Y/120 Voltage: TBD.
    - b. 480Y/277 Voltage: TBD.
- H. SPD shall have a minimum EMI/RFI filtering of -50Db at 100 kHz with an insertion ratio of 50:1 using MIL-STD-220A methodology.
- I. SPD shall have the following diagnostic features: transient counter, status lights on each phase, and one set of 1 NO and 1 NC auxiliary dry contacts for alarming.
- J. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if transients destroy them during the warranty period. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

### **PART 3 – EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.
- B. Install Variable Speed Motor Controllers in accordance with manufacturers recommendations, the NEC, as shown on the drawings and in accordance with NEMA ICS 7.1.C.
- C. Furnish and install heater elements in motor starters to match the installed motor characteristics.

#### **3.2 SPARE PARTS**

Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

**3.3 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS**

- A. Schedule and perform all required inspections and tests for each piece of equipment as required by the manufacturers and specified in the contract documents in the presence of the Resident Engineer. Performance shall include all new and existing to be reused components. Performance shall include running the equipment and controls as applicable through their complete operational cycles with all components installed.
- B. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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

**SECTION 26 29 21**  
**DISCONNECT SWITCHES**  
**(MOTOR & CIRCUIT)**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation and connection of low voltage disconnect switches.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.

**1.3 QUALITY ASSURANCE**

Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data as applicable.
- B. Shop Drawings:
  - 1. Include sufficient information, clearly presented, to determine compliance with the drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting, material, enclosure types, fuse type and class.
  - 3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.
- C. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
  - 1. Complete operating and maintenance manuals shall be provided including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver copies to the Resident Engineer not less than 4 weeks prior to final inspection.
  - 2. Identify terminals on wiring diagrams to facilitate operation and maintenance.
  - 3. Wiring diagrams shall indicate internal wiring and any interlocking.
- D. Certifications: Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an



Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.

1.5 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. National Fire Protection Association (NFPA):
  - 70.....National Electrical Code (NEC)
- B. National Electrical Manufacturers Association (NEMA):
  - KS 1.....Enclosed and Miscellaneous Distribution Equipment Switches  
(600 Volts Maximum)
- C. Underwriters Laboratories, Inc. (UL):
  - 98.....Enclosed and Dead-Front Switches
  - 198C .....High-Interrupting-Capacity Fuses, Current Limiting Type
  - 198E .....Class R Fuses
  - 977.....Fused Power-Circuit Devices

PART 2 – PRODUCTS

2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS

- A. Switch mechanism: Quick-make, Quick-break type in accordance with UL 98, NEC and NEMA KS 1.
- B. Minimum duty rating: NEMA classification General Duty (GD) for 240 volts and Heavy Duty (HD) for 277/480 volts, and shall be horsepower rated.
- C. Shall have the following features:
  - 1. Copper blades visible in the OFF position.
  - 2. An arc chute for each pole.
  - 3. External operating handle shall indicate ON and OFF position and shall have lock-open padlocking provisions.
  - 4. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position defeatable by a special tool to permit inspection.
  - 5. Fuse mounting for the size and type of fuses specified. Furnish switches completely fused. Furnish a complete set of spare fuses for each switch being installed. Provide additional sets of spare fuses to constitute not less than two complete sets for the type, size, and rating of each set installed. Deliver the fuses to the Resident Engineer prior to the final inspection.
  - 6. Electrically operated.
  - 7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
  - 8. Ground Lugs: One for each ground conductor.

9. Enclosures:

- a. Shall be the NEMA types shown on the drawings for the switches.
- b. Where the types of switch enclosures are not shown, they shall be the NEMA types which are most suitable for the environmental conditions where the switches are being installed.
- c. Unless otherwise indicated on the plans all outdoor switches shall be NEMA 3R.
- d. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel.

2.2 LOW VOLTAGE UNFUSED SWITCHES RATED 600 AMPERES AND LESS

Shall be the same as Low Voltage Fusible Switches rated 600 amperes and less except it shall not accept fuses.

2.3 LOW VOLTAGE FUSIBLE SWITCHES RATED OVER 600 AMPERES TO 1200 AMPERES

Shall be the same as Low Voltage Fusible Switches rated 600 amperes and less except minimum duty rating NEMA classification Heavy Duty (HD). Switch shall be horsepower rated.

2.4 MOTOR RATED TOGGLE SWITCH

- A. Motor rated toggle switch shall be single pole, 115 volts and shall include overload protection and pilot light to indicate the "ON" or "RUNNING" condition of motor.
- B. Enclosures shall be most suitable for the environmental conditions where the switches are being installed.

2.5 IDENTIFICATION SIGNS

- A. Install nameplate identification signs on each disconnect switch to identify the equipment controlled.
- B. Nameplates shall be laminated black phenolic resin with a white core, with engraved lettering, a minimum of 1/4-inch high. Secure nameplates with screws.

**PART 3 – EXECUTION**

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, and as required by the contract documents.
- B. Fusible disconnect switches shall be furnished complete with fuses. Two weeks prior to the final inspection furnish inside the enclosure one complete set of spare fuses for each fusible disconnect.
- C. Disconnects shall be labeled with engraved phenolic plates identifying the equipment controlled and the feeder panel/circuit.

3.2 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS

- A. Schedule and perform all required inspections and tests for each piece of equipment as required by the manufacturers and specified in the contract documents in the presence of the Resident Engineer. Performance shall include all new and existing to be reused components. Performance shall include running the equipment and controls as applicable through their complete operational cycles with all components installed.

**VAMC Providence Respiratory Services**  
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- 3.3      Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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

**SECTION 26 51 00**  
**INTERIOR LIGHTING**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishings, installation, and connection of the interior lighting.

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 27 26, WIRING DEVICES: Wiring devices used as part of the lighting systems.
- 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.

**1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Manufacturer & Product Qualifications: Each product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly engaged in manufacturing items of the type specified. Additional or better features, not specifically prohibited by the specifications, but which are parts of the manufacturer's standard commercial product shall be included in the product.
- C. Source Limitations: Each product type shall be the same and the product of a single manufacturer.

**1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data as applicable.
  - 1. Material and construction details include housing, optics system, lens/diffuser.
  - 2. Physical dimensions and description.
  - 3. Wiring schematic and connection diagram.
  - 4. Installation details.
  - 5. Energy efficiency data.

6. Photometric data based on laboratory tests complying with IESNA Lighting Measurements testing and calculation guides.
  7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours) and color temperature (degrees Kelvin).
  8. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts and total harmonic distortion (THD).
- B. Shop Drawings:
1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  2. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, lenses, louvers, lamps, and controls.
- C. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS. Complete operating and maintenance manuals shall be provided including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver copies to the Resident Engineer not less than 4 weeks prior to final inspection.
- D. Certifications: Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by an electrical system specialist, and testing shall be performed by a qualified technician.
- 1.5 APPLICABLE PUBLICATIONS
- Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.
- A. American National Standards Institute (ANSI):
- C78.1 .....Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
- C78.2 .....Fluorescent Lamps - Preheat-Start Types - Dimensional and Electrical Characteristics
- C78.3 .....Fluorescent Lamps - Instant Start and Cold-Cathode Types - Dimensional and Electrical Characteristics
- C78.376 .....Chromaticity of Fluorescent Lamps
- B. Certified Ballast Manufacturers Association (CBM):
- Requirements for Ballast Certification
- C. Institute of Electrical and Electronic Engineers (IEEE):
- C62.41 .....Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits
- D. National Electrical Manufacturer's Association (NEMA):
- C82.1 .....Ballasts for Fluorescent Lamps - Specifications
- C82.2 .....Method of Measurement of Fluorescent Lamp Ballasts

- C82.4 .....Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps
- C82.11 .....High Frequency Fluorescent Lamp Ballasts
- E. National Fire Protection Association (NFPA):
  - 70 .....National Electrical Code (NEC)
  - 101 .....Code for Safety to Life from Fire in Buildings and Structures
- F. Federal Communications Commission (FCC):
  - Code of Federal Regulations (CFR), Title 47, Part 18
- G. Underwriters Laboratories, Inc. (UL):
  - 57 .....Electric Lighting Fixtures
  - 496 .....Edison-Base Lampholders
  - 542 .....Lampholders, Starters, and Starter Holders for Fluorescent Lamps
  - 844 .....Electrical Lighting Fixtures for Use in Hazardous (Classified) Locations
  - 924 .....Safety Emergency Lighting and Power Equipment
  - 935 .....Fluorescent-Lamp Ballasts
  - 1029 .....High-Intensity-Discharge Lamp Ballasts
  - 1574 .....Standard for Track Lighting Systems
  - 1598 .....Luminaires
  - 2108 .....Standard for Low-Voltage Lighting Systems
  - 8750 .....Light Emitting Diode (LED) Light Sources for Use in Lighting Products

## PART 2 – PRODUCTS

### 2.1 LIGHTING FIXTURES (LUMINAIRES)

- A. Shall be in accordance with NFPA 70, UL 1598, and shall be 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 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; lens doors shall close in a light tight manner.
  - 4. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, and latches shall function easily by finger action without the use of tools.

- C. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.
- D. Lamp Sockets:
  - 1. Fluorescent: Lampholder contacts shall be the biting edge type or phosphorous-bronze with silver flash contact surface type and shall conform to the applicable requirements of UL 542 and ANSI C-81. Contacts for recessed double contact lampholders and for slimline lampholders shall be silver-plated. Lampholders for bi-pin lamps, with the exception of those for "U" type lamps, shall be of the telescoping compression type, or of the single slot entry type requiring a one-quarter turn of the lamp after insertion.
  - 2. Incandescent: Shall have porcelain enclosures and conform to the applicable requirements of UL 496.
  - 3. High Intensity Discharge (H.I.D.): Shall have porcelain enclosures.
- E. Recessed incandescent fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- F. Fluorescent fixtures with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vapor tight fixtures shall have pressure clamping devices in lieu of the latches.
- G. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- H. Metal Finishes:
  - 1. The manufacturer shall apply his 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.
  - 2. Interior light reflecting finishes shall be white with not less than 85 percent reflectance, except where otherwise shown on the drawing.
  - 3. Exterior finishes shall be as selected by the VA from the manufacturer's catalog.
- I. Provide all lighting fixtures with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor.
- J. Light Transmitting Components for Fluorescent Fixtures:
  - 1. Shall be 100 percent virgin acrylic plastic or water white, annealed, crystal glass.
  - 2. Flat lens panels shall have not less than 3.2 mm (1/8-inch) of average thickness. The average thickness shall be determined by adding the maximum thickness to the minimum unpenetrated thickness and dividing the sum by 2.
  - 3. Unless otherwise specified, lenses, 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 of the lens without distortion or cracking.
- K. Lighting Fixtures in Hazardous Areas: Fixtures shall be suitable for installation in flammable atmospheres as defined in NFPA 70 and shall comply with UL 844.
- L. Compact Fluorescent Fixtures: Fixtures shall be manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Assemblies designed to retrofit

incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures. Fixtures shall be designed for lamps as specified.

- M. Light fixtures shall include a power disconnect device as required by NEC 410-130.G.

## 2.2 LAMP BALLASTS

- A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 – 277V) electronic instant-start/ rapid-start type, complying with UL 935 and with ANSI C 82.11 **without visible flicker**, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including 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 Rating: 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. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, 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 other ballast and so on to the innermost lamp. Within a given room, each switch shall uniformly control the same corresponding lamp 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 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.

- B. Low-Frequency Linear T8 Fluorescent Lamp Ballasts: Allowed for Surgery Suites, Critical Care Units and Animal Labs – 120V/277V hybrid electronic-electromagnetic rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output; including the following features:

1. Automatic lamp starting after lamp replacement.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: 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 47 CFT 18, Ch.1, Subpart C, 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 other ballast and so on to the innermost lamp. Within a given room, each switch shall uniformly control the same corresponding lamp 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 single lamp ballast for operation of the center lamp.
- C. Compact Fluorescent Lamp Ballasts: Multi-voltage (120 – 277V), electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including 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 Rating: 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 47 CFR 18, Ch 1, Subpart C, 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.
- D. Ballasts for high intensity discharge fixtures: Multi-tap voltage (120 – 480v) electromagnetic ballast for high intensity discharge lamps. Comply with ANSI C82.4 and UL 1029. 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 high intensity discharge 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 Rating: 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 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
  - 10. Protection: Class P thermal cut.
- F. Ballasts for lighting fixtures controlled by dimming devices shall be the electronic, high frequency type equipped for dimming and conform to the recommendations of the manufacturer of the associated dimming devices to assure satisfactory operation of the lighting system.

## **2.3 FLUORESCENT EMERGENCY BALLAST**

- A. Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
  - 1. Emergency Connection: Operate fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
  - 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  - 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
  - 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
  - 5. Integral Self-Test: Automatically initiates test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing LED.

## **2.4 LAMPS**

- A. Linear and U-shaped T5 and T8 Fluorescent Lamps:
  - 1. Rapid start fluorescent lamps shall comply with ANSI C78.1; and instant-start lamps shall comply with ANSI C78.3.
  - 2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
  - 3. Lamps shall include the F32T8, F32T8/U 32 watt energy saving type and EPACT approved F40T12 type if specifically required for special applications.

4. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature between 3500<sup>0</sup> and 4100<sup>0</sup> K, a Color Rendering Index (CRI) of greater than 70, average rated life of 20,000 hours, and be suitable for use with dimming ballasts, unless otherwise indicated. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.
    - 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<sup>0</sup> K.
    - b. In utility areas, service closets, maintenance closets and non-medical storage spaces, utilize energy saving light white lamps.
    - c. Other areas as indicated on the drawings.
  - B. Long Twin-Tube Fluorescent Lamps: T5, CRI 80 (minimum), color temperature between 3500<sup>0</sup> and 4100<sup>0</sup> K, 20,000 hours average rated life.
  - C. Compact Fluorescent Lamps: T4, CRI 80 (minimum), color temperature 3500<sup>0</sup> K, and suitable for use with dimming ballasts, unless otherwise indicated.
  - D. Incandescent lamps shall be the general service inside frosted type rated 130 volts with 3,000 hour extended service except where otherwise shown on the drawings.
  - E. High Intensity Discharge Lamps:
    1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900<sup>0</sup> K, and average rated life of 24,000 hours, minimum.
    2. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000<sup>0</sup> K.
    3. Ceramic, Pulse-Start, Metal-Halide Lamps: CRI 80 (minimum), and color temperature 4000<sup>0</sup> K.
    4. Low-Pressure Sodium Lamps: ANSI 78.41, CRI 0, and color temperature 1800<sup>0</sup> K.
  - F. Light Emitting Diode (LED) Lamps: TBD.
    1. LED Board: Array of high brightness royal blue LED's
    2. Remote Phosphor Technology: Phosphor lens assembly positioned in front of LED array to convert blue light to white. Color shift not exceed +/-100K over life.
    3. Optical Mixing Chamber: To redirect light through aperture
    4. Thermal Management: Heat sink
    5. Color Temperature: 3500<sup>0</sup> K
    6. Rated Life: 50,000 hours at 70% lumen maintenance based on IESNA LM-80
- 2.5 RADIO INTERFERENCE FREE FLUORESCENT FIXTURES
- A. Shall be specially designed for suppressing radio frequency energy produced within the fixtures. The Rules and Regulations of FCC (CFR 47, Part 18) shall apply.
  - B. Lenses shall have a light transparent layer of metal permanently bonded to them, and in positive contact with the steel housing or equal to prevent the radio frequency interferences from passing through the lenses. The effective light transmittance of the lenses shall be not less than 75 percent.

- C. Install line filters within the body of the fixtures and wired in series with the supply circuit conductors to eliminate the transmission of radio frequency energy into the supply circuit.

## **2.6 SCHEDULE**

- A. Fluorescent Fixtures: Refer to drawings for details unless otherwise specified.
  - 1. As manufactured by Lithonia – Premium Grade.
  - 2. Refer to drawings for additional requirements.
- B. Incandescent Fixtures: Refer to drawings for details unless otherwise specified.
  - 1. Prescolite LFIL9HSQ-9RALT-9DOPL-9NTG-PKT261
  - 2. Prescolite LFIL11HSQ-13RALT-13DOPL-13NTG with 24 inch bar hangers
  - 3. Refer to drawings for additional requirements.
- C. Lens Diffusers: Refer to drawings for details unless otherwise specified.
- D. Exit Sign Fixture: Refer to drawings for details. Lightalarms Simplicity Series SLEDWRW with self diagnostic option, canopy kit as needed, and “EXIT” text.
- E. Laser Sign Fixtures: Refer to drawings for details. Lightalarms Simplicity Series SLEDWGW with self diagnostic option, canopy kit as needed, and “LASER IN USE” text.
- F. X-Ray Sign Fixtures: Refer to drawings for details. Lightalarms Simplicity Series SLEDWGW with self diagnostic option, canopy kit as needed, and “X-RAY IN USE” text.
- G. X-Ray Film Illuminators: Not Applicable.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as required by the contract documents. Provide separate neutrals for each lighting circuit. Do not share neutral wires between circuits.
- B. Verify in advance of performing any work the availability, type, capacity, location of electrical power necessary to perform the work.
- C. Provide all necessary components eg, conduit, feeders, transformers, ballasts, cables, hardware, circuit breakers for new and existing systems including panelboards as necessary for all equipment to operate in the manner intended. In the event that the electrical characteristics of any equipment do not agree with the type of available power make the necessary modifications.
- D. All materials, equipment, components, articles, and assemblies installed shall be complete for operation, service and maintenance for the purpose intended not limited to the details and information provided.
- E. Align, mount and level the lighting fixtures uniformly.
- F. Avoid interference with and provide clearance for equipment. Where the indicated locations for lighting fixtures conflict with the locations for equipment re-coordinate the locations for the equipment by the minimum distance necessary as approved by the Resident Engineer.
- G. Lighting Fixture Supports:
  - 1. Shall provide support at each corner of the fixture with a yoke support at each end 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 re-lamping.
3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
4. Recessed lighting fixtures:
  - a. Recessed lighting fixtures shall be supported to the building structure with two (2) safety chains in trapeze style at all four (4) corners. All fixture mounting devices connecting fixtures to the ceiling system or building structure shall have a capacity for a horizontal force of 100 percent of the fixture weight and a vertical force of 400 percent of the fixture weight.
  - b. Mounting devices shall clamp the fixture to the ceiling system structure (main grid runners or fixture framing cross runners) at four points in such a manner as to resist spreading of these supporting members. Each support point device shall utilize a screw or approved hardware to "lock" the fixture housing to the ceiling system, restraining the fixture from movement in any direction relative to the ceiling. The screw or approved hardware shall pass through the ceiling member, or it may extend over the inside of the flange of the channel or spline that faces away from the fixture, in a manner that prevents any fixture movement.
  - c. 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.
  - d. In addition to the above, the following is required for fixtures exceeding 9 kg (20 pounds) in weight. Note: Ceiling types are defined in ASTM Standard C635 69.
    - 1) Where fixtures mounted in "Intermediate" and "Heavy Duty" ceilings weigh between 20 pounds and 56 pounds provide two 12 gauge safety hangers hung slack between diagonal corners of the fixture and the building structure.
    - 2) Where fixtures weigh over 56 pounds they shall be independently supported from the building structure by approved hangers. Two way angular bracing of hangers shall be provided to prevent lateral motion.
5. Surface mounted lighting fixtures:
  - a. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts or stud clips shall be minimum 1/4-20 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 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 15 pounds in weight and occupying less than 2 square feet of ceiling area may, 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 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.
  - 6. Single or double pendent mounted lighting fixtures: Each stem shall be supported by an approved outlet box, mounted swivel joint and canopy which holds the stem captive and provides spring load dampening of fixture oscillations. Outlet box shall be supported vertically from the building structure.
  - 7. Outlet boxes for support of lighting fixtures 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.
  - H. Furnish and install lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.
  - I. Coordinate with the electrical and ceiling Trades to assure that the approved lighting fixtures are furnished in the proper sizes and installed with the proper devices, to match the ceiling system being installed.
  - J. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 26 05 26, GROUNDING & BONDING FOR ELECTRICAL SYSTEMS.
  - K. At completion of project, re-lamp all fixtures which have failed/burned-out lamps. Clean all lenses, diffusers and louvers which have accumulated dust/dirt during construction.
- 3.2 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS
- A. Inspections (visual/mechanical) and Tests shall be performed during a minimum of two periods (rough and final). Due to project phasing and construction coordination additional periods may be necessary. The electrical system shall be considered ready for the rough Inspections and Tests once the conduit system is complete and all the cables have been pulled. Inspection and Tests requires witness of the VA scheduled 2 weeks in advance, and documentation reports.
  - B. Testing shall be performed with calibrated precision digital meters/instruments. Test instruments, materials, labor shall be supplied by an independent agency utilizing a qualified system specialist furnished by the Contractor.
  - C. Verify compliance of all material, workmanship and installation with approved Submittals, Contract Documents, and applicable Codes. Verify nameplate data with drawings and specifications.
  - D. Inspect all installed and reused equipment, lighting, devices and components for physical integrity, anchorage, alignment, grounding, required clearances & mechanical condition for proper operation within manufacturer's tolerances and applicable requirements.
  - E. Either obtain equipment vendor approval or perform all test procedures recommended by manufacturers and demonstrate that all equipment and components meet the manufacturer's requirements and are installed properly, complete and ready for use for the purpose intended.
  - F. Refer to PART 3 of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - G. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

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**SECTION 27 05 11**  
**REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS**

PART 1 – GENERAL

1.1 STANDARDS

- A. The Contractor shall, as a minimum, perform all telecommunications installation, testing and labeling in compliance with the following standards and specifications:
  - 1. TIA/EIA 568A, "Commercial Building Wiring Standards"
  - 2. TIA/EIA 606, "Labeling and Marking of Telecommunications Cable and Infrastructure"
  - 3. National Electrical Code (NEC).

1.2 CABLE TERMINATION METHODS

- A. Installation and termination methods and procedures shall conform to the requirements of TIA/EIA 568A.

1.3 LABELING AND MARKING

- A. The marking and labeling of all installed cable shall conform to TIA/EIA-606 requirements and guidelines.

1.4 INSTALLATION OF TWISTED PAIR CABLES

- A. All cable and wiring work to be performed in support of site-specific requirements shall include all labor, wire closet backboards, hole drilling, terminals, blocks, connectors, wire support rings, and all other hardware, supplies, and tools as necessary to cause the stations and/or cable to be installed in accordance with the specifications and methods specified in the most recent issue of the Building Industry Consulting Services International (BICSI) *Telecommunications Distribution Methods Manual*, installation practices and procedures.
- B. All horizontal cable shall be routed and attached per the Building Industry Consulting Services International (BICSI) *Telecommunications Distribution Methods Manual* installation practices and procedures.
- C. If any local or state regulatory code conflicts with the BICSI requirements, the regulatory code shall prevail.
- D. At cut over, the Contractor shall be responsible for providing all data cross-connect patch cables at the closet end. Four (4) data patch cords, color coded at the closet end, is required per data drop. Data patch cables shall be RJ45 to RJ45, 4 pair, Category 6, EIA/TIA 568A compliant cable unless specified otherwise herein. The required quantity data patch cables is detailed within the work order and materials listing. All patch cables shall be factory made (fabrication by installation contractor is not permissible).
- E. A minimum 10-foot service loop shall be provided at all termination locations. The 10-foot loop shall be that loop which is available after all termination activity is performed. Additionally, a 10-foot service loop shall be left in all manhole locations.

1.5 CABLE DISTRIBUTION SYSTEM AND SIZING

- A. The Contractor shall utilize the site location's existing manholes and conduits except as noted or which are required to be constructed by the Contractor under the site preparation requirements. The Contractor shall utilize sound engineering state-of-the-art practices to design

the outside cable plant conduits. The Contractor shall furnish all fiber optic patches, jumpers, etc. at each facility to make the system completely operational. Exception: Patch cables are not to be provided at the station (drop) locations.

**1.6 BUILDING DISTRIBUTION AND WIRING SYSTEM**

- A. Inside cable shall, at a minimum, consist of UTP Category 6 Enhanced data grade cable and/or optical fiber cable for inside the buildings as required. All cable, connectors, jacks, wall plates and patch panels shall meet TIA/EIA 568A standards. Patch panels will be of the Ortronics UTP Cat 6, 24, 48, or 96 port panels.

**1.7 MATERIALS AND EQUIPMENT**

- A. Materials and equipment shall be commercially available products, shall be the manufacturer's latest design, and meet or exceed EIA/TIA 568A standards. All cable and cable-related materials furnished by the Contractor shall be new and meet current industry standards. No obsolete material or items no longer supported by the manufacturer shall be used in the installation. A manufacturer's label or nameplate shall be secured to each major item or equipment or stenciled on cables. Refer to work order for exact equipment requirements.

**B. Description**

1. ORTRONICS TRACJACK FACEPLATE, 4 PORT, FOG WHITE
2. ORTRONICS RJ45 JACK, CAT 6, 8P8C, 568A, WHITE
3. ORTRONICS RJ45 JACK, CAT 6, 8P8C, 568A, YELLOW
4. ORTRONICS RJ45 JACK, CAT 6, 8P8C, 568A, GREEN
5. ORTRONICS RJ45 JACK, CAT 6, 8P8C, 568A, BLUE
6. ORTRONICS PATCH PANEL 24 PORT, 568A, 110 (minimum)
7. ORTRONICS HORIZONTAL WIRE MANAGER
8. CAT 6, UTP, 4 PAIR, PLENUM, WHITE JACKET
9. CAT 6, UTP, 4 PAIR, PLENUM, YELLOW JACKET
10. CAT 6, UTP, 4 PAIR, PLENUM, GREEN JACKET
11. CAT 6, UTP, 4 PAIR, PLENUM, BLUE JACKET

**1.8 HORIZONTAL CABLE**

- A. All horizontal cable shall be 4 pair, Category 6, UTP cable and shall be compliant with TIA/EIA 568A requirements for cable. The cable shall meet NEC requirements as a plenum grade cable. The cable shall be stenciled, at regular intervals throughout its entire length, with both Category 6 and NEC plenum designations. The cable shall be UL tested to meet EIA/TIA 568A requirements. The work order states approximately how many 4-cable Category 6 drops are required. Less cable may be required for locations that require voice connectivity only, such as wall phones. Due to this uncertainty, Contractor should verify drawings and consult with facility IRM for those exact locations that require less than four cables.

**1.9 PATCH PANEL**

- A. The Contractor shall equip each telecommunications room/equipment room that serves as a horizontal wiring distribution location, with data termination/patch panels for each horizontal data cable run. The patch panel shall be a Category 6, RJ45, EIA/TIA 568A, 4 pair, Patch panels will be of the Ortronics UTP Cat 6 panels as designated in the work order.



- B. The patch panel shall be of a modular design to allow the flexibility to connect a network circuit directly to any equipment circuit. Patch panels may be rack or wall mounted, as required. If rack mounted, fiber and copper patch panels may be installed in the same rack.
- C. Fiber optic patch panels must be provided for all fiber optic cable terminations. Fiber optic patch panels shall be modular and provide adequate space for storing cable slack and for accommodating cable routing and fastenings. The contractor will provide the patch panel (type, style and size) detailed in the materials listing. The contractor will submit details of the panel included within their quotation.
- D. Modular patch panels with RJ45 type jacks (meeting EIA/TIA 568A standards) connected to Category 6 approved connecting blocks shall be installed.

#### **1.10 WORKSTATION JACKS**

- A. Each work station shall be equipped with a minimum of four (4) each, eight-position, Category 6, RJ 45 type modular jacks. Three (3) jacks will be for data and one (1) jack for voice. Data jacks will carry a unique color to differentiate them from voice. The station wire connection shall be a direct insulation displacement wire connection; screw-type connections are not authorized. When fiber optic jacks are required they can be installed in the same wall box. The eight-position (RJ 45 type) jack, as a minimum, shall meet the specifications in EIA/TIA TSB40 and be terminated according to EIA/TIA 568A standards.

#### **1.11 HORIZONTAL CABLE**

- A. The horizontal cable shall be installed as follows. Four pair (4 pr.), 24 AWG, 100 ohm UTP copper cable shall be installed between the telecommunications room and the station outlet box. The UTP shall be terminated in the telecommunications room on patch panels and at the work station on eight (8) position, Category 6, modular jacks (RJ 45 type). Cable labeling and station labeling shall be in accordance with the labeling plan outlined in the Construction Specifications. Should a labeling plan not be provided to the contractor, the contractor shall label all cables according to EIA/TIA 606 standards.

#### **1.12 BUILDING ENTRANCE CONDUIT/DUCT**

- A. The entrance conduit shall extend from the equipment room/area as available through the building structure and through the building's exterior wall. The entrance conduit shall then extend either a minimum of five feet out from the building or beyond surface obstructions such as parking lots, equipment platforms, sidewalks, etc., to the nearest manhole/handhold for underground plant, or to a pole for each aerial plant.

#### **1.13 EXISTING PLANT DRAWINGS**

- A. Plant drawings will be furnished for Contractor reference if available. The Contractor shall be responsible for the ultimate accuracy and completeness of all data, drawings, plans, material lists, and work schedules produced as part of this contract.

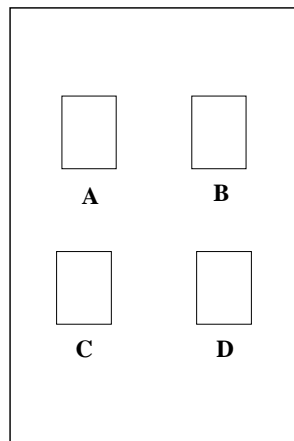
#### **1.14 PERSONNEL QUALIFICATIONS**

- A. The contractor shall provide personnel having the required levels of professional/technical experience to perform the work required. Contractor personnel must hold a valid telecommunications license issued by the State of R.I. under RIGL 5-70-7 "Telecommunications Regulations."

#### **1.15 QUAD DROP SPECIFICATIONS**

- A. All drops will be CATEGORY 6 quadruple cable runs to each faceplate. The intended use of the four ports at each user location faceplate includes three data ports and one voice port. Each four port faceplate shall house four (4) uniquely colored CAT 6 jacks. Each four (4) port

faceplate Horizontal Cabling shall be populated with uniquely colored CAT 6 jacks in the following manner:



- B. The contractor shall provide four different color cables for each workstation outlet as follows: A= yellow B= blue C= green and D= white. The contractor shall supply one patch cord for each cable terminated at the patch panel. The patch cord shall match the color of the associated horizontal cable and CAT 6 jack to affect a uniquely colored “channel” from end to end.
- C. The horizontal voice and data cabling is to be collocated in one centrally located telecommunications room. Each wire run will terminate in the respective panel and be positioned “top to bottom” in a manner that will accommodate vertical wire management as illustrated below:

Panel A	Panel B	Panel C	Panel D
Yellow	Blue	Green	White
Cat 6 Patch Panel	Cat 6 Patch Panel	Cat 6 Patch Panel	Cat 6 Patch Panel
Data Equipment	Data Equipment	Data Equipment	Telephone Equipment

Note: Panel “A” will house all Data CAT 6 cables, color yellow.

Panel “B” will house all Data CAT 6 cables, color blue.

Panel “C” will house all Data CAT 6 cables, color green.

Panel “D” will house all Telephony CAT 6 cables, color white.

## **PART 2 – PRODUCTS**

### **2.1 TESTING REQUIREMENTS**

- A. The Contractor shall engineer, furnish, install, test and make operational a new twisted pair cable (UTP) cable plant. The Contractor shall provide all equipment and materials required to install and test the cable plant system to ensure it meets the requirements. The Contractor

shall provide final test results, which shall meet or exceed the EIA/TIA 568A Cat. 6 enhanced cabling standards.

**2.2 CUT-OVER PLAN**

- A. The Contractor shall create a Cut-over Plan to be submitted with the proposal. After a successful cut-over and prior to final acceptance of the contractor's work; two (2) sets each of "As-Built" prints shall be delivered to the COTR. These "As-Built" shall be in both hard copy (2 sets), and soft copy (2 sets). Soft copy shall be in AutoCAD.

**2.3 ACCEPTANCE TEST PLAN**

- A. The Contractor shall provide a complete detailed acceptance test plan or test procedure covering the cable installation. The Contractor's test plan will shall be approved/ disapproved within twenty (20) days of submittal. A disapproved test plan shall be revised in accordance with recommendations and resubmitted. All corrections and changes must be delineated or otherwise clearly identified to facilitate follow-up review and approval. Additionally, the contractor shall meet the testing and acceptance requirements set forth in the construction specifications for both the UTP and fiber optic cable. The Contractor shall make the final operational test of the fiber optic cable system in compliance with industry accepted practices or as detailed elsewhere herein. The Contractor shall be responsible for recording all test data. Copies of all test data will be submitted to the COTR for his/her review/approval. All test and acceptance forms shall be submitted in both hard and soft copy. Soft copy shall be in MS Word 2000 or later or in MS Excel 2000 or later.

**2.4 SERVICE INTERRUPTIONS**

- A. There shall be no scheduled interruptions of service for system changes, upgrades, etc., without prior consent of the facility IRM. A service interruption is defined as any discontinuance or impairment of any service and/or features assigned to a user or a group of users.

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

**SECTION 28 13 11**  
**PHYSICAL ACCESS CONTROL SYSTEM (PACS)**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. Connect to the facilities existing Physical Access Control System.

**1.2 RELATED WORK**

- A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.
- B. For labeling and signs, Section 10 14 00, SIGNAGE.
- C. For connection of high voltage, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- D. For power cables, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
- E. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- F. For infrastructure, Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
- G. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.
- H. For perimeter lighting, Section 26 56 00, EXTERIOR LIGHTING.
- I. For screening of personnel and shipments, Section 28 13 53, SECURITY ACCESS DETECTION.
- J. For alarm systems, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).
- K. For control and operation of all security systems, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.
- L. For security camera systems, Section 28 23 00 VIDEO SURVEILLANCE.
- M. For emergency and interior communications, Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS).
- N. For Warranty of Construction, see GENERAL CONDITIONS.
- O. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

**1.3 QUALITY ASSURANCE**

- A. The Contractor shall be responsible for providing, installing, and the operation of the PACS as shown. The Contractor shall also provide certification as required.
- B. The security system will be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.
- C. 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.

**1.4 SUBMITTALS**

- A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, and Section 02 41 00, DEMOLITION.
- B. Provide certificates of compliance with Section 1.3, Quality Assurance.

- C. Provide a complete and thorough pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.
- D. Pre-installation design and as-built packages shall include, but not be limited to:
  - 1. Index Sheet that shall:
    - a. Define each page of the design package to include facility name, building name, floor, and sheet number.
    - b. Provide a complete list of all security abbreviations and symbols.
    - c. Reference all general notes that are utilized within the design package.
    - d. Specification and scope of work pages for all individual security systems that are applicable to the design package that will:
      - (1) Outline all general and job specific work required within the design package.
      - (2) Provide a detailed device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
  - 2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
    - a. Include a title block as defined above.
    - b. Clearly define the drawings scale in both standard and metric measurements.
    - c. Provide device identification and location.
    - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
    - e. Identify all pull box and conduit locations, sizes, and fill capacities.
    - f. Address all general and drawing specific notes for a particular drawing sheet.
  - 3. A detailed riser drawing for each applicable security subsystem shall:
    - a. Indicate the sequence of operation.
    - b. Relationship of integrated components on one diagram.
    - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
    - d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
  - 4. A detailed system drawing for each applicable security system shall:
    - a. Clearly identify how all equipment within the system, from main panel to device, shall be laid out and connected.
    - b. Provide full detail of all system components wiring from point-to-point.
    - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
    - d. Show device locations that correspond to the floor plans.

- e. All general and drawing specific notes shall be included with the system drawings.
  - 5. A detailed schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
    - a. Device ID.
    - b. Device Location (e.g. site, building, floor, room number, location, and description).
    - c. Mounting type (e.g. flush, wall, surface, etc.).
    - d. Power supply or circuit breaker and power panel number.
    - e. In addition, for the PACS, provide the door ID, door type (e.g. wood or metal), locking mechanism (e.g. strike or electromagnetic lock) and control device (e.g. card reader or biometrics).
  - 6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall go through a full review process conducted by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
- 1. 35 percent
  - 2. 65 percent
  - 3. 90 percent
  - 4. 100 percent
- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.
- G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per Section 01 00 00, GENERAL REQUIREMENTS.
- 1.5 APPLICABLE PUBLICATIONS
- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
  - B. American National Standards Institute (ANSI)/ Security Industry Association (SIA):
    - AC-01.....Access Control: Wiegand Card Reader Interface Standard
    - AC-03.....Access Control: Badging Techniques
  - C. American National Standards Institute (ANSI)/ International Code Council (ICC):
    - A117.1 .....Standard on Accessible and Usable Buildings and Facilities
  - D. Department of Justice American Disability Act (ADA)
    - 28 CFR Part 36-90 .....ADA Standards for Accessible Design
  - E. Government Accountability Office (GAO):
    - GAO-03-8-02 .....Security Responsibilities for Federally Owned and Leased Facilities

- F. National Electrical Contractors Association  
303-2005 ..... Installing Closed Circuit Television (CCTV) Systems
- G. National Electrical Manufacturers Association (NEMA):  
250-03 ..... Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. National Fire Protection Association (NFPA):  
70-05..... Article 780-National Electrical Code
- I. Underwriters Laboratories, Inc. (UL):  
294-99 ..... Standard for Access Control  
305-97 ..... Standard for Panic Hardware  
639-97 ..... Standard for Intrusion-Detection Units  
752-05 ..... Standard for Bullet-Resisting Equipment  
827-96 ..... Central Station Alarm Services  
1076-95 ..... Standards for Proprietary Burglar Alarm Units and Systems  
1981-03 ..... Central Station Automation System  
2058-05 ..... High Security Electronic Locks
- J. Homeland Security Presidential Directive (HSPD):  
HSPD-12 ..... Policy for a Common Identification Standard for Federal Employees and Contractors
- K. Federal Information Processing Standards (FIPS):  
FIPS-201 ..... Personal Identity Verification (PIV) of Federal Employees and Contractors
- L. National Institute of Standards and Technology (NIST):  
IR 6887 V2.1 ..... Government Smart Card Interoperability Specification (GSC-IS)  
Special Pub 800-96 ..... PIV Card Reader Interoperability Guidelines
- M. Institute of Electrical and Electronics Engineers (IEEE):  
C62.41 ..... IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
- N. International Organization for Standardization (ISO):  
7810..... Physical Characteristics of Credit Card Size Document  
7811..... Physical Characteristics for Magnetic Stripe Cards  
7816-1 ..... Physical Characteristics of the Card  
7816-2 ..... Dimensions and Contact Position of the card  
7816-3 ..... Electrical Signals and Transmission Protocols  
7816-4 ..... Inter-Industry Command for Interchange  
14443..... RFID cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 inches distance  
15693..... RFID cards; Contactless Vicinity Cards Operating at 13.56 MHz in up to 50 inches distance

- O. Uniform Federal Accessibility Standards (UFAS) 1984
- P. ADA Standards for Accessible Design 1994

**1.6 WARRANTY OF CONSTRUCTION.**

Warrant PACS work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.

**PART 2 – PRODUCTS**

**2.1 EQUIPMENT AND MATERIALS**

- A. All equipment associated within the PACS shall be UL 294 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
- B. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 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 easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.
- D. All PACS 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 NFPA 70, Chapter 5.
- E. All equipment and materials for the system will be compatible to ensure correct operation as outlined in FIPS 201, March 2006 and HSPD-12.

**2.2 EQUIPMENT ITEMS**

- A. 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.
- B. PACS equipment shall meet or exceed all requirements listed below.
- C. A PACS shall be comprised of, but not limited to, the following components:
  - 1. Control/Communications Panels
  - 2. Electronic Security Management System
  - 3. Card Reader and Credential Cards
  - 4. Picture ID and Badging Station (To be provided in accordance with the VA PIV enrollment and issuance system.)
  - 5. Biometrics
  - 6. Portal Control Devices
  - 7. Door Status Indicators
  - 8. Entry Control Device
  - 9. Power Supplies
  - 10. Wires and Cables
- D. Control/Communication Panels:



1. Shall be a central point provided for monitoring, controlling, and programming the PACS.
2. Shall provide a means of controlling up to 16 doors per panel.
3. Shall be expandable and provide a means of networking multiple panels to provide overall control of all doors on the PACS via a primary panel.
4. Shall be system specific addressable, Internet Protocol (IP) addressable, and programmable via a computer.
5. Shall be able to be interfaced directly from a computer or via the Internet or Intranet. Access to the panels shall be password protected. All individuals with access to the panels shall have a user specific password.
6. Shall be of the same manufacturer and part number to ensure full compatibility within the system.
7. The operating system for the panel must utilize a single seamlessly integrated relational database for all functionality. This integration shall be provided with one operating environment. The operating environment shall be the fully multi-tasking multi-threading Microsoft Windows 2003/2000/Windows XP Operating System.
8. The panel's web enabled client applications shall be capable of running on independent client operating systems including Windows 2003/2000, Windows XP, Windows NT, Windows 98, Windows 95, Macintosh, UNIX, Linux, and Solaris. The web-enabled applications shall utilize the same common database as the other system modules.
9. The panel programming shall be written so that all system modules (e.g. access control, alarm monitoring, credential management, digital video, visitor management, intrusion detection, asset management, etc.) are developed and built from a unified 32-bit source code set. There absolutely shall not be separate source code bases for the individual modules of the PACS.
10. Shall allow for the operation and control of up to 16 doors.
11. Shall consist of or have the equivalent of, at a minimum, a General Control Module and an Access Control Module. Both modules shall be programmable via a computer.
12. The General Control Module shall:
  - a. Provide for full distributed processing of access control and alarm monitoring operations.
  - b. Store the following information and function using a high speed, local 32-bit microprocessor:
    - 1) access levels
    - 2) hardware configurations
    - 3) programmed alarm outputs assigned at a administration client workstation
  - c. Process all access granted/denied decisions to provide fast responses to card reader transactions. A fully configured general control module with 64 card readers shall require less than one-half (0.5) seconds to grant access to an authorized cardholder or deny access to an unauthorized cardholder.
  - d. Meet the following minimum requirements:
    - 1) A minimum host communications speed of 115,200 bps.
    - 2) Support direct connect connections.
    - 3) Have remote dial up.
    - 4) Minimum on-board memory of eight (8) MB.

- 5) Local Area Network (LAN) Support RJ45 (10/100baseT) Ethernet Interface Token Ring four (4) MB connectivity.
  - 6) Minimum memory storage of up to 5,000 cardholders and 100,000 events.
  - 7) Downstream ports for connecting card readers and data gathering panels via RS-485 multi-drop wiring configuration.
  - 8) Support of multiple card technologies.
  - 9) Supervised Communications with PACS system software.
  - 10) Support of up to eight card formats and facility codes.
  - 11) RS-485 Full Duplex, UL 1076 Grade AA communication channel to the system head-end.
  - 12) Integration with all manufacturers' card readers.
  - 13) Biometric Interface Support.
  - 14) 12 VAC or 12 volts direct current (VDC) input power via a UL certified step-down transformer or power supply.
  - 15) Issue Code Support for both Magnetic and Wiegand Card Formats.
  - 16) Individual Shunt Times
  - 17) Up to Nine Digit PIN Codes.
  - 18) Downstream serial RS-232 device support.
  - 19) Status LED's to identify normal component and communication status.
13. The access control module shall:
- a. Control up to 16 doors utilizing input and output relays that are fully programmable via network software.
  - b. Input relays shall meet the following minimum requirements:
    - 1) Provide up to 16 UL 1076 analog unsupervised alarm input zones to monitor and report alarm conditions, power faults, and tampers.
    - 2) Operate independently and in conjunction with output relays, which will send an output signal to a corresponding output device upon alarm input activation. Once an alarm has been received, the input relay shall activate any or all alarm outputs.
    - 3) Contain the following features:
      - (a) UL 294 Certified.
      - (b) Alarm contact status scanning at up to 120 times per second for each zone.
      - (c) A low power Complementary-symmetry/metal-oxide semiconductor (CMOS) microprocessor.
      - (d) Filtered data for noise rejection to prevent false alarms.
      - (e) Up to 16 supervised inputs.
      - (f) 12 VAC or 12 VDC Input Power.
      - (g) Two (2) dedicated inputs for tamper and power status.
14. Output relays shall meet the following minimum requirements:

- a. Shall be capable of controlling a corresponding output device upon any input activation or on command from the PACS.
- b. Shall be capable of responding to:
  - 1) Input alarms.
  - 2) Commands from a System Operator.
  - 3) Time zone control commands for automatic operation.
- c. Shall be capable of:
  - 1) Pulsing for a predetermined duration. Duration shall be programmable for each relay individually.
  - 2) Responding on command from the System Operator to pulse, command on, command off, or reset to normal state.
  - 3) Operating outputs rated at 5 amps (A) @ 30 VDC.

**E. Electronic Security Management System (SMS) :**

- 1. Shall allow the configuration of an enrollment and badging, alarm monitoring, administrative, asset management, digital video management, intrusion detection, visitor enrollment, remote access level management, and integrated client workstations or any combination of all or some.
- 2. Shall be expandable to support an unlimited number of individual module or integrated client workstations. All access control field hardware, including Intelligent System Controllers (ISC), shall be connected to all Windows 2003/2000/XP based access control system workstation on the network.
- 3. Shall have the ability to compose, file, maintain, update, and print reports for either individuals or the system as follows.
  - a. Individual reports that consist of an employees name, office location, phone number or direct extension, and normal hours of operation. The report shall provide a detail listing of the employee's daily events in relation to accessing points within a facility.
  - b. System reports shall be able to produce information on a daily/weekly/monthly basis for all events, alarms, and any other activity associated with a system user.
  - c. All reports shall be in a date/time format and all information shall be clearly presented.
- 4. Shall be designed to allow it to work with any industry standard network protocol and topology listed below:
  - a. Transmission Control Protocol (TCP)/IP
  - b. Novell Netware (IPX/SPX)
  - c. Banyan VINES
  - d. IBM LAN Server (NetBEUI)
  - e. Microsoft LAN Manager (NetBEUI)
  - f. Network File System (NFS) Networks
  - g. Remote Access Service (RAS) via ISDN, x.25, and standard phone lines.
- 5. Shall provide full interface and control of the PACS to include the following subsystems within the PACS:

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**VA Project No. 650-10-022**  
**PAI Project No. 35919.00**

- a. Public Key Infrastructure
  - b. Card Management
  - c. Identity and Access Management
  - d. Personal Identity Verification
6. Shall have the following features or compatibilities:
- a. The ability to be operated locally or remotely via a LAN, WAN, internet, or intranet.
  - b. Event and Alarm Monitoring
  - c. Database Partitioning
  - d. Ability to fully integrate with all other security subsystems
  - e. Enhanced Monitoring Station with Split Screen Views
  - f. Alternate and Extended Shunt by Door
  - g. Escort Management
  - h. Enhanced IT-based Password Protection
  - i. N-man Rule and Occupancy Restrictions
  - j. Open Journal Data Format for Enhanced Reporting
  - k. Automated Personnel Import
  - l. ODBC Support
  - m. Windows 2000 Professional, Windows Server 2003, Windows XP Professionals for Servers
  - n. Field-Level Audit Trail
  - o. Cardholder Access Events
7. For the SMS network a server and client workstation shall be required and must meet the following minimum technical characteristics:
- a. Server:

Processor	1.8 GHz Intel Pentium IV
Free Hard Disk Space	3.0 GB
Memory	1.0 GB
Network Card	10/100 Base-T
CD-ROM Drive	10X
Monitor/Video Adapter board	17" SVGA (1024 x 768)
Operating System	Windows 2000 Professional, Windows Server 2003, Windows XP Professional
Ports	2 serial, 1 parallel, USB
Backup	Tape or CDRW
Modem	56.7 Kbps

b. Client Workstation:

Processor	1.5 GHz Intel Pentium III
Free Hard Disk Space	2.0 GB
Memory	512 MB RAM
Network Card	10 Base-T
CD-ROM Drive	10X
Monitor/Video Adapter board	17" SVGA (1024 x 768), 64 MB RAM
Operating Systems	Windows 2000 Professional or XP Professional

F. Card Readers and Credential Cards:

1. 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.
2. Will be fully programmable and addressable, locally and remotely, and hardwired to the system.
3. Shall be individually home run to the main panel.
4. Shall be installed in a manner that they comply with:
  - a. The Uniform Federal Accessibility Standards (UFAS)
  - b. The Americans with Disabilities Act (ADA)
  - c. The ADA Standards for Accessible Design
5. 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 compliant. The reader output can be Wiegand, RS-22, 485 or TCP/IP.
6. Are to be housed in an aluminum bezel with a wide lead-in for easy card entry.
7. Shall contain read head electronics, and a sender to encode digital door control signals.
8. LED's shall be utilized to indicate card reader status and access status.
9. Shall be able to support a user defined downloadable off-line mode of operation (e.g. locked, unlocked, or facility code), which will go in effect during loss of communication with the main control panel.
10. 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 audible feedback.
11. Shall have a minimum of two programmable inputs and two programmable outputs.
12. All card readers that utilize keypad controls along with a reader and shall meet the following specifications:
  - a. 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.

- b. 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.
  - c. 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.
  - d. Shall be powered from the source as designed and shall not dissipate more than 150 Watts.
  - e. Shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
  - f. Shall provide a means for users to indicate a duress situation by entering a special code.
13. Card readers shall come in the following formats:
- a. Magnetic Stripe Card Reader
    - 1) Shall be utilized during the transition from the existing technology to the contactless smart card technology as defined in FIPS-201.
    - 2) Shall read credential cards that utilize single layer 4000 units of magnetic field strength per magnetic tape material.
    - 3) The magnetic tape material shall be coated with Teflon and affixed to the back of the credential card near the top. This reader shall allow the card to either be swiped or inserted into the reader.
    - 4) Shall meet or exceed the following minimum technical characteristics:

Card Speed	5 to 30 inches (203 to 1270mm) per second
Data Rate	1 ms per bit
Connections	Plug-in with 8" (200mm) pigtail cable
Output Format	26 or 34-bit
Power	Per Manufacturers Specifications
Lifetime	250,000 wear cycles with a MTBF 22,000 hours
Error Rate	5% false reject 2x10-6 false accept
Static Discharge	Withstands up to 20,000 volts
LED	If required per the design package.
Card Format Output Format	EMPI 26 or 34-bit ANSI/ABA All bits Clock-and-Data up to 37 characters 10 Digit ANSI/ABA 26 or 34-bit

b. Wiegand Card Reader:

- 1) Shall be utilized during the transition from the existing technology to the contactless smart card technology as defined in FIPS-201.
- 2) Shall read credential cards which are encoded using Wiegand effect ferromagnetic wires laminated into the credential card.
- 3) Shall create a magnetic field and output a coded representation of the unique pattern of magnetic flux changes produced by moving the credential card through the card reader.
- 4) The output shall be a series of electrical signals and shall constitute a unique identification code number.
- 5) Wiegand credential cards shall use at least 24 binary digits to generate a unique credential card identification code.
- 6) The card reader shall meet or exceed the following technical characteristics:

Card Speed	5 to 30 inches (203 to 1270mm) per second
Data Rate	1ms per bit
Connections	RJ-45 Jack or multi- conductor quick disconnect
Output Formats	26 or 34-bit
Power	Per Manufacturers Specifications
Lifetime	600,000 pass read head
Error Rate	false accept
Static Discharge	Withstands 20,000 volts
LED	If required per the design package
Card Output Format	EMPI 26 or 34-bit ANSI/ABA All bits Clock-and-Data up to 37 characters 10 Digit ANSI/ABA 26 or 34-bit

c. 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. Proximity (PROX) Card Reader:
    - 1) Shall be utilized during the transition from the existing technology to the contactless smart card technology as defined in FIPS-201.
    - 2) Shall use active/passive proximity detection and shall not require contact with the proximity credential card for operation.
      - (a) Active detection proximity card readers shall provide power to compatible credential cards through magnetic induction and receive and decode a unique identification code number transmitted from the credential card.
      - (b) Passive detection proximity card readers shall use a swept-frequency, radio frequency field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
    - 3) Shall read proximity cards in a range from 0 to at least six (6) inches (0 to at least 15 cm) from the reader. The credential card design shall allow for a minimum of 32,000 unique identification codes per facility.
    - 4) Shall be able to read cards from two (2) inches (5cm) to 6 inches (15cm).
    - 5) For exterior parking lots or garages shall be 16 inches (40 cm).
    - 6) The operating frequency shall be determined by the type of access control system being utilized.
  - e. Credential Cards: Shall be in accordance with FIPS 201 and controlled by the PIV enrollment and issuance system.
- G. Picture ID and Badging Station:
  - 1. Shall be FIPS 201 compliant and will be controlled by the PIV enrollment and issuance system.
  - 2. Shall provide a form-based interface for the entry of badge holder data and access information. All data, including images, shall be stored on the system server.
  - 3. Shall allow image and signature capture for use in badge production, and provides tools for badge design. Both video and digital cameras may be utilized.
  - 4. Shall meet the following minimum characteristics:
    - a. Windows 2000/XP
    - b. Support for all ID Cards, Reader and Printer Technologies
    - c. Centralized User Enrollment
    - d. Password Protected
    - e. High Speed Photo Capture
    - f. Signature and/or Biometric Data Capture
    - g. Digital Certificate Management



- h. Report Generator
- i. Intelli-Check ID Check Integration or Equivalent
- j. Photo Capture via Digital or Video Camera
- k. In-line Encoding of Magnetic Stripe and Barcode
- l. ZD (PDF-417) Barcode Support
- m. Image Compression Control
- n. Image FX Gallery
- o. Program Badge
- p. Chromakey and Ghosting

**H. Biometrics:**

1. Shall be FIPS 201 and NIST SP 800-76 compliant.
2. Shall utilize hand/palm, fingerprint, retinal, or voice verification and could be utilized as secondary authentication in conjunction with card readers in high security area as defined by the VA. (Note: VA policy requires that the use of biometric measurements is limited to secondary authentication in high or medium security applications).
3. Shall be programmable, addressable, and hardwired directly to the main control panel and individually home run to the main control panel.
4. Shall be installed in a manner that they comply with:
  - a. The Uniform Federal Accessibility Standards (UFAS)
  - b. The Americans with Disabilities Act (ADA)
  - c. The ADA Standards for Accessible Design
5. Shall include a means to construct individual templates or profiles based upon measurements taken from the person to be enrolled. This template shall be stored as part of the System Reference Database Files. The stored template shall be used as a comparative base by the personnel identity verification equipment to generate appropriate signals to the associated local processors.
6. Shall interface with PACS and SMS and provide the employee's name, contact information, and point of access.
7. Shall allow for surface, flush, or pedestal mounting.
8. Shall have communications protocol in place that shall allow for communications with the SMS.
9. Shall determine when multiple attempts were made for verification, and shall automatically prompt the user for additional attempts up to a maximum of three tries. After a third failed attempt the unit shall generate an entry control alarm. This alarm will report to the SMS and the CCTV system. The camera viewpoint for where the alarm was generated shall automatically be called up onto a monitor and be recorded via the recording equipment. An alarm within the SMS shall also be generated recording, at a minimum, the date, time, and attempted point of entry.
10. Hand/Palm Geometry Verification:
  - a. Shall utilize unique human hand measurements to identify authorized, enrolled personnel.

- b. During the scan process the hand geometry device, which shall allow the user's hand to remain in full view during the scanning process, shall a three (3) dimensional measurement of the user's hand identifying its size and shape.
  - c. This scan process shall start automatically once the user's hand is positioned. The hand geometry device shall be able to use either left or right hands for enrollment and verification.
  - d. Shall include an LED or other type of visual indicator display and provide visual or visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
  - e. Shall only be updated at the unit itself and automatic updates via the SMS shall not be allowed.
  - f. Any significant change to the user's hand, scars, loss of digit, or any other change that will alter the three dimension view of the hand shall require an update to the unit and SMS.
  - g. Shall provide an enrollment, recognition, and code/credential verification mode. The enrollment mode shall create a hand template for new personnel and enter the template into the entry control database file created for that person. Template information shall be compatible with the system application software. The operating mode shall be selectable by the system manager/operator from the central processor. When operating in recognition mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches a hand geometry template stored in the database files. When operating in code/credential verification mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches the hand geometry template associated with the identification code entered into a keypad; or matches the hand geometry template associated with credential card data read by a card reader.
11. Fingerprint Verification:
- a. Shall use a unique human fingerprint pattern to identify authorized, enrolled personnel.
  - b. Shall allow the user's hand to remain in full view during the scanning process, shall incorporate positive measures to establish that the hand or fingers being scanned by the device belong to a living human being.
  - c. Shall provide an optical or other type of scan of the user's fingers. The fingerprint verification scanner shall automatically initiate the scan process provided the user's fingers are positioned.
  - d. LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
  - e. Any significant change to the user's finger such as scars, loss of digit, or any other change that will alter the finger print shall require an update to the unit and SMS.
  - f. Shall provide an adjustable acceptance tolerance or template match criteria under system manager/operator control.
  - g. Shall respond to passage requests by generating signals to the local processor. The verification time shall be 2.0 seconds or less from the moment the finger print analysis scanner initiates the scan process until the fingerprint analysis scanner generates a response signal.

- h. Shall:
    - 1) Provide an enrollment mode, recognition mode, and code/credential verification mode. The enrollment mode shall create a fingerprint template for new personnel and enter the template into the system database file created for that person.
    - 2) Template information shall be compatible with the system application software.
    - 3) The operating mode shall be selectable by the system manager/operator from the central station.
  - i. When operating in recognition mode, the fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt matches a fingerprint template stored in the database files.
  - j. When operating in code/credential verification mode, the fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt matches a fingerprint template associated with the identification code. When entered into a keypad or it matches the fingerprint template associated with credential, the card data will then be recognized by the card reader.
  - k. Shall store template transactions involving fingerprint scans. The template match scores shall be stored in the matching personnel data file in a format compatible with the system application software, and shall be used for report generation.
12. Iris Verification:
- a. Shall utilize unique patterns within the human eye to identify authorized, enrolled personnel.
  - b. Shall use ambient light to capture an image of the iris of the person presenting themselves for identification. The resulting video image shall be compared against a stored template that was captured during the enrollment process.
  - c. Shall utilize a threshold for identification. The efficiency and accuracy of the device shall not be adversely affected by enrollees who wear contact lenses or eye glasses.
  - d. Shall provide a means for enrollees to align their eye for identification that does not require facial contact with the device.
  - e. Initiation for the scan should be automatic, but push-button could be provided to initiate the scan process. The device shall include adjustments to accommodate differences in enrollee height and mounting height shall be UFAS compliant.
  - f. The LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
  - g. Verification time for the retinal verification unit shall be no greater than 1.5 seconds from the moment the action is initiated until a response signal has been generated.
  - h. Shall provide an enrollment mode, recognition mode, and code/credential verification mode:
    - 1) The enrollment mode shall create an iris template for new personnel and enter the template into the system database file created for that person. Template information shall be compatible with the system application software.

- 2) When operating in recognition mode, the retinal verification unit shall allow passage when the retinal verification data from the verification attempt matches an iris template stored in the database files.
    - 3) When operating in code/credential verification mode, the iris scanner shall allow passage when the retinal verification data from the verification attempt matches the retinal verification template. This will occur when the associated information matches the identification code entered into a keypad or matches the retinal verification template associated with the credential card data when recognized by a card reader.
  - i. Shall store template transactions involving retinal verifications. The template match scores shall be stored in the matching personnel data file in a file format compatible with the system application software, and shall be used for report generation.
13. Voice Verification:
  - a. Shall utilize unique patterns within the human speech pattern to identify authorized, enrolled personnel.
  - b. Shall digitize a profile of a person's speech to produce a stored model voice print, or template. Users shall record their full names utilizing their natural voice tendencies. This process shall be initiated by a push to talk button on the voice verification device.
  - c. Shall utilize a threshold for identification. The efficiency and accuracy of the device shall not be adversely affected by enrollees who have a speech impediment.
  - d. Shall provide a means for enrollees to align their voice for identification that does not require contact with the device.
  - e. The LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
  - f. Verification time for the voice verification unit shall be no greater than 1.5 seconds from the moment the action is initiated until a response signal has been generated.
  - g. Shall provide an enrollment mode, recognition mode, and code/credential verification mode:
    - 1) The enrollment mode shall create a voice template for new personnel and enter the template into the system database file created for that person. Template information shall be compatible with the system application software.
    - 2) When operating in recognition mode, the voice verification unit shall allow passage when the voice verification data from the verification attempt matches a voice template stored in the database files.
    - 3) When operating in code/credential verification mode, the voice verifier shall allow passage when the voice verification data from the verification attempt matches the voice verification template. This will occur when the associated information of the identification code entered into a keypad matches the voice verification template associated with a credential card data is recognized by a card reader.
      - (a) Shall store template transactions involving voice verifications. The template match scores shall be stored in the matching personnel data file in a file format compatible with the system application software, MPEG or equivalent, and shall be used for report generation.

I. Portal Control Devices:

1. Shall be used to assist the PACS.
2. Such devices shall:
  - a. Provide a means of monitoring the doors status.
  - b. Allow for exiting a space via either a push button, request to exit, or panic/crash bar.
  - c. Provide a means of override to the PACS via a keypad or key bypass.
  - d. Assist door operations utilizing automatic openers and closures.
  - e. Provide a secondary means of access to a space via a keypad.
3. Shall be connected to and monitored by the main PACS panel.
4. Shall be installed in a manner that they comply with:
  - a. The Uniform Federal Accessibility Standards (UFAS)
  - b. The Americans with Disabilities Act (ADA)
  - c. The ADA Standards for Accessible Design
5. Shall provide a secondary means of access control within a secure area.
6. Keypads: Refer to Section 2.2.F.12 for keypad requirements.
7. Push-Button Switches:
  - a. 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.
  - b. 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.
  - c. 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.
  - d. Shall have double-break silver contacts that will make 720 VA at 60 amperes and break 720 VA at 10 amperes.
8. Crash Bar:
  - a. Emergency Exit with Alarm (Panic):
    - 1) Entry control portals shall include panic bar emergency exit hardware as designed.
    - 2) Panic bar emergency exit hardware shall provide an alarm shunt signal to the PACS and SMS.
    - 3) The panic bar shall include a conspicuous warning sign with one (1) inch (2.5 cm) high, red lettering notifying personnel that an alarm will be annunciated if the panic bar is operated.
    - 4) Operation of the panic bar hardware shall generate an intrusion alarm that reports to both the SMS and Intrusion Detection System. The use of a micro switch installed within the panic bar shall be utilized for this.

- 5) The panic bar shall have a fully mechanical connection only and shall not depend upon electric power for operation.
    - 6) The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key by-pass. Refer to Section 2.2.1.9 for key-bypass specifications.
  - b. Normal Exit:
    - 1) Entry control portals shall include panic bar non-emergency exit hardware as designed.
    - 2) Panic bar non-emergency exit hardware shall be monitored by and report to the SMS.
    - 3) Operation of the panic bar hardware shall not generate a locally audible or an intrusion alarm within the IDS.
    - 4) When exiting, the panic bar shall depend upon a mechanical connection only. The exterior, non-secure side of the door shall be provided with an electrified thumb latch or lever to provide access after the credential I.D. authentication by the SMS.
    - 5) The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key by-pass. Refer to Section 2.2.1.9 for key-bypass specifications. The strikes/bolts shall include a micro switch to indicate to the system when the bolt is not engaged or the strike mechanism is unlocked. The signal switches shall report a forced entry to the system in the event the door is left open or accessed without the identification credentials.
9. Key Bypass:
  - a. Shall be utilized for all doors that have a mortise or rim mounted door hardware.
  - b. Each door shall be individually keyed with one master key per secured area.
  - c. Cylinders shall be six (6)-pin and made of brass or equivalent. Keys for the cylinders shall be constructed of solid material and produced and cut by the same distributor. Keys shall not be purchased, cut, and supplied by multiple dealers.
  - d. All keys shall have a serial number cut into the key. No two serial numbers shall be the same.
  - e. All keys and cylinders shall be stored in a secure area that is monitored by the Intrusion Detection System.
10. Automatic Door Opener and Closer:
  - a. Shall be low energy operators.
  - b. Door closing force shall be adjustable to ensure adequate closing control.
  - c. Shall have an adjustable back-check feature to cushion the door opening speed if opened violently.
  - d. Motor assist shall be adjustable from 0 to 30 seconds in five (5) second increments. Motor assist shall restart the time cycle with each new activation of the initiating device.
  - e. Unit shall have a three-position selector mode switch that shall permit unit to be switched "ON" to monitor for function activation, switched to "H/O" for indefinite

hold open function or switched to "OFF," which shall deactivate all control functions but will allow standard door operation by means of the internal mechanical closer.

- f. Door control shall be adjustable to provide compliance with the requirements of the Americans with Disabilities Act (ADA) and ANSI standards A117.1.
- g. All automatic door openers and closers shall:
  - 1) Meet UL standards.
  - 2) Be fire rated.
  - 3) Have push and go function to activate power operator or power assist function.
  - 4) Have push button controls for setting door close and door open positions.
  - 5) Have open obstruction detection and close obstruction detection built into the unit.
  - 6) Have door closer assembly with adjustable spring size, back-check valve, sweep valve, latch valve, speed control valve and pressure adjustment valve to control door closing.
  - 7) Have motor start-up delay, vestibule interface delay; electric lock delay and door hold open delay up to 30 seconds. All operators shall close door under full spring power when power is removed.
  - 8) Are to be hard wired with power input of 120 VAC, 60Hz and connected to a dedicated circuit breaker located on a power panel reserved for security equipment.

**J. Door Status Indicators:**

- 1. Shall monitor and report door status to the SMS.
- 2. Door Position Sensor:
  - a. Shall provide an open or closed indication for all doors operated on the PACS and report directly to the SMS.
  - b. Shall also provide alarm input to the Intrusion Detection System for all doors operated by the PACS and all other doors that require monitoring by the intrusion detection system.
  - c. Switches for doors operated by the PACS shall be double pole double throw (DPDT). One side of the switch shall monitor door position and the other side if the switch shall report to the intrusion detection system. For doors with electromagnetic locks a magnetic bonding sensor (MBS) can be used in place of one side of a DPDT switch, in turn allowing for the use of a single pole double throw (SPDT) switch in place of a DPDT switch.
  - d. Switches for doors not operated by the PACS shall be SPDT and report directly to the IDS.
  - e. Shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).
- 3. Request-to-Exit (RTE):
  - a. Shall be utilized to de-energize the locking hardware on a door to allow for exiting a secure area.
  - b. Shall be either an infrared sensor or a push button.
  - c. Infrared sensors shall meet the following minimum technical characteristics:

Alarm Output	2 Form "C" relay contacts
Indicators	1 activation LED
Power Requirements	12 or 24 VAC, 12 or 24 VDC, 26 mA @ 12 VDC
Relay Latch	Time Adjustable to 60 seconds

K. 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 veristor (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.
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 mag-lock shall be surface mounted to the door frame and the door plate shall be surface mounted to the door.
  - c. Ensure a diode or MOV is installed in line with the DC voltage supplying power to the unit in order to prevent back-check on the system when the mag-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	1500 lbs (675 Kg)
	Sliding Doors	500 lbs (225 Kg)

8. Turnstiles:

- a. Shall operate at 110 VAC, 60 Hz or 220 VAC, 50 Hz supplied from a dedicated circuit breaker on a security power panel. This device does not require a back-up power source.
- b. Shall be utilized as a means of monitoring and controlling access in a lobby.
- c. Shall meet the following minimum requirements:
  - 1) Be UFAS compliant.
  - 2) Provide either an audible or visual confirmation that access has been granted to a cleared individual.
  - 3) Provide an audible alarm in the event a non-cleared individual is attempting to gain access.
  - 4) Interface with the SMS and utilize a card reader for accessing and exiting a facility, and provide a recorded event of personnel accessing these points.
  - 5) Have a built-in step-down transformer to provide power to a card reader unit.
  - 6) Have built-in signal wiring chassis to allow for plug and play capabilities with the PACS.
  - 7) Have the ability to detect tailgating within one quarter on an inch to prevent unauthorized access to a facility.

L. Power Supplies:

1. Shall be UL rated and able to adequately power two entry control devices on a continuous base without failure.
2. Shall meet the following minimum technical characteristics:

INPUT POWER	110 VAC 60 HZ 2 amp
OUTPUT VOLTAGE	12 VDC Nominal (13.8 VDC) 24 VDC Nominal (27.6 VDC) Filtered and Regulated
BATTERY	Dependant on Output Voltage shall provide up to 14 Ah
OUTPUT CURRENT	10 amp max. @ 13.8 VDC 5 amp max. @ 27.6 VDC
PRIMARY FUSE SIZE	6.3 amp (non-removable)
BATTERY FUSE SIZE	12 amp, 3AG
CHARGING CIRCUIT	Built-in standard

**M. Wires and Cables**

1. Shall meet or exceed the manufactures recommendations for power and signal.
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 clearly marked every with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
5. Conduit fills shall not exceed 50 percent unless otherwise documented.
6. A pull rope shall be pulled along with signal and power cables to assist in future work.
7. At all locations where core drilling is conducted to allow for conduit to be installed, then fire stopping shall be applied to that area.
8. High power and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High power for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
9. Signal Cables:
  - a. Shall meet or exceed all specifications and requirements called out by the manufactures.
  - b. Shall be twisted pairs.
  - c. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within 3 feet, (1 meter) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:
    - 1) A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and peak current of 60 amperes.
    - 2) An 8 microsecond rise time by 20 microsecond pulse width wave form with a peak voltage of 1000 volts and peak current of 500 amperes.
10. Power Cables:
  - a. Shall be rated for either 110 or 220 VAC, 50 or 60 Hz, and shall comply with VA Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).
  - b. Shall be sized according and comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket.
  - c. Low Voltage Power Cables:
    - 1) All cables shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.

- 2) Specific cable size shall be determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.
- d. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.

## **2.3 INSTALLATION KIT**

- A. General: The kit shall be provided that at a minimum includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. 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 outlined are the minimum required installation sub-kits:
  1. 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
  2. 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.
  3. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier strips, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
  4. 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.

5. 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.
6. 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.
7. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to provide the system documentation as required by this document and explained herein.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. System installation shall be in accordance with UL 294, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.
- B. Components shall be configured with appropriate "service points" to pinpoint system trouble in less than 30 minutes.
- C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a operable system.
- D. The PACS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a network.
- E. For integration purposes, the PACS shall be integrated where appropriate with the following associated security subsystems:
  1. CCTV:
    - a. Provide 24 hour coverage of all entry points to the perimeter and agency buildings. As well as all emergency exits utilizing a fixed color camera.
    - b. Be able to monitor, control and record cameras on a 24 hours basis.
    - c. Be programmed automatically call up a camera when an access point is but into an alarm state.
    - d. For additional PACS system requirements as they relate to the CCTV, refer to Section 28 23 00, VIDEO SURVEILLANCE.
  2. IDS:
    - a. Be able monitor door control sensors.
    - b. Be able to monitor and control the IDS on a 24 hours basis.
    - c. Be programmed to go into an alarm state when an IDS device is put into an alarm state, and notify the operator via an audible alarm.
    - d. For additional PACS system requirements as they relate to the IDS, refer to Section 28 16 11, INTRUSION DETECTION SYSTEM.
  3. Security Access Detection:
    - a. Be able to monitor all objects that have been screened with an x-ray machine and be able to monitor all data acquired by the bomb detection unit.

- b. For additional PACS system requirements as they relate to the Security Access Detection, refer to Section 28 13 53, SECURITY ACCESS DETECTION.
- 4. EPPS:
  - a. Be programmed to go into an alarm state when an emergency call box or duress alarm/panic device is activated, and notify the Access Control System and Database Management of an alarm event.
  - b. For additional PACS requirements as they relate to the EPPS, refer to Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM.
- F. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.
- G. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.
- H. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system. The Contractor shall not take any corrective action without written permission from the Government.
- I. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.
- J. Existing Equipment:
  - 1. The Contractor shall connect to and utilize existing door equipment, control signal transmission lines, and devices as outlined in the design package. Door equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.
  - 2. The Contractor shall perform a field survey, including testing and inspection of all existing door equipment and signal lines intended to be incorporated into the PACS, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
  - 3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
  - 4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or improper installation of equipment.
  - 5. The Contracting Officer shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.

- K. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.
- L. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.
- M. Control Panels:
  - 1. Connect power and signal lines to the controller.
  - 2. Program the panel as outlined by the design and per the manufacturer's programming guidelines.
- N. SMS:
  - 1. Coordinate with the VA agency's IT personnel to place the computer on the local LAN or Intranet and provide the security system protection levels required to insure only authorized VA personnel have access to the system.
  - 2. Program and set-up the SMS to ensure it is in fully operation.
- O. Card Readers:
  - 1. Connect all signal inputs and outputs as shown and specified.
  - 2. Terminate input signals as required.
  - 3. Program and address the reader as per the design package.
  - 4. Readers shall be surface or flushed mounted and all appropriate hardware shall be provided to ensure the unit is installed in an enclosed conduit system.
- P. Biometrics:
  - 1. Connect all signal input and output cables along with all power cables.
  - 2. Program and ensure the device is in operating order.
- Q. Portal Control Devices:
  - 1. Install all signal input and output cables as well as all power cables.
  - 2. Devices shall be surface or flush mounted as per the design package.
  - 3. Program all devices and ensure they are working.
- R. Door Status Indicators:
  - 1. Install all signal input and output cables as well as all power cables.
  - 2. RTE's shall be surface mounted and angled in a manner that they cannot be compromised from the non-secure side of a windowed door, or allow for easy release of the locking device from a distance no greater than 6 feet from the base of the door.
  - 3. Door position sensors shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).
- S. Entry Control Devices:
  - 1. Install all signal input and power cables.

2. Strikes and bolts shall be mounted within the door frame.
3. Mortise locks shall be mounted within the door and an electric transfer hinge shall be utilized to transfer the wire from within the door frame to the mortise lock inside the door.
4. Electromagnetic locks shall be installed with the mag-lock mounted to the door frame and the metal plate mounted to the door.

**T. System Start-Up:**

1. The Contractor shall not apply power to the PACS until the following items have been completed:
  - a. PACS equipment items and have been set up in accordance with manufacturer's instructions.
  - b. A visual inspection of the PACS has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
  - c. System wiring has been tested and verified as correctly connected as indicated.
  - d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
  - e. Power supplies to be connected to the PACS have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

**U. Supplemental Contractor Quality Control:**

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed PACS; and are approved by the Contracting Officer.
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

**3.2 TESTING AND TRAINING**

- A. All Testing And Training Shall Be Compliant With The VA General Requirements, Section 01 00 00, General Requirements.**

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

**SECTION 28 31 00**  
**FIRE DETECTION & ALARM**  
**(CONNECTION TO EXISTING SYSTEM)**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of new fire alarm equipment to the existing equipment to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm indicating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring.
- B. Fire Alarm systems shall comply with requirements of NFPA 72 and 72A for local building systems except as modified and supplemented by this specification. Local building systems shall be zone coded with positive non-interfering and succession (PNIS) features.
- C. Each area shall have coded fire alarm signals to notify occupants to evacuate. The coded signal shall identify the area of the endangered building from which the alarm was initiated. The alarm system shall be electrically supervised.
- D. Each area's system shall transmit the following:
  - 1. A separate and distinct coded building alarm signal to the facility fire alarm headquarters and designated personnel in other buildings via the base loop compatible with the facility system.
  - 2. A separate and distinct coded building trouble signal to the facility fire alarm headquarters via the base trouble loop compatible with the facility system.
- E. The fire alarm system shall interface with the facility existing system. The system component installation and programming shall be performed in accordance with the requirements of the facility service company of record.
  - 1. Verify with the facility service companies of record for the extent of work required to connect into the system.
  - 2. Vendors: R.B. Allen (603-964-8140) ... Simplex Grinnell (401-435-1650).

**1.2 RELATED WORK**

Provide and coordinate all necessary work and products meeting the requirements associated with all applicable specification sections and plans to produce a system complete, functional and ready for the purpose intended. No statements here in shall relieve the Contractor of responsibilities described elsewhere in the contract documents.

- A. Division 01, GENERAL REQUIREMENTS: Work performance.
- B. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- C. Section 07 92 00, JOINT SEALANTS: Sealing around penetrations to prevent moisture and water migration.
- D. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.

**1.3 QUALITY ASSURANCE**



- A. Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Installer Qualifications: The installer has factory trained technical qualifications and specialized experience in installing products similar in material, design, and extent to those indicated with a record of successful in-service performance. Submit list of acceptable installations.
- C. Manufacturer Qualifications: The manufacturer is regularly engaged in manufacturing the specified material as a principal product with a minimum of five (5) years experience.
- D. Product Qualifications: The product submitted has been in satisfactory and efficient operation at three installations similar and equivalent to this Project for three (3) years. Submit list of acceptable product installations.
- E. Source Limitations: Each product type shall be the same and the product of a single manufacturer.
- F. Service Qualifications: There shall be a permanent service organization maintained that will render satisfactory service to this installation within four (4) hours of receipt of notification for service. Submit name and address of service organizations.

#### **1.4 SUBMITTALS**

In accordance with Section 01 33 23, SHOP DRAWINGS – PRODUCT DATA – SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:

- A. Manufacturer's Literature and Data (as applicable): Devices, wiring, wire numbering, color coding, zoning, device identification and operation has been established and shall be consistent with the existing system. The existing fire alarm system manufacturer is Edwards Systems Technologies (EST). All new devices and equipment shall be by "EST".
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include ratings, power requirements, dimensions, mounting, equipment, device arrangement, complete wiring diagrams (including floor plans), connection diagrams with terminal identification, material, and description of operation. Wiring and connection diagrams shall be certified by the fire alarm manufacturer.
  - 3. Show annunciator layout, codes, piping diagram, fire/smoke barrier interface, base loop interface, and auxiliary functions.
  - 4. Include information indicating who will certify the system and who will perform the post contract maintenance.
- C. Operation and Maintenance Manuals: Submit in accordance with Article, INSTRUCTION MANUALS, in Section 01 00 00, GENERAL REQUIREMENTS.
  - 1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
    - a. Wiring diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
    - b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
    - c. Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

- d. Approvals will be based on complete submissions of manuals together with shop drawings.
- 2. Four weeks prior to final inspection, deliver 4 copies of the final updated operating and maintenance manual to the Resident Engineer.
  - a. The manual shall be updated to include any information necessitated by shop drawing approval.
  - b. Complete "As installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.
  - c. Show all terminal identification.
  - d. Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
  - e. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
  - f. Show all codes.
  - g. Furnish manuals in loose-leaf binder or manufacturer's standard binder.
- D. Certifications:
  - 1. Together with the shop drawing submittal, submit a certification from the major equipment (EST) manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include name and address in the certification.
  - 2. Together with the shop drawing submittal, submit a certification from both the major equipment manufacturer and the detector manufacturer that the detectors being furnished are listed by UL as being compatible with the control equipment. The VA will not approve any submittal without this certification.
  - 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 requirements. The VA will not approve any submittal without this certification.
  - 4. Prior to the next Section of electrical work, submit to the Resident Engineer 4 copies of the inspection/testing report tabulating results, analysis, recommendations including records documenting that the material and installation is in accordance with all applicable manufacturers' recommendations, codes and contract requirements. Certifications by an Independent Inspection/Testing Organization – Inspection shall be performed by a registered professional Fire Protection Engineer (FPPE), and testing shall be performed by a qualified technician/representative authorized by the manufacturer of the major fire alarm system equipment.

#### 1.5 POST CONTRACT MAINTENANCE

- A. Complete maintenance and inspection service for the fire alarm system shall be provided for a period of one (1) year after acceptance of the installation by the Resident Engineer.
- B. Maintenance and inspection service shall be performed by factory trained authorized representatives of the major equipment manufacturer.
- C. Maintenance service shall include the following:
  - 1. Inspection:
    - a. Systematic examination of all equipment at six month intervals.

- b. Testing, cleaning, adjusting, repairing, and replacing of all components as necessary, to keep the system in reliable condition and proper working order.
  - c. Furnishing all tools, test instruments, cleaning materials and parts required.
  - d. Battery and charger maintenance shall be included.
- 2. Emergency Service:
  - a. Provide a response within 2 hours.
  - b. Overtime emergency callback service shall be limited to minor adjustments and repairs to affect the integrity of the system.
- 3. Non-included Work:
  - a. Maintenance service shall not include the performance of any work due to improper use, accidents, or negligence for which the Contractor is not directly responsible.
- D. Service and emergency personnel shall report to the Project Engineer, or his authorized representative, upon arrival at the hospital and again upon the completion of the required work. A copy of the work order containing a complete description of the work performed and parts replaced shall be given to the Project Engineer.
- E. The Contractor shall maintain a log at the fire alarm control panel. The log shall list the date and time of all examinations and trouble calls, condition of the system, and name of the technician. Each trouble call shall be fully described, including the nature of the trouble, necessary correction performed, and parts replaced.

#### 1.6 APPLICABLE PUBLICATIONS

Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

- A. National Fire Protection Association (NFPA):
  - 70.....National Electrical Code (NEC)
  - 72.....National Fire Alarm Code
  - 72A .....Local Protective Signaling Systems
  - 72E .....Automatic Fire Detectors
- B. Underwriters Laboratories, Inc. (UL):
  - 50 .....Safety Enclosures for Electrical Equipment
  - 268 .....Smoke Detectors for Fire Protective Signaling Systems
  - 864 .....Control Units for Fire Protective Signaling Systems

## PART 2 – PRODUCTS

### 2.1 EQUIPMENT AND MATERIAL

- A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by Underwriters Laboratories, Inc., or Factory Mutual Research Corporation. The authorized representative of the major equipment manufacturer such as control panel, annunciator, transmitters, and

initiating devices, shall install and be responsible for satisfactory total system operation and its certification.

- B. Devices, wiring, wire numbering, color coding, zoning, device identification and operation has been established and shall be consistent with the existing system. The existing fire alarm system manufacturer is Edwards Systems Technologies (EST). All new devices and equipment shall be by "EST".

## 2.2 WIRING

- A. Conduit Section 26 05 33, RACEWAY & BOXES FOR ELECTRICAL SYSTEMS, and Wire Section 26 05 21, LOW VOLTAGE ELECTRICAL CONDUCTORS & CABLES (600 Volts & Below), shall apply:
  - 1. Wiring shall be in accordance with NEC, as specified by the VA and as recommended by the manufacturer of the fire alarm system. All wires shall be color coded and installed in metal conduit. Conduit fill shall not exceed 40 percent of interior cross sectional area. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG.
  - 2. Base loop wiring shall be multi-conductor cable and not less than No. 12 AWG, but shall be sized in accordance with length of circuits. Cable for base loop wiring shall have color coded polyethylene insulated wires with polyethylene jacket, as per International Municipal Signal Association Specification No. 20-1, and as approved by the manufacturer of the fire alarm system. Tag each cable with a white letters on a red phenolic tag where it enters and exits manholes, handholes or junction boxes. Attach tags with nylon ties. Engrave each tag with easily readable, uppercase 1/4-inch block letters the following: "BASE LOOP", "ZONE NUMBER \_\_\_\_", "NUMBER OF CONDUCTORS \_\_\_\_" and "\_\_\_\_ AWG".
  - 3. Minimum conduit size shall be 3/4-inch.
  - 4. Wires in junction boxes and cabinets shall be permanently tagged and identified with phenolic tags attached by nylon ties.
- B. Provide type(s) of loop(s) as follows:
  - 1. An alarm loop (incoming codes).
  - 2. A trouble loop (incoming codes).
  - 3. A summoning loop (outgoing codes).
  - 4. Provide four spare wires as part of the base loop cable wiring for future purposes.
- C. Terminal Boxes, Junction Boxes and Cabinets:
  - 1. All boxes and cabinets shall be galvanized steel and in accordance with UL.
  - 2. Paint box and cover red and identify with letters of white paint stenciled as "Fire Alarm System" in accordance with Section 09 91 00, PAINTING.
  - 3. Junction boxes shall have a volume 40 percent greater than required by the NEC. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
  - 4. Terminal cabinets shall have identified pressure type terminal strips, and shall be located at the base of each riser as shown on the drawings.
- D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted.
- E. Provide complete wiring and conduit between all components. All devices shall be mounted upon and splices made in boxes.

- F. Fire alarm control systems and devices shall be connected to separate dedicated branch circuits, sized as required for proper service. Circuits shall be labeled "FIRE ALARM".

## 2.3 AUDIBLE/VISIBLE NOTIFICATION APPLIANCES

Shall be wall mounted. Appliance type and location shall meet the requirements of the NFPA, ADA, VA, contract documents and be compatible with the existing components in use at the facility.

## 2.4 VISIBLE NOTIFICATION APPLIANCES

Shall be wall mounted at exit stairways. Appliance style and location shall meet the requirements of the NFPA, ADA, VA, contract documents and be compatible with the existing components in use at the facility.

## 2.5 LOCATION-DESIGNATING LIGHTS

Shall be ceiling mounted above the manual stations. Appliance style and location shall meet the requirements of the NFPA, ADA, VA contract documents, and be compatible with the existing components in use at the facility.

## 2.6 SMOKE DETECTORS

- A. Smoke detectors shall be photoelectric system type, complying with applicable UL standards and be compatible with the existing components in use at the facility. Install in accordance with the manufacturer's recommendation and NFPA 72E. All detectors shall have an insect screen. Detectors shall have an indicator lamp to denote an alarm condition. Also provide a set of auxiliary contacts, one each normally open and normally closed (Form "C").
- B. Photoelectric detectors shall be factory calibrated. The sensitivity of any photoelectric detector shall be factory set at 3.2 percent plus or minus 0.5 percent obscuration per foot. These detectors shall be mounted as required for detection of the particles of combustion at the installed location without causing nuisance activation.
- C. Duct detectors shall be listed and labeled for duct installation. See the mechanical drawings for locations of duct detectors. 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). Duct detectors whose operation requires the heads to be mounted inside of ducts are not acceptable. Interlocking with fans shall be provided as specified in PART 3 under Article, TYPICAL OPERATION. Provide remote indicator lamps and identification nameplates (smoke detector) for smoke detectors concealed from normal view.
- D. Guaranteed simultaneous operation: Detector power supply shall be such that guaranteed simultaneous operation of all detectors shall result in alarm reporting and detector function of all detectors without losing any detector signal. Detectors shall be supplied with power circuit wiring separate from the alarm circuit wiring with sufficient capacity to operate all detectors simultaneously.
- E. Control and power panels necessary for operation of smoke detectors shall be provided as individual units, or integral with the fire alarm control panel. Detectors and associated panels must be compatible with the fire alarm control panel and suitable for use in supervised circuits. Detectors must be capable of functioning upon loss of normal AC system operating power and all necessary equipment and devices to permit such operation shall be provided. Malfunction of the circuitry to the detector or its control, or power units shall result in operation of the system trouble devices. Reset of detectors, after alarm, shall be from the fire alarm control panel.

## 2.7 ELECTROMAGNETIC DOOR HOLDERS

- A. Door holders are specified under Section 08 71 00, DOOR HARDWARE, connect and coordinate into the fire alarm system as specified in this section.

- B. Operation shall be by 24 volt DC supplied from a battery located at the fire alarm control panel. Coordinate door holders as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring, and fire alarm system for the operation specified.
- C. A maximum of eight door holders shall be provided for each circuit with its own fuses, disconnect switch and pilot light.
- D. Associated relay control circuits shall be electrically supervised.
- E. Smoke detectors shall not be incorporated as an integral part of door holders, but are functionally associated as hereinafter specified.
- F. Provide master control switches with pilot light, for maintaining power to door holders during fire alarm tests. A switch shall be located at the fire alarm control panel.

### **PART 3 – EXECUTION**

#### **3.1 GENERAL**

Preserve building fire protection zones during construction. Contractor shall remove fire alarm system smoke detectors that can be affected by construction work and temporarily replace devices with system compatible heat detectors (Rate-of-Rise & 135 F Fixed Temperature features). Prior to removal, test the smoke detectors to assure correct operation. After installation, test the system for proper operation, and report the results to the VA Safety Officer. After construction is substantially complete, remove the heat detectors, clean the existing smoke detectors, reinstall, and test each device for proper system operation. Contractor shall contract the fire alarm service company of record to program each new and reinstalled compatible device when each device is removed or installed into the existing fire alarm system ... R B Allen (North Hampton, NH) for the disconnection/installation of components, and the facility service company of record for the testing of installed and serviced devices should be coordinated for these tasks.

#### **3.2 INSTALLATION**

- A. Installation shall be in accordance with the NFPA, NEC, as recommended by the major equipment manufacturer and as required by the contract documents. Contractor shall coordinate work for seamless continual operation of the system.
- B. Approved smoke sensor dust covers for existing sensors may be installed each day wherever demolition or construction occurs in proximity to live sensors – VA Safety Officer acceptance is required. Covers used on live devices shall be removed at the end of each workday.
- C. Contractor shall contract with the fire alarm service company of record to program each device into the fire alarm system at the time each and any device is removed/installed.
- D. The fire alarm manufacturer shall be required to program the devices for the smoke/fire control zone matrix as defined by the existing smoke partitions.
- E. Install cleaned smoke detector heads not more than two (2) weeks prior to final inspection. Test the smoke detectors in place.
- F. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall perform the tests in Article 3.4 Tests. The representative shall demonstrate that the system functions properly in every respect in the presence of a VA representative.

#### **3.3 FIELD QUALITY ASSURANCE**

- A. Acceptance Testing: Contractor shall notify the Resident Engineer in writing seven (7) days after the pretest has been completed and 30 days prior to the date acceptance testing is expected to begin. The system shall be tested in the presence of the Resident Engineer.

Contractor shall verify that the total system meets all of the requirements of the specification and complies with all appropriate standards.

- B. Work shall interface with the facility existing system where applicable. Installation shall be performed in accordance with the requirements of the facility service company of record. Final connections and programming of components shall be performed by the facility service company of record.
- C. Normal System Operation: Actuation of any smoke shall cause the following operations to occur, unless otherwise specified:
  - 1. Operate the audible signals in the building; transmitting four rounds of coded signals.
  - 2. Flash the fire lights in unison with audible signals. Lights shall continue to flash "march time" until reset at the fire alarm control panel.
  - 3. Light the associated zone and category lamp on the annunciator.
  - 4. Release all magnetic door holders on the floor from which alarm was initiated after one round of code. Single impulses with time delay shall not release the door holders.
  - 5. Transmit a separate code alarm signal, via an individual auxilialized transmitter and base loop wiring, to remote locations.
  - 6. Duct smoke detectors and waterflow switches shall perform the functions indicated in the mechanical section specifications and as shown on the mechanical drawings.
- D. Verify with the facility service company of record for the extent of work required to connect into the system.

[JP – Simplex-Grinnell \(1-800-746-7539\) of Westminster, MA](#)

[JP – R B Allen \(1-800-258-7264\) of North Hampton, NH](#)

### 3.4 FIELD INSPECTIONS, OPERATING AND PERFORMANCE TESTS

- A. Schedule and perform all required inspections and tests for each piece of equipment as required by the manufacturers and specified in the contract documents in the presence of the Resident Engineer. Performance shall include all new and existing to be reused components. Performance shall include running the equipment and controls as applicable through their complete operational cycles with all components installed.
- B. Inspections (visual/mechanical) and Tests shall be performed during a minimum of two periods (rough and final). Due to project phasing and construction coordination additional periods may be necessary. The electrical system shall be considered ready for the rough Inspections and Tests once the conduit system is complete and all the cables have been pulled. Inspection and Tests requires witness of the VA scheduled 2 weeks in advance, and documentation reports.
- C. A factory-trained representative of the manufacturer of the major equipment shall perform the required tests described in Article 3.4, and as recommended in 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 the VA Resident Engineer.
- D. Provide the service of a 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 Resident Engineer.
- E. 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 Resident Engineer. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm system meets all contract requirements. After the system has passed the test and been approved by the Resident

Engineer, the contractor may request a final inspection. Final acceptance of system will not be made until retested at 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. Verify that all codes are coming in clearly and correctly. Verify time delay on water flow switches to assure that water surges do not trip transmitters. Submit report listing all water flow switch operations and their retard time.
4. Open fire alarm station circuits to see if trouble signal actuates.
5. Open audible signal circuits to see if the trouble signal actuates.
6. Ground fire alarm station circuits and verify response of trouble signals.
7. Ground audible signal circuits and verify response of trouble signals.
8. Check code transmission of all fire alarm devices and verify proper operation of positive non-interfering succession requirements by operating two fire alarm stations simultaneously.
9. Check installation, supervision, operation and sensitivity of smoke detectors to ascertain that they will avoid false alarm signals and will function as specified. See Article, SMOKE DETECTORS.
10. Contractor shall furnish the Resident Engineer one approved smoke test device.
11. Verify compliance of products/installation with approved Submittals, Contract Documents, and Codes.

- F. Make necessary modifications for compliance with applicable criteria. Accomplish all necessary field settings, adjustments and modifications to comply with the project intent. Demonstrate results compared to acceptable values.

### 3.5 INSTRUCTIONS TO GOVERNMENT PERSONNEL

- A. Refer to PART 3 of Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Furnish the services of a competent instructor for not less than two 4-hour periods for instructing personnel in the operation and maintenance of the system, on the dates requested by the Resident Engineer.

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