

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and Division 00 and 01, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:

1. Medical-surgical vacuum piping, designated "medical vacuum."
2. Waste anesthetic gas disposal piping, designated "WAGD."
3. Dental vacuum piping, designated "dental vacuum."
4. Oral evacuation piping, designated "HVE."
5. Healthcare laboratory vacuum piping, designated "medical laboratory vacuum."
6. Laboratory low-vacuum piping, designated "laboratory low vacuum."
7. Laboratory high-vacuum piping, designated "laboratory high vacuum."

- B. Related Requirements:

1. Division 11 for gas outlets in laboratory fume hoods.
2. Division 12 for gas outlets in casework.
3. Division 22 for combined medical air, vacuum, and gas alarms.

### 1.3 DEFINITIONS

- A. HVE: High-volume (oral) evacuation.
- B. WAGD: Waste anesthetic gas disposal.
- C. Medical vacuum piping systems include medical vacuum, WAGD, dental vacuum, HVE, and medical laboratory vacuum piping systems.
- D. Nonmedical laboratory vacuum piping systems include laboratory low-vacuum and laboratory high-vacuum piping systems.

### 1.4 CODES AND STANDARDS

- A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.

### 1.5 SUBMITTALS

- A. General: See Division 23 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: For each type of product.
- C. Qualification Data: For [Installer] [and] [testing agency].
- D. Material Certificates: Signed by Installer certifying that medical vacuum piping materials comply with requirements in NFPA 99.

- E. Brazing certificates.
- F. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical vacuum suction inlets.
    - a. Medical Vacuum: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
    - b. WAGD: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
  - 2. D.I.S.S. Service Connections: Furnish complete medical vacuum suction inlets complying with CGA V-5.
    - a. Medical Vacuum D.I.S.S. No. 1220: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
    - b. WAGD D.I.S.S. No. 2220: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Medical Vacuum Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
  - 2. Pressure-Seal Joining Procedure for Copper Tubing: An authorized representative who is trained and approved by manufacturer.
  - 3. Extruded-Tee Outlet Procedure: An authorized representative who is trained and approved by manufacturer.
  - 4. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is [ a member of the Medical Gas Professional Healthcare Organization or is] an NRTL, and that is acceptable to authorities having jurisdiction.
  - 1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

## PART 2 – PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Medical vacuum operating at [15 in. Hg] [20 in. Hg] [30 in. Hg] <Insert value>.
- B. WAGD operating at [14 in. Hg] [15 in. Hg] <Insert value>.
- C. Dental vacuum operating at [10 in. Hg] [12 in. Hg] <Insert value>.
- D. HVE operating at [5 in. Hg] [8 in. Hg] <Insert value>.
- E. Medical laboratory vacuum operating at [12 in. Hg] [20 in. Hg] [24 in. Hg] <Insert value>.
- F. Laboratory low vacuum operating at [12 in. Hg] [20 in. Hg] <Insert value>.
- G. Laboratory high vacuum operating at [24 in. Hg] [29 in. Hg] <Insert value>.

### 2.2 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for medical vacuum piping materials.
- B. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
- C. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper [ that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service].
- D. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service.
- E. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- F. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
  - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
  - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- G. Shape-Memory-Metal Couplings:
  - 1. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

- H. Pressure-Seal Fittings:
  - 1. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
  - 2. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- I. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.
- J. PVC Pipe: ASTM D 1785, [Schedule 40] [and] [Schedule 80].
- K. PVC Fittings: [ASTM D 2466, Schedule 40] [and] [ASTM D 2467, Schedule 80]; socket type.
- L. Transition Fittings: PVC socket type with copper threaded insert on one end.
- M. Flexible Pipe Connectors:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flex-Hose Co., Inc.
    - b. Flexicraft Industries.
    - c. Hyspan Precision Products, Inc.
    - d. Mercer Rubber Co.
    - e. Metraflex, Inc.
    - f. Proco Products, Inc.
    - g. Unaflex.
    - h. Universal Metal Hose; a Hyspan Co.
    - i. Or Approved Equal.
  - 2. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
    - a. Working-Pressure Rating: [200 psig] [250 psig] minimum.
    - b. End Connections: Threaded copper pipe or plain-end copper tube.

### 2.3 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- C. Threaded-Joint Tape: PTFE.
- D. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- F. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

## 2.4 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
  - 1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.
- B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.
  - 1. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Allied Healthcare Products, Inc.; Chemetron Div.
      - 2) Allied Healthcare Products, Inc.; Oxequip Health Industries.
      - 3) Amico Corporation.
      - 4) BeaconMedaes.
      - 5) Squire-Cogswell/Aeros Instruments, Inc.
      - 6) Or Approved Equal.
    - b. Interior Finish: Factory-applied white enamel.
    - c. Cover Plate: [Aluminum or extruded-anodized aluminum] [Satin-chrome finish steel] [Stainless steel with NAAMM AMP 503, No. 4 finish] with frangible or removable windows.
    - d. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
  - 2. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Tri-Tech Medical.
      - 2) Or Approved Equal.
    - b. Interior Finish: Factory-applied white enamel.
    - c. Cover Plate: [Aluminum or extruded-anodized aluminum] [Stainless steel with NAAMM AMP 503, No. 4 finish] with frangible or removable windows.
    - d. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- C. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Healthcare Products, Inc.; Chemetron Div.

- b. Allied Healthcare Products, Inc.; Oxequip Health Industries.
  - c. Amico Corporation.
  - d. BeaconMedaes.
  - e. Conbraco Industries, Inc.
  - f. NIBCO INC.
  - g. Squire-Cogswell/Aeros Instruments, Inc.
  - h. Tri-Tech Medical.
  - i. Or Approved Equal.
2. Pressure Rating: 300 psig minimum.
  3. Ball: Full-port, chrome-plated brass.
  4. Seats: PTFE or TFE.
  5. Handle: Lever [ type with locking device].
  6. Stem: Blowout proof with PTFE or TFE seal.
  7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Bronze Check Valves: In-line pattern.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Healthcare Products, Inc.; Chemetron Div.
    - b. Amico Corporation.
    - c. BeaconMedaes.
    - d. Conbraco Industries, Inc.
    - e. Squire-Cogswell/Aeros Instruments, Inc.
    - f. Tri-Tech Medical.
    - g. Or Approved Equal.
  2. Pressure Rating: 300 psig minimum.
  3. Operation: Spring loaded.
  4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- E. PVC Ball Valves: MSS SP-122, with union ends and [150-psig] <Insert pressure> minimum working-pressure rating and suitable for vacuum service.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Valve, Inc.
    - b. Asahi/America.
    - c. Colonial Valve; a div. of Colonial Engineering, Inc.
    - d. George Fischer Inc.
    - e. Hayward Industrial Products, Inc.
    - f. IPEX Inc.
    - g. Jomar International Ltd.
    - h. NIBCO INC.
    - i. Plast-O-Matic Valves, Inc.
    - j. Sloane, George Fischer, Inc.
    - k. Spears Manufacturing Co.
    - l. Thermoplastic Valves Inc.
    - m. Or Approved Equal.

- F. PVC Butterfly Valves: Lug type with lever handle and [150-psig] <Insert pressure> minimum working-pressure rating and suitable for vacuum service.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Valve, Inc.
    - b. Asahi/America.
    - c. Colonial Valve; a div. of Colonial Engineering, Inc.
    - d. George Fisher Inc.
    - e. Hayward Industrial Products, Inc.
    - f. IPEX Inc.
    - g. NIBCO INC.
    - h. Sloane, George Fischer, Inc.
    - i. Spears Manufacturing Co.
    - j. Thermoplastic Valves Inc.
    - k. Or Approved Equal.
- G. PVC Check Valves: Ball-, in-line-, piston-, or swing-check design with flanged or union ends and [70-psig] [100-psig] <Insert pressure> minimum working-pressure rating and suitable for vacuum service.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Valve, Inc.
    - b. Asahi/America.
    - c. Colonial Valve; a div. of Colonial Engineering, Inc.
    - d. George Fisher Inc.
    - e. NIBCO INC.
    - f. Sloane, George Fischer, Inc.
    - g. Spears Manufacturing Co.
    - h. Thermoplastic Valves Inc.
    - i. Or Approved Equal.

## 2.5 MEDICAL VACUUM SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Healthcare Products, Inc.; Chemetron Div.
  2. Allied Healthcare Products, Inc.; Oxequip Health Industries.
  3. Amico Corporation.
  4. BeaconMedaes.
  5. Squire-Cogswell/Aeros Instruments, Inc.
  6. Tri-Tech Medical.
  7. Or Approved Equal.
- B. General Requirements for Medical Vacuum Service Connections:
1. Suitable for specific medical vacuum service listed.
  2. Include roughing-in assemblies, finishing assemblies, and cover plates.

3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
  4. Recessed-type units made for concealed piping unless otherwise indicated.
- C. Roughing-in Assembly:
1. Steel outlet box for recessed mounting and concealed piping.
  2. Brass-body inlet block.
  3. Seals that will prevent vacuum leakage.
  4. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
- D. Finishing Assembly:
1. Brass housing with primary check valve.
  2. Seals that will prevent vacuum leakage.
  3. Cover plate with gas-service label.
- E. Quick-Coupler Suction Service Connections:
1. Inlets for [medical vacuum] [medical vacuum and WAGD evacuation] [and] [WAGD] with noninterchangeable keyed indexing to prevent interchange between services.
  2. Constructed to permit one-handed connection and removal of equipment.
  3. With positive-locking ring that retains equipment stem in valve during use.
- F. D.I.S.S. Suction Service Connections:
1. Inlets complying with CGA V-5.
  2. Threaded indexing to prevent interchange between services.
  3. Constructed to permit one-handed connection and removal of equipment.
  4. Medical Vacuum: CGA V-5, D.I.S.S. No. 1220.
  5. WAGD: CGA V-5, D.I.S.S. No. 2220.
- G. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
- H. Cover Plates:
1. One piece.
  2. [Aluminum] [or] [stainless steel].
  3. Permanent, color-coded, identifying label matching corresponding service.

## 2.6 NITROGEN

- A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

## PART 3 – EXECUTION

### 3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have

supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb. of chemical to 3 gal. of water.
  - a. Scrub to ensure complete cleaning.
  - b. Rinse with clean, hot water to remove cleaning solution.

### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, vacuum producer sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Comply with NFPA 99 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install vacuum piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver [ and separator]. Comply with requirements in Division 22.
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.

- N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- O. Install medical vacuum piping from medical vacuum service connections specified in this Section, to equipment specified in Division 22 and to equipment specified in other Sections requiring medical vacuum service.
- P. Piping Restraint Installation: Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Division 22.
- Q. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
- T. Install unions in copper vacuum tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- U. Install unions in PVC vacuum piping NPS 2 and smaller adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- V. Install flanges in PVC vacuum piping NPS 2-1/2 and larger adjacent to flanged valves and at final connection to each machine, specialty, and piece of equipment.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.

### 3.3 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

### 3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.

- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Apply appropriate tape to external pipe threads.
- E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Do not use flux. Continuously purge joint with oil-free dry nitrogen during brazing.
- F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
- G. PVC-to-Copper Joints: Join transition fitting PVC socket end as solvent-cemented joint to PVC pipe and join fitting end with insert to copper tube as threaded joint.
- H. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by tube manufacturer.
- I. Flanged Joints:
  - 1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
  - 2. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- J. Pressure-Sealed Joints: Join copper tube and copper and copper-alloy fittings with tools recommended by fitting manufacturer.
- K. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.
- L. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. Apply primer and join according to ASME B31.9 and ASTM D 2672 for solvent-cemented joints.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 for seismic-restraint devices.
- B. Comply with requirements in Division 22 for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
  2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within [12 inches] <Insert dimension> of each fitting and coupling.
- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4: 60 inches with 3/8-inch rod.
  2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
  3. NPS 3/4: 84 inches with 3/8-inch rod.
  4. NPS 1: 96 inches with 3/8-inch rod.
  5. NPS 1-1/4: 108 inches with 3/8-inch rod.
  6. NPS 1-1/2: 10 feet with 3/8-inch rod.
  7. NPS 2: 11 feet with 3/8-inch rod.
  8. NPS 2-1/2: 13 feet with 1/2-inch rod.
  9. NPS 3: 14 feet with 1/2-inch rod.
  10. NPS 3-1/2: 15 feet with 1/2-inch rod.
  11. NPS 4: 16 feet with 1/2-inch rod.
  12. NPS 5: 18 feet with 1/2-inch rod.
  13. NPS 6: 20 feet with 5/8-inch rod.
  14. NPS 8: 23 feet with 3/4-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.
- K. Install [vinyl-coated] hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 30 inches with 3/8-inch rod.
  2. NPS 1-1/2 and NPS 2: 36 inches with 3/8-inch rod.
  3. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
  4. NPS 4 and NPS 5: 48 inches with 1/2-inch rod.
  5. NPS 6 and NPS 8: 54 inches with 5/8-inch rod.
- L. Install supports for vertical PVC piping every 48 inches.

### 3.6 IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22.
- B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Vacuum: Black letters on white background.
2. WAGD: White letters on violet background.
3. Dental Vacuum: [Black boxed letters on white-and-black diagonal stripe background] <Insert color code>.
4. HVE: [Black boxed letters on white-and-black diagonal stripe background] <Insert color code>.
5. Medical Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

### 3.7 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and to prepare test and inspection reports.
- B. Tests and Inspections:
  1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of [medical compressed-air piping] [and] [medical gas piping] systems.
  2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
    - a. Initial blowdown.
    - b. Initial pressure test.
    - c. Cross-connection test.
    - d. Piping purge test.
    - e. Standing pressure test for vacuum systems.
    - f. Repair leaks and retest until no leaks exist.
  3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
    - a. Standing pressure test.
    - b. [Individual-pressurization] [or] [pressure-differential] cross-connection test.
    - c. Valve test.
    - d. Master and area alarm tests.
    - e. Piping purge test.
    - f. Final tie-in test.
    - g. Operational vacuum test.
    - h. Verify correct labeling of equipment and components.
  4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
    - a. Inspections performed.
    - b. Procedures, materials, and gases used.
    - c. Test methods used.
    - d. Results of tests.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

### 3.8 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

- A. Testing Agency: [Owner will engage] [Engage] qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities and to prepare test and inspection reports.
- B. Tests and Inspections:
  - 1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop-in pressure.
    - a. Test Pressure for Copper Tubing: [100 psig] [150 psig] <Insert value>.
    - b. Test Pressure for PVC Piping: [50 psig] [100 psig] <Insert value>.
  - 2. Repair leaks and retest until no leaks exist.
  - 3. Inspect filters for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

### 3.9 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

### 3.10 PIPING SCHEDULE

- A. Connect new copper tubing to existing copper tubing with memory-metal couplings.
- B. Connect PVC pipe to copper tube with transition fittings.
- C. Flanges may be used where connection to flanged equipment is required.
- D. Medical Vacuum Piping: Use copper [medical gas] [water] tube, wrought-copper fittings, and brazed joints.
- E. WAGD Piping: Use copper [medical gas] [water] tube, wrought-copper fittings, and brazed joints.
- F. Dental Vacuum Piping: Use copper water tube, wrought-copper fittings, and [brazed] [soldered] joints.
- G. HVE Piping: Use [ one of] the following piping materials for each size range:
  - 1. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, wrought-copper fittings, and [brazed] [soldered] joints.

2. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, press-type fittings, and pressure-sealed joints.
  3. [NPS 4] <Insert size> and Smaller: [Schedule 40 PVC pipe, Schedule 40] [and] [Schedule 80 PVC pipe, Schedule 80] PVC fittings, and solvent-cemented joints.
  4. [NPS 5 to NPS 8] <Insert range>: [Type L, copper medical gas] [Type M, copper water] tube; wrought-copper fittings; and [brazed] [soldered] joints.
  5. [NPS 5 to NPS 8] <Insert range>: [Schedule 40 PVC pipe, Schedule 40] [and] [Schedule 80 PVC pipe, Schedule 80] PVC fittings, and solvent-cemented joints.
- H. Medical Laboratory Vacuum Piping: Use [ one of] the following piping materials for each size range:
1. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, wrought-copper fittings, and [brazed] [soldered] joints.
  2. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, press-type fittings, and pressure-sealed joints.
  3. [NPS 5 to NPS 8] <Insert range>: Copper [medical gas] [water] tube, wrought-copper fittings, and [brazed] [soldered] joints.
- I. Laboratory Low-Vacuum Piping: Use [ one of] the following piping materials for each size range:
1. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, wrought-copper fittings, and [brazed] [soldered] joints.
  2. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, press-type fittings, and pressure-sealed joints.
  3. [NPS 5 to NPS 8] <Insert range>: Copper [medical gas] [water] tube, wrought-copper fittings, and [brazed] [soldered] joints.
  4. [All Sizes] <Insert range>: Extruded-tee fittings and brazed joints may be used instead of standard tee fittings.
- J. Laboratory High-Vacuum Piping: Use [ one of] the following piping materials for each size range:
1. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, wrought-copper fittings, and [brazed] [soldered] joints.
  2. [NPS 4] <Insert size> and Smaller: Copper [medical gas] [water] tube, press-type fittings, and pressure-sealed joints.
  3. [NPS 5 to NPS 8] <Insert range>: Copper [medical gas] [water] tube, wrought-copper fittings, and [brazed] [soldered] joints.
  4. [All Sizes] <Insert range>: Extruded-tee fittings and brazed joints may be used instead of standard tee fittings.

### 3.11 VALVE SCHEDULE

A. Shutoff Valves:

1. Copper Tubing: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
2. PVC Piping:
  - a. NPS 4 and Smaller: [Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions] [PVC ball valve].

- b. NPS 5 and Larger: PVC butterfly valve.
- B. Zone Valves: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

**END OF SECTION**