

ADDENDUM NUMBER THREE

To the Drawings and Project Manual

Dated: January 9, 2025

Entitled:

INDIANA UNIVERSITY
BL027 Swain West, BL070 Simon Hall, BL071 Chemistry, BL072
Chemistry Addition, - Research Labs Renovation -
IU 20240397
Bloomington, Indiana

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Addendum Dated: January 29, 2025

Project Number: 00360477

TABLE OF CONTENTS

1. See the attached revised table of contents

CHANGES TO THE PROJECT MANUAL

1. Specification Section 11 53 13 Laboratory Fume Hoods
 - a. Replace entire section
2. Specification Section 11 90 00 Local Vacuum Network System
 - a. Add this section
3. Specification Section 22 10 05
 - a. Replaced entire section.
2. Specification Section 22 60 00
 - a. Added this section.

CHANGES TO THE DRAWINGS

1. DRAWING SHEETS G000, A000, AD100, AD101A, AD101B, AD102, A500, LF001.Y, LF411A, LF411B, LF412, LF601, LF602, P100, P101, P200', P210, P211, P212, P213, P402, P403, P404, P406, P501
 - a. See the attached full-sized sheets.
2. DRAWING SHEETS: P209, LFD05.X
 - a. See the full sized newly added sheets.

END OF ADDENDUM NUMBER THREE

Attachments: Specifications: 11 53 13, 11 90 00, 22 10 05, 22 60 00. Full sized revised sheets: G000, A000, AD100, AD101A, AD101B, AD102, A500, LF001.Y, LF411A, LF411B, LF412, LF601, LF602, P100, P101, P200', P210, P211, P212, P213, P402, P403, P404, P406, P501. Full sized newly added sheets P209 LFD05.X.

**SECTION 00 01 10
TABLE OF CONTENTS
Edited with
Addendum No 3**

PROCUREMENT AND CONTRACTING REQUIREMENTS

DIVISION 00 -- PROCUREMENT AND CONTRACTING REQUIREMENTS

- 00 01 02 - Project Information
- 00 01 03 - Project Directory
- 00 01 11 - IU CPF Procurement Division 00 and 01
- 00 31 00 - Available Project Information
- 00 43 25 - Substitution Request Form - During Bidding
- 00 43 30 - Proposed Subcontractor and Material Form
- 00 63 25 - Substitution Request Form - During Construction

SPECIFICATIONS

DIVISION 01 -- GENERAL REQUIREMENTS

- 01 10 00 - Summary
- 01 23 00 - Alternates
- 01 25 00 - Substitution Procedures
- 01 30 00 - Administrative Requirements
- 01 32 16 - Construction Progress Schedule
- 01 40 00 - Quality Requirements
- 01 42 19 - Reference Standards
- 01 50 00 - Temporary Facilities and Controls
- 01 60 00 - Product Requirements
- 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions
- 01 70 00 - Execution and Closeout Requirements
- 01 74 19 - Construction Waste Management and Disposal
- 01 78 00 - Closeout Submittals
- 01 79 00 - Demonstration and Training

DIVISION 02 -- EXISTING CONDITIONS

- 02 41 00 - Demolition

DIVISION 06 -- WOOD, PLASTICS, AND COMPOSITES

- 06 10 00 - Rough Carpentry

DIVISION 07 -- THERMAL AND MOISTURE PROTECTION

- 07 26 00 – Vapor Retarders
- 07 84 00 - Firestopping
- 07 92 00 - Joint Sealants

DIVISION 08 -- OPENINGS

- 08 11 13 - Hollow Metal Doors and Frames
- 08 14 16 - Flush Wood Doors
- 08 31 00 - Access Doors and Panels
- 08 71 00 - Door Hardware
- 08 80 00 – Glazing

DIVISION 09 -- FINISHES

- 09 05 61 – Common Work Results for Flooring Preparation
- 09 21 16 – Gypsum Board Assemblies
- 09 51 00 - Acoustical Ceilings
- 09 65 00 – Resilient Flooring
- 09 68 13 - Tile Carpeting
- 09 91 23 - Interior Painting

DIVISION 10 -- SPECIALTIES

- 10 26 00 - Wall and Door Protection
- 10 28 00 - Toilet, Bath, and Laundry Accessories
- 10 44 00 - Fire Protection Specialties

DIVISION 11 -- EQUIPMENT

- 11 53 13 - Laboratory Fume Hoods
- 11 90 00 – Local Vacuum Network System

DIVISION 12 -- FURNISHINGS

- 12 35 53.13 - Metal Laboratory Casework

DIVISION 21 -- FIRE SUPPRESSION

- 21 05 00 - Common Work Results for Fire Suppression
- 21 05 48 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment
- 21 05 53 - Identification for Fire Suppression Piping and Equipment
- 21 11 00 - Facility Fire-Suppression Water-Service Piping
- 21 13 00 - Fire-Suppression Sprinkler Systems

DIVISION 22 -- PLUMBING

- 22 05 13 – Common Motor Requirements for Plumbing Equipment
- 22 05 17 - Sleeve and Sleeve Seals for Plumbing Piping
- 22 05 19 – Meters and Gauges for Plumbing Piping
- 22 05 23 - General-Duty Valves for Plumbing Piping
- 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
- 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
- 22 05 53 – Identification for Plumbing Piping and Equipment
- 22 07 19 – Plumbing Piping Insulation
- 22 07 19.11 – Under-Lavatory Pipe and Supply Covers
- 22 10 05 – Plumbing Piping
- 22 10 06 – Plumbing Piping Specialties
- 22 40 00 – Plumbing Fixtures
- 22 45 00 – Emergency Plumbing Fixtures

22 60 00 – Gas and Vacuum System for Laboratory and Healthcare

Facilities

- 22 61 14 - Laboratory High-Purity Specialty Gas Piping Systems
- 22 66 00 – Chemical-Waste Systems for Laboratory and Healthcare Facilities
- 22 66 54 – Special Waste and Special Vent Piping
- 22 67 13 – Pure Water Piping

DIVISION 23 -- HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

- 23 05 00 – Common Work Results for HVAC
- 23 05 13 – Common Motor Requirements for HVAC Equipment
- 23 05 19 - Meters and Gauges for HVAC Piping
- 23 05 23 – General Duty Valves for HVAC Piping
- 23 05 29 – Hangers and Supports for HVAC Piping and Equipment
- 23 05 49 - Vibration Control for HVAC Piping and Equipment
- 23 05 53 - Identification for HVAC Piping and Equipment
- 23 05 93 - Testing, Adjusting, and Balancing for HVAC
- 23 05 95 - Certification of Fume Hood
- 23 07 00 - HVAC Insulation
- 23 09 06 - Control Installation Contract
- 23 21 13 - Hydronic Piping
- 23 21 21 - Process Cooling Water Piping (stainless)
- 23 21 22 - Process Cooling Water Piping (CPVC)
- 23 25 00 - HVAC Water Treatment

- 23 31 13 - Metal Ducts
- 23 33 00 - Air Duct Accessories
- 23 34 16 - Centrifugal HVAC Fans
- 23 36 00 - Air Terminal Units
- 23 37 13 – Diffusers, Registers, and Grilles
- 23 73 13 - Modular Indoor Air-Handling Units
- 23 84 16 – Dehumidification Units
- 23 82 16 - Air Coils
- 23 82 33 - Commercial Finned Tube Radiators

DIVISION 26 – ELECTRICAL

- 26 05 05 – Selective Demolition for Electrical
- 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- 26 05 26 - Grounding and Bonding for Electrical Systems
- 26 05 29 - Hangers and Supports for Electrical Systems
- 26 05 33.13 - Conduit for Electrical Systems
- 26 05 33.16 - Boxes for Electrical Systems
- 26 05 33.23 – Surface Raceways for Electrical Systems
- 26 05 53 - Identification for Electrical Systems
- 23 05 73 - Power System Studies
- 26 09 23 - Lighting Control Devices
- 26 24 16 - Panelboards
- 26 27 26 - Wiring Devices
- 26 28 13 - Fuses
- 26 28 16.13 – Enclosed Circuit Breakers
- 26 28 16.16 – Enclosed Switches
- 26 29 23 - Variable-Frequency Motor Controllers
- 26 51 00 - Interior Lighting

DIVISION 27 – COMMUNICATIONS

- 27 00 01 - Communications
- 27 05 29 - Hangers and Supports for Communication Systems
- 27 05 33 - Conduit for Communication Systems
- 27 05 36 - Cable Trays for Communication Systems
- 27 10 00 - Structured Cabling

DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY

BL000B - BL027 Swain West, BL070 Simon Hall, BL071 Chemistry,
BL072 Chemistry Addition - Research Labs Renovation
Bloomington, Indiana
IU 20240397; BSA# 00360477

28 46 00 - Fire Detection and Alarm

END OF SECTION

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**SECTION 11 53 13
LABORATORY FUME HOODS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Standard laboratory fume hoods, prepared for face velocity monitor to be installed by Division 23 contractor.
- B. Work surfaces.
- C. Service fittings and outlets.
- D. Airflow indicators and alarms.
- E. Piping within fume hoods for service fittings.
- F. Wiring within fume hoods for light fixtures and receptacles.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Blocking and nailers for anchoring fume hoods.
- B. Section 09 21 16 - Gypsum Board Assemblies: Reinforcements in metal-framed partitions for anchoring fume hoods.
- C. Section 09 22 16 - Non-Structural Metal Framing: Reinforcements in metal-framed partitions for anchoring fume hoods.
- D. Section 09 65 00 - Resilient Flooring: Resilient base applied to base cabinets.
- E. **Division 11 Section 119000 Local Vacuum Network System.**
- F. Section 12 35 53.13 - Metal Laboratory Casework: Additional requirements for base cabinets for fume hoods.
- G. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Field quality-control testing of fume hoods.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide fume hood exterior and interior dimensions and construction, utility and service requirements and locations.
- C. Shop Drawings: Indicate locations, large scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, clearances required, locations and types of service fittings.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Provide documentation of successful Factory Acceptance Testing.
- E. Test Reports: Indicate that each type of fume hood has been factory-tested and meets specified ASHRAE Std 110 (AM) requirements.
- F. Operation Data: Include description of equipment operation and required adjusting and testing.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- H. Project Record Documents: Record actual locations of concealed utility connections.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- D. Preconstruction Testing: Factory-test each type of hood as per referenced standard.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.06 FIELD CONDITIONS

- A. Ambient Conditions: Maintain temperature and relative humidity at occupancy levels during and after installation of fume hoods.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide one year manufacturer warranty for manufacturer's standard items (listed by part number in manufacturer's official publication).

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Laboratory Fume Hoods:
 - 1. Kewaunee Scientific Corp: www.kewaunee.com, Supreme Air Venture series
 - 2. Mott Manufacturing Ltd: www.mott.ca, RFV2
 - 3. Labconco Corporation; www.labconco.com, Xstream
 - 4. Air Master Systems
 - 5. Lab Crafters, Inc: www.lab-crafters.com, Air Sentry
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 VARIABLE AIR VOLUME (VAV) FUME HOODS

- A. Restricted-Bypass Fume Hoods:
 - 1. Provide a compensating bypass arrangement above the sash to open after sash is closed to less than 20 percent open. Bypass to maintain exhaust capacity of at least 100 CFM per square foot of work surface regardless of sash position.

2.03 PERFORMANCE REQUIREMENTS

- A. Fume hoods complying with the following when tested in accordance with ASHRAE Std 110:
 - 1. As-Manufactured (AM) Rating: AM 0.01 (0.01 ppm).
 - 2. As-Installed (AI) Rating: AI 0.10 (0.10 ppm).
 - 3. Average Face Velocity: 100 FPM (0.51 m/s) plus or minus 10 percent with sashes fully open.
 - 4. Face-Velocity Variation: Not more than 10 percent of average face velocity across the face opening with sash(es) fully open.
 - 5. Release Rate: 4.0 L/min.

6. Static-Pressure Loss: Not more than 1/2-inch w.g. (124 Pa) at 100 FPM (0.51 m/s) face velocity with sash fully open when measured at four locations 90 degrees apart around the exhaust duct and at least three duct diameters downstream from duct collar.

2.04 FUME HOODS

- A. General Requirements:
 1. Comply with SEFA 1.
 - a. Provide fume hoods UL listed and labeled for compliance with UL 1805.
 2. Pre-pipe fume hoods for service fittings.
 3. Pre-wire fume hoods for light fixtures and receptacles.
 - a. Terminate all wiring in a junction box on top of hood.
- B. Fume Hood:
 1. Ventilation: Variable Air Volume (VAV).
 2. Configuration: Standing-height; bench mounted, on chemical storage cabinets. Refer to elevations.
 3. Nominal Interior Height: 48 inches.
 4. Sash Type: Vertical rising.
 - a. Leak-free enclosure box, manufacturer's standard construction, for vertical rising sash.
 - b. Glazing: Laminated safety glass.
 - c. Sash Guides: Corrosion-resistant polyvinyl chloride (PVC) track.
 - d. Vertical Sash mechanism: Designed to prevent sash drop in case of mechanism failure.
 - 1) Cable: Minimum 3/32 inch (2 mm) thick stainless steel of construction standard with the manufacturer.
 - (a) Sprocket system for Sash Chain: Hardened sprockets with one full-width shaft per sash, running in ball-bearings.
 - e. Vertical Sash Pull: Type 316 stainless steel, with No.4 finish.
 5. Top Front Panel: Standard integral grille stamped into panel of same materials as fume hood exterior.
 6. Exterior: Sheet steel.
 7. Interior Lining: Polypropylene.
 - a. Color/Finish: White.
 8. Service Fittings and Fixtures:
 - a. As specified in 12 35 53.13 - Metal Laboratory Casework.
 - b. Cup Sink : Drop-in Epoxy, complete with removable stainer and waste fitting, side-mounted at floor-mounted fume hood.
 - 1) Shape: Oval.
 - 2) Size: 3 inches by 9 inches (75 by 228 mm).
 - c. **Reference standard for Outlet Fitting Assembly, except for vacuum: Model ColorTech manufactured by Water Saver Faucet Co..**
 - d. **Valves and outlets for vacuum shall be furnished to the fume hood manufacturer by Vacuubrand for factory installation. Coordinate delivery of valves and outlets with Vaccubrand.**
 - e. **Piping for vacuum shall be piping as furnished by Vacuubrand**
 9. Access Panels: Provide removable panels on both sides hood exterior and interior lining panels.
 10. Work Surface:
 - a. Work Top for Fume Hoods Other Than Floor-mounted Type: Epoxy resin.

- 1) Edge: Raised rim with beveled edges and corners.
- C. Fume Hood Base Cabinets:
1. See Section 12 35 53.13 - Metal Laboratory Casework.
 2. Exterior construction: Metal cabinets.
 3. Material: Sheet steel.
 4. Color/Finish: As indicated on drawings.
- D. Light Fixtures: UL labeled, vaporproof, one-tube, T-5 fluorescent light fixtures. Number and length of fixtures as necessary for fume hood width. Mounted above sealed safety glass panel. White baked-enamel finish on fixture interior.
1. Average Interior Illumination Level: 80 footcandles.

2.05 FABRICATION

- A. General: Assemble fume hoods in factory to greatest extent possible. Disassemble fume hoods only as necessary for shipping and handling limitations, or as necessary to permit movement through a 35 inches by 79 inches clear door opening.
- B. Steel Exterior: Fabricated from steel sheet, 0.048 inch (18-Gauge) thick, with component parts screwed together to allow removal of end panels, front fascia, and airfoil and to allow access to plumbing lines and service fittings. Chemical-resistant finish applied to interior and exterior surfaces of component parts before assembly.
- C. Ends: Fabricated with double-wall end panels. Close area between double walls at front of fume hood and as needed to house sash counterbalance weights, utility lines, and remote-control valves.
- D. Lining Assembly: Unless otherwise indicated, assembled with stainless-steel fasteners or epoxy adhesive, concealed where possible. Joints sealed by filling with chemical-resistant sealant during assembly.
1. Lining components fastened together with stainless-steel cleats or angles to form a rigid assembly to which exterior panels are attached.
 2. Punched fume hood lining side panels for service fittings and remote controls. Removable plug buttons for holes not used for indicated fittings.
- E. Rear Baffle: Same material as fume hood lining, unless otherwise indicated, at rear of hood with openings at top and bottom, with corrosion-resistant fasteners. Fabricated for removal to facilitate cleaning behind baffle.
1. Preset baffles, unless otherwise indicated.
- F. Exhaust Plenum: Full width of fume hood, sized and configured to provide uniform airflow, of same material as hood lining, and with duct stub for exhaust connection.
1. Duct-Stub Material: Epoxy-coated steel, unless otherwise indicated.
- G. Airfoil: At bottom of fume hood face opening, with ~~4-inch~~ no gap between bottom of airfoil and work top. Sash to close on top of airfoil. Designed to direct airflow across work.
1. Fabricated from ~~44-gauge, 0.0781-inch~~ 18-gauge paint steel.
- H. Ceiling Extensions: Filler panels matching fume hood exterior to enclose space above fume hoods at front and sides of fume hoods, and extending from tops of fume hoods to ceiling. Flange, notch, and reinforce ceiling extensions as required for rigidity. Fabricate to form well-fitting closures, free from oil-canning.
1. Provide bottom-hinged access panels within the front ceiling extension filler panel to facilitate access to light fixture and other fume hood components at top of hood not readily accessible by other means.

- I. Finished Back Panels: Where rear surfaces of fume hoods are exposed to view, provide finished back panels matching rest of fume hood enclosure.
- J. Comply with requirements of other sections for factory installation of water and laboratory gas service fittings, piping, electrical devices, and wiring. Securely anchor fittings, piping, and conduit to fume hoods, unless otherwise indicated.

2.06 MATERIALS

- A. Steel Sheet: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.
- B. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- C. Glass-Fiber-Reinforced Polyester: Polyester laminate with a chemical-resistant gel coat on exposed faces, and having a flame-spread index of 25 or less according to ASTM E84.
- D. Epoxy: Factory molded, modified epoxy-resin formulation with smooth, nonspecular finish.
 - 1. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 pounds per square inch.
 - b. Modulus of Elasticity: Not less than 2,000,000 pounds per square inch.
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 degrees F.
 - f. Flame-Spread Index: 25 or less according to ASTM E84.
 - 2. Chemical Resistance: As follows when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
 - a. No Effect:
 - 1) Acetic acid (98 percent).
 - 2) Acetone.
 - 3) Ammonium hydroxide (28 percent).
 - 4) Benzene.
 - 5) Carbon tetrachloride.
 - 6) Dimethyl formamide.
 - 7) Ethyl acetate.
 - 8) Ethyl alcohol.
 - 9) Ethyl ether.
 - 10) Methyl alcohol.
 - 11) Nitric acid (70 percent).
 - 12) Phenol.
 - 13) Sulfuric acid (60 percent).
 - 14) Toluene.
 - b. Slight Effect:
 - 1) Chromic acid (60 percent).
 - 2) Sodium hydroxide (50 percent).
 - 3. Color: Black.
- E. Polypropylene: Unreinforced polypropylene complying with ASTM D4101, Group 01, Class 1, Grade 2.
- F. Laminated Safety Glass: ASTM C1172.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Fasteners: Stainless-steel, where exposed to fumes.

2.07 ACCESSORIES

- A. Airflow Monitors/Indicators and Alarms: Provide cut out for each fume hood for an airflow monitor/indicator by Division 23.
 - 1. Source: Laboratory ventilation controls manufacturer.
 - 2. Airflow Monitor/Indicator Functionality:
 - 3. Airflow Alarm functionality: Audible (85 dB @ 4 inch distance), and visual alarm that activates when airflow sensor reading is outside of preset range.
 - a. Reset and test mode.
 - b. Programmable Switch: Designed to silence audible alarm and automatically reset when airflow returns to within preset range. Warning light to stay on when alarm is silenced.
 - c. Capability for integration with BAS (Building Automation System) via BACnet.
- B. Fume Hood Controller: Airflow Indicator/monitor with built-in electronics to control a dedicated exhaust fan and/or exhaust valve.
 - 1. Controller is part of a control system specified in Section Div 23.
- C. Sash Stops: Spring-loaded stops to limit hood opening to 18 inches height. Manually releasable to open sash fully, and to reset automatically when sash is lowered below set level.

2.08 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory testing of each type of fume hood.
- C. Non-Complying Work: See Section 01 40 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Locate concealed framing, blocking, and reinforcements that support fume hoods by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- B. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fume hoods according to manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Comply with indicated requirements for installing water and laboratory gas service fittings, and electrical and telecommunications devices.
 - 1. Install fittings in accordance with shop drawings, installation requirements in SEFA 2, and manufacturer's written instructions. Set bases and flanges of sink and work top-mounted fittings in sealant recommended by manufacturer of sink or work-top material. Securely anchor fittings to fume hoods.

3.03 FIELD QUALITY CONTROL

- A. Field test fume hoods as specified below.

1. General: Test fume hoods as installed to assess airflow velocity. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.
 2. Preparation:
 - a. Inspect each fume hood to confirm its installation complies with drawings and specifications.
 - b. Inspect laboratory space to verify that construction complies with drawings and specified requirements.
 - c. Do not proceed with fume hood testing until an acceptable TAB report has been received.
 - d. Verify that proper temperature and pressurization of the lab space can be maintained, with door(s) to the space in closed and open positions.
 - e. Adjust non-complying physical and control systems until conditions favorable to testing fume hoods are present.
 3. Operating Conditions Tests:
 - a. Conduct face velocity tests to confirm that target velocities are being achieved within acceptable tolerances.
 - b. Conduct airflow indicator/monitor tests to confirm acceptable variation from corresponding measured value. Calibrate and adjust device to function within specified accuracy parameters.
 - c. Conduct exhaust flow and static pressure tests of the HVAC system and its controls to confirm flow volume and static pressures are within acceptable tolerances.
 - d. In projects with VAV lab ventilation systems, conduct response time and stability tests to confirm how the HVAC supply and exhaust systems respond to different sash opening positions.
 - e. Conduct tests of alarm device by shutting off the fume hood exhaust and verify that the individual fume hood alarm activates and operates in specified manner.
 - f. Conduct tests of individual controls provided at the fume hood (such as unoccupied cycle override, alarm override, etc.) to verify they operate in specified manner.
 4. Containment Performance Tests:
 - a. Conduct airflow visualization tests (local smoke challenges) to provide a visual indication of fume hood's capture performance.
 - b. Conduct tracer gas containment tests, using mannequins to confirm gas concentrations meet (are below) specified criteria.
 - 1) Use tracer gas agreed-upon with Owner.
- B. Field test installed fume hoods in accordance with requirements of Section 23 05 93.
- C. Reporting Requirements: Comply with Section 5 of NEBB Fume Hood Testing (FHT) Standard, current edition. Organize and include, at a minimum, the following information:
1. Report title.
 2. Report certification.
 3. Table of contents.
 4. Report summary/ remarks.
 5. Appropriate forms.
 6. Instrument calibration.
 7. List of abbreviations used.
 8. A room layout drawing for each tested item. Identify: walls; doors; fume hood(s); other present environmental enclosures (e.g. biological safety cabinet(s), laminar flow hood(s), canopy hood(s), etc.); location and airflow pattern of all air supply, return, and exhaust grilles, registers and diffusers.

3.04 ADJUSTING

- A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand only. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

3.05 CLEANING

- A. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

3.06 DEMONSTRATION

- A. Demonstrate proper operation of fume hoods and their accessories to Owner's designated representative.

3.07 FUME HOOD SCHEDULE

- A. See drawings for Fume Hood Schedule/ requirements.

END OF SECTION

**SECTION 22 10 05
PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary waste piping, above grade.
- B. Chemical-resistant sanitary waste piping.
- C. Domestic water piping, above grade.
- D. Natural gas piping, above grade.
- E. Vacuum piping, above grade.
- F. Pipe flanges, unions, and couplings.
- G. Pipe hangers and supports.
- H. Pipe sleeve-seal systems.
- I. Ball valves.
- J. Balancing valves.
- K. Flow-balancing valves.
- L. Pressure reducing valves.
- M. Strainers.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
- D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
- E. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.
- F. Sustainable Design Documentation: For products meeting regulatory lead-content restrictions.
- G. Project Record Documents: Record actual locations of valves.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, ABOVE GRADE

- A. Continuous Flexible Self-Plunging Waste Pipes: IAPMO IGC 361, provide to connect lavatories and sink tail piece to PVC sanitary waste piping.
- B. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- C. PVC Pipe: ASTM D2729.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 CHEMICAL-RESISTANT SANITARY WASTE PIPING

- A. CPVC Pipe: ASTM D2846/D2846M, ASTM F441/F441M, or ASTM F442/F442M.
 - 1. Fittings: CPVC; ASTM D2846/D2846M, ASTM F437, ASTM F438, or ASTM F439.
 - 2. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement.

2.04 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Pipe: ASTM B88 (ASTM B88M), Type K (A), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.

2.05 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.
- B. Flexible Gas Piping:
 - 1. Corrugated Stainless Steel Tubing: Comply with ANSI LC 1/CSA 6.26.
 - 2. Comply with ASTM E84.
 - 3. Fittings: Provided by piping system manufacturer.
- ~~C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A) or L (B) annealed.
 - 1. Fittings: ASME B16.26, cast bronze.~~

ADD THREE

ADD
THREE

~~2. Joints: Flared.~~

~~D. Copper Tube: Listed, ASTM B88 (ASTM B88M), Type K (A), annealed.~~

2.06 VACUUM PIPING, ABOVE GRADE

~~A. Aluminum Tube: ASME B31.3, 6063 alloy, T5 temper.~~

~~1. Manufacturers:~~

~~a. Applied System Technologies; _____: appliedsystemtech.com/#sle.~~

~~b. Prevost Corporation; PPS: www.prevostusa.com/#sle.~~

~~2. Fittings and Joints 2-1/2 inch and Smaller:~~

~~a. Fittings: Comply with ASME B31.1 and ASME B31.3, aluminum or iron.~~

~~b. Joints: Mechanical compression, coupling, push-connect bite ring coupling with stainless steel clamping washer, or threading.~~

~~c. Gasket Material: High nitrile rubber seal suitable for operating temperature range from minus 4 to 176 degrees F.~~

2.07 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.

2.08 PIPE SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 - 1. BMW Company; _____: www.bmwcompany.com/#sle.
 - 2. GPT, a company of Enpro Industries, Inc; _____: www.gptindustries.com/#sle.
- B. Modular Mechanical Seals:
 - 1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
 - 2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
 - 3. Size and select seal component materials in accordance to service requirements.
 - 4. Glass reinforced plastic pressure end plates.

2.09 BALL VALVES

- A. Manufacturers:
 - 1. Anvil International; _____: www.anvilintl.com/#sle.
 - 2. Apollo Valves; _____: www.apollovalves.com/#sle.
 - 3. Nibco, Inc; _____: www.nibco.com/#sle.
- B. Construction, 4 inch and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.10 BALANCING VALVES

- A. Manufacturers:
 - 1. Anvil International; _____: www.anvilintl.com/#sle.
 - 2. ITT Bell & Gossett; _____: www.bellgossett.com/#sle.
 - 3. Taco, Inc; _____: www.taco-hvac.com/#sle.

- B. Construction: Class 125, brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Manual Operated Y-Pattern Globe, Size 1/2 to 2 inch:
 - 1. Class 125, brass or bronze body, multi-turn handwheel, memory stop, variable orifice, soldered connections, dual PT (hot and cold pressure-temperature) test ports for 300 psi, minus 4 to 250 deg F WOG service.
- D. Automatic Flow Limiting Cartridge, Size 3/4 inch:
 - 1. Class 125, brass or bronze body, stainless steel cartridge, threaded connections with built-in union, dual PT (hot and cold pressure-temperature) test ports for 400 psi, 0.5 gpm WOG service.
- E. Automatic Flow Limiting Cartridge with Ball Valve, Size 1/2 to 1 inch:
 - 1. Class 125, brass or bronze body, stainless steel cartridge, leak-proof stem, threaded or soldered connections with built-in union, dual PT (hot and cold pressure-temperature) test ports for 400 psi, 0.25 to 1.5 gpm WOG service.
- F. Calibration: Control flow within five percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

2.11 FLOW-BALANCING VALVES

- A. Manufacturers:
 - 1. Anvil International; _____: www.anvilintl.com/#sle.
 - 2. Griswold Controls; _____: www.griswoldcontrols.com/#sle.
 - 3. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

2.12 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - 2. Green Country Filter Manufacturing; _____: www.greencountryfilter.com/#sle.
 - 3. WEAMCO; _____: www.weamco.com/#sle.
- B. Size 2 inch and Smaller:
 - 1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
 - 2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- G. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- H. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- I. Pipe Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a watertight seal.
 - 6. Install in accordance with manufacturer's recommendations.

3.04 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 FIELD TESTS AND INSPECTIONS

- A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.
- B. Domestic Water Systems:
 - 1. Perform hydrostatic testing for leakage prior to system disinfection.
 - 2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
 - 3. General:
 - a. Fill the system with water and raise static head to 10 psi above service pressure. Minimum static head of 50 to 150 psi. As an exception, certain codes allow a maximum static pressure of 80 psi.
- C. Gas Distribution Systems:

1. Test Preparation: Close each appliance valve or disconnect and cap each connected appliance.
2. General Systems:
 - a. Inject a minimum of 10 psi of compressed air into the piping system for a duration of 15 minutes and verify with a gauge that no perceptible pressure drop is measured.
 - b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound.
- D. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.07 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with Section 33 01 10.58.
- B. Prior to starting work, verify system is complete, flushed, and clean.
- C. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- D. Maintain disinfectant in system for 24 hours.
- E. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

3.08 SERVICE CONNECTIONS

- A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.
 1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

END OF SECTION

SECTION 22 60 00
GAS AND VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, tube, and fittings.
- B. Valves.
- C. Regulators and flowmeters.

1.02 ABBREVIATIONS AND ACRONYMS

- A. CGA: Compressed Gas Association.

1.03 PERFORMANCE REQUIREMENTS

- A. General: Provide medical gas and vacuum equipment and piping systems that comply with the following NFPA 99, "Health Care Facilities Code" level categories:
 - 1. Level 1: For entire facility systems in which failure of equipment or system is likely to cause major injury or death of patients, staff or visitors.
 - 2. Level 2: For entire facility systems in which failure of equipment or systems is likely to cause minor injury to patients, staff or visitors.
 - 3. Level 3: For entire facility systems in which failure of equipment or systems is likely to cause injury to patients, staff or visitors.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's literature and data sheets for each product. Include capacities, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
- C. Shop Drawings: Provide for products listed below. Indicate general assembly of components, mounting and installation details, unit dimensions, required clearances, construction details, field piping connection details, and electrical characteristics and connection requirements.
 - 1. Manifolds: Include dimensioned plans and elevations showing manifold, header assemblies, and cylinder arrangements.
 - 2. Outlets: Include elevation drawings showing arrangements of medical outlet wall assemblies.
- D. Independent Inspection, Testing, and Verification Agency Reports: Documentation of inspection, testing, and verification results showing system compliance with NFPA 99.
- E. Manufacturer's Instructions: Provide for products listed below. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
 - 1. Manifolds.
- F. Installer's qualifications statement.
- G. Inspector's qualification statement.
- H. Testing and verification company's qualification statement.
- I. Operation and Maintenance Data: For each product, provide manufacturers installation, operating, testing, and maintenance instructions.
- J. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

- K. Project Record Documents: Complete set of floor plans showing actual installed locations of components, equipment, tanks, cylinders, piping, and valving. See Section 01 78 00 for additional requirements.
- L. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Service Kits: Provide first-year service kit for each air compressor and vacuum pump.

1.05 QUALITY ASSURANCE

- A. Laboratory Gas Systems: Select products and execute work in compliance with NFPA 55.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.
 - 1. Brazing: Qualified in accordance with ASME BPVC-IX or AWS B2.2/B2.2M.
- D. Inspector Qualifications: Company specializing in performing testing of type specified in this section, with minimum five years of documented experience.
- E. Testing and Verification Qualifications: Company specializing in performing testing of type specified in this section, with minimum five years of documented experience.
- F. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept material on-site in factory containers and packing. Inspect for damage.
- B. Protect from damage and contamination by maintaining factory packaging and caps in place until installation.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for equipment furnished. Complete forms in Owner's name and register with manufacturer.
- C. Installer Warranty: Provide 2-year warranty for systems installed commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with installer.

PART 2 PRODUCTS

2.01 PERFORMANCE CRITERIA

- A. Laboratory:
 - 1. Laboratory Air: 50 to 55 psig operating pressure.
 - 2. Laboratory Nitrogen: 160 to 185 psig operating pressure.
 - 3. Laboratory Helium: 160 to 185 psig operating pressure.

2.02 PIPE, TUBE, AND FITTINGS

- A. Laboratory Gases:
 - 1. General Requirements:
 - a. Piping cleaned by manufacturer with pipe ends and tube ends factory capped or plugged by manufacturer prior to shipping and kept sealed until time of installation.
 - 2. Copper Pipe:

- a. ASTM B819, seamless, drawn, Type L.
 - 1) For nitrogen and laboratory air systems with operating pressures in excess of 185 psig and with pipe sizes NPS 3 and larger, use Type K.
- b. ASTM B280, seamless, drawn, Type ACR.
- c. Brazed Fittings and Joints:
 - 1) Fittings: Wrought copper, ASME B16.22 or ASME B16.50.
 - 2) Joints: Brazed, AWS A5.8M/A5.8, copper-phosphorus or copper-phosphorus-silver brazing filler.
- ~~B. Axially Swaged Fittings:~~
 - ~~1. Description: Bronze, elastic strain preload fittings providing metal-to-metal seals with temperatures rating not less than 1000 deg. F and pressure rating of 300 psi and factory cleaned and bagged for oxygen use.~~
 - ~~2. Manufacturer:~~
 - ~~a. Lokring Technology LLC.~~
 - ~~b. Medlok.~~
- ~~C. Memory-Metal Couplings:~~
 - ~~1. Description: Nickel-titanium, shape-memory-alloy, cryogenic compression fitting for joining copper tube without heat.~~
 - ~~2. Cleaning: Factory cleaned, purged, and bagged for oxygen service according to ASTM B819.~~
 - ~~3. Manufacturers:~~
 - ~~a. Smart Technologies, Inc.~~
- ~~D. Flexible Pipe Connectors:~~
 - ~~1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.~~
 - ~~2. Cleaning: Factory cleaned, purged, and sealed or bagged for oxygen service according to ASTM B819.~~
 - ~~3. Working pressure ratings: 200 psig minimum.~~
 - ~~4. End connections NPS 2 and smaller: Threaded copper pipe or plain-end copper tube.~~
 - ~~5. End connections NPS 2-1/2 and larger: Flanged copper alloy.~~
 - ~~6. Manufacturers:~~
 - ~~a. Flex-Hose Co., Inc.~~
 - ~~b. Flexicraft Industries.~~
 - ~~c. Hyspan Precision Products, Inc.~~
 - ~~d. Mercer Gasket and Shim, Inc.~~
 - ~~e. Metraflex, Inc.~~
 - ~~f. Proco Products, Inc.~~
 - ~~g. Unaflex Inc.~~

2.03 VALVES

- A. Manufacturers:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
 - 3. Jomar Valve.
 - 4. Milwaukee Valve.
 - 5. Nibco.
 - 6. Pattons Medical.
 - 7. Powerex Inc.

- B. General Requirements for Valves for Medical Gas Systems:
 - 1. Manufacturer cleaned in accordance with CGA G-4.1.
 - 2. Sealed, bagged, and labeled prior to shipping in accordance with CGA G-4.1 and kept bagged and sealed until the time of installation.
- C. Ball Valves:
 - 1. Three-piece, bronze body, MSS SP-110, double-seal, with quarter-turn handle and replaceable neoprene or teflon seat and stem seals, 600 psi cold working pressure.
 - 2. Ball Valves for Medical Gas Systems: Provide manufacturer-installed ASTM B819 Type K copper extensions with threaded purge ports on upstream and downstream sides of valve.
- D. Check Valves:
 - 1. Brass or bronze body, three piece, spring loaded, in-line removable and serviceable, 300 psi cold working pressure.
 - 2. Check Valves for Medical Gas Systems: Provide manufacturer-installed ASTM B819 Type K copper extensions with threaded purge ports on upstream and downstream sides of valve.
- E. Pressure Relief Valves:
 - 1. Brass, bronze, or stainless steel body, direct-acting spring relief; select valve seats appropriate to gas system type; select relief settings to suit system components and operating pressures.
- F. Automatic Drain Valves:
 - 1. Description: Corrosion-resistant metal body and internal parts, 200-psig minimum working-pressure rating, and capable of automatic discharge of collected condensate.
- G. Pressure Regulators:
 - 1. Description: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

2.04 REGULATORS AND FLOWMETERS

- A. General Requirements for Pressure Regulators and Flowmeters for Medical and Laboratory Gas Systems:
 - 1. Manufacturer cleaned in accordance with CGA G-4.1.
 - 2. Sealed, bagged, and labeled prior to shipping in accordance with CGA G-4.1 and kept bagged and sealed until the time of installation.
- B. Single Stage Gas Pressure Regulators:
 - 1. Spring loaded, diaphragm type with manual pressure-adjustment knob.
 - 2. Body: Brass.
 - 3. Gas purity: General purpose, unless indicated otherwise.
 - 4. Application: Cylinder regulator.
 - 5. Delivery-Pressure Range: Select to suit gas being regulated.
 - a. Helium: 0 to 50 psig.
 - b. Nitrogen: 0 to 200 psig.
 - 6. Delivery Pressure Gauge: Dual scale, 2-inch diameter.
- ~~C. Gas Flowmeters:
 - 1. Thorpe style, brass body with needle valve and graduated, labeled flow-tube in polycarbonate housing. Provide valves labeled and color coded in accordance with NFPA 99.~~

- ~~2. Flow Accuracy: Plus/minus 10 percent of reading.~~
- ~~3. Single stage, oil-less compressors with pressure lubricated power end separated from compression, chamber with atmospheric vented distance piece, Teflon piston compression and guide rings.~~
- ~~4. Tank mounted~~

2.05 TEST GAS

- A. Description: Oil-free dry nitrogen NF complying with NFPA 99, for purging and testing of piping.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General
 1. Refer to all project specifications outside of division 22 sections for additional requirements not listed.
 2. Install medical gas systems in accordance with NFPA 99, CGA, and/or any other Federal, State, or Local codes and ordinances covering these installations.
 3. All piping, fittings, valves, and other devices shall be received on the job site cleaned, sealed, and marked for oxygen service. On-site cleaning is prohibited.
 4. Tools used for cutting or reaming shall be kept free from oil or grease.
 5. Install products and equipment in accordance with manufacturer's instructions.
 6. Install equipment according to NFPA 55 and NFPA 99.
 7. Brazed joints shall be made using a brazing compound containing silver alloys having a melting point of 1000°F or higher. Piping shall be purged with nitrogen during brazing to prevent the formation of copper oxide particles. The outside of the pipe and fittings shall be cleaned by washing with hot water after assembly.
 8. Clean equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical applications according to CGA G-4.1.
- B. Pipe, Tube, and Fittings:
 1. Install piping parallel and perpendicular to walls. Install without springing or forcing.
 2. Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Extend 2 inches above finished floors.
 3. Make changes in size with reducing fittings.
 4. Make changes in direction or required turns or offsets with fittings.
 5. Cut pipe and tubing accurately and squarely.
 6. Ream pipe and tube ends. Remove burrs.
 7. Remove scale and dirt from outside of piping before assembly.
 8. Braze joints in pipe and tubing in accordance with AWS B2.2/B2.2M. Continuously purge piping with oil-free, dry nitrogen during brazing.
 9. Install thermometers and pressure gauges per NFPA 99 requirements.
 10. Install piping concealed from view and protected from physical contact by building occupants except in equipment rooms and service areas.
 11. Install piping in equipment room and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.
 12. Install piping adjacent to equipment to allow service and maintenance.
 13. Install branch connections to mains at or above centerline of horizontal mains.
 14. Install piping to permit valve servicing and access.
 15. Install piping free from sags and bends.

16. After installation of piping, but before installation of the outlets, purge medical gas piping using oil-free dry nitrogen.
 17. Medical gas piping shall not be installed in kitchens, electrical rooms, elevator shafts, and areas with open flames.
 18. Join new systems to existing system according to manufacturer procedures when shape memory metal couplings or axially swaged fittings are utilized.
 19. Protect piping and fitting from damage.
 20. Retain sealing plugs in tubing until installation. Remove sealing plugs of sections being joined during installation and brazing process.
- C. Pipe Hangers and Supports:
1. Install in accordance with MSS SP-58.
 2. Support horizontal piping within 12 inches of each fitting.
 3. Rod diameter may be reduced one size for double rod hangers with 3/8 inch minimum rods.
 4. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - a. NPS 1/2 to 3/4: 72 inches with 3/8 inches rod.
 - b. NPS 1 to 1-1/2: 96 inches with 3/8 inches rod.
 - c. NPS 2 to 6: 10 feet with 1/2 inch rod.
 5. Install supports for vertical copper tubing every 10 feet.
 6. System routed in wall or on pipe rack shall be securely tightened with anti-vibration steel clamp with thermoplastic elastomer by use of channel mount cushion clamp. Tape of any kind shall not be used.
 7. All vertical pipe system drops to zone valves, outlets and equipment shall be securely anchored and supported at the top, bottom and mid-span of the wall cavity. Pipe support brackets shall be anchored to the wall cavity studs on both sides.
- D. Piping Identification:
1. Install labeling on pipe at intervals of not more than 20 feet and at least once in each room and each story traversed by pipeline.
 2. Apply pipe labeling during the installation process and not after installation is complete. Unlabeled systems shall be removed and replaced.
 - a. At intervals of not more than every 20'.
 - b. At least once in or above every room.
 - c. On both sides of walls or partitions penetrated by the piping.
 - d. At least once in every story height traversed by risers.
 3. Captions and Color-Coding: Use the following or similar medical gas captions and color-coding for medical gas piping products where required by NFPA 99 "Health Care Facilities Code":
 - a. Oxygen: White letters on green background or green letters on white background.
 - b. Medical air: Black letters on yellow background.
 - c. Instrument air: White letters on red background.
 - d. Nitrous oxide: White letters on blue background.
 - e. Nitrogen: White letters on black background.
 - f. Carbon dioxide: Black or white letters on gray background.
 - g. Medical vacuum: Black letters on white background.
 - h. WAGD: White letters on purple background.
 - i. Label medical gas systems operating at other-than-standard pressure with system operating pressure.
 4. Locate pipe labels as follows:

5. Medical gas piping shall not be painted.
- E. Underground Piping:
1. After pressure testing, evenly backfill entire trench width by handplacing backfill material and hand tamping in compacted layer.
 2. Encase buried piping in PVC pipe.
 - a. PVC pipe to be provided with weep holes spaced every 8'.
 - b. Terminated pipe encasement a minimum of 6" above floor level or grade and sealed water tight between carrier pipe and system.
 3. Install buried piping below frost depth or below minimum of 36 inches of cover, whichever is deeper.
 4. Excavate and backfill pipe trenches. Provide utility warning and identification tape above buried lines at depth of 8 to 12 inches below finish grade.
 5. Install continuous detectable underground warning tapes during backfilling of trenches for exterior underground medical gas piping. Locate tapes below finished grade, directly over piping.
- F. Valves:
1. Install isolation valves at connections to equipment.
 2. Install zone valves in valve boxes.
 - a. Install valve boxes recessed in wall and anchored to substrate. Single boxes to be used for multiple valves that serve same area or function.
 - b. Install zone valves and gauges in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
 - 1) Pressure system valves: Install pressure gauge downstream from valve.
 - 2) Suction system valves: Install vacuum gauge upstream from valve.
 - 3) Install labels on zones for rooms served within the zone valve box and on removable cover.
 - c. Install sensors for medical gas systems within zone valve box unless otherwise indicated on plan.
 3. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.
 4. Install check valves to maintain correct direction of fluid flow to and from medical gas specialties and equipment.
 5. Install pressure safety and vacuum relief valves where recommended by specialty manufacturers.
 6. Install emergency medical gas connections with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.
 7. Install pressure regulators in piping to reduce pressure.
- G. Manifolds:
1. Install relief valves between final pressure regulator and source valve.
 2. Install relief valve piping to building exterior and sized at least full size of the relief valve outlet.
 3. Extend relief valve vent piping to exterior of building and a minimum of 6 feet above pedestrian areas. Turn down discharge piping and provide a screen over outlet.
 - 4.
- H. Outlets:
1. Install medical gas service connections, of types indicated, in walls.
 - a. Attach roughing-in assembly to substrate.

- b. Attach finishing assembly to roughing-in assembly.
 2. Install medical gas service connections, of types indicated, in medical gas service units.
 3. Medical gas outlets to be installed in non-rated walls.
 4. Make final connections to booms and pedestals according to manufacturer requirements.
 5. Protect outlets from damage and debris until final cover plates are installed.
- I. Compressors and Vacuum Pumps:
 1. Vibration and Noise Isolation: See Section 22 05 48.
 2. Install compressors and vacuum pumps on concrete housekeeping pad.
 - a. Maintain manufacturer's recommended clearances.
 - b. Arrange units so controls and devices that require service are accessible.
 - c. Place and secure anchorage devices.
 - d. Anchor equipment to substrate.
 3. Install isolation valves at connections to equipment.
 4. Isolate systems including receivers, dryers, and filters until after completion and approval of purity tests for compressed air system. Tie-in at flange or union joint.
 5. Install flexible pipe connectors at each connection to medical air and vacuum equipment.
 6. Install vacuum exhaust and air intake with termination at exterior of building with elbow turned down and screen on end of elbow.
 7. Install the following devices on medical air equipment:
 - a. Thermometer, pressure gauges, and safety valves on each receiver.
 - b. Pressure regulators installed downstream of compressors, dryers, and filter assemblies.
 - c.
- J. Alarm system:
 1. Install medical gas alarm system components in locations required by and according to NFPA 99 and manufacturer's written instructions.
 2. Install medical gas alarm panels where indicated.
 3. Install medical gas local alarm panels at source equipment.
 4. All wiring and metal conduit required to interconnect and operate the complete medical gas alarm system specified herein shall be included in the mechanical contract.
 5. Control wiring shall be installed in accordance with an electrical wiring diagram prepared and furnished by the supplier of the medical gas outlets who shall be solely responsible for its accuracy and completeness.
 6. All medical gas alarm wiring shall be installed in EMT conduit and included in the mechanical contract.
 7. Medical gas alarm panels to be installed in non-rated walls.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Testing agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Installer performed tests:
 1. Perform the following tests in accordance with procedures in NFPA 99.
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive pressure medical gas systems.

- f. Standing pressure tests for vacuum systems.
 2. Prepare written reports documenting testing procedures and results. maintain records of all reports on site and submit with O&Ms.
 - D. System verification/certification tests:
 1. Upon completion of installer performed tests, perform the following in accordance with procedures in NFPA 99.
 - a. Standing pressure test.
 - b. Cross connection test.
 - c. Individual system pressurization.
 - d. Valve test.
 - e. Alarm test.
 - f. Piping purge test.
 - g. Piping particulate test.
 - h. Piping purity test.
 - i. Final tie-in test.
 - j. Operation pressure test.
 - k. Medical gas concentration test.
 - l. Medical air purity test.
 - m. Labeling verification.
 - n. Source equipment verification.
 - 1) Manifolds.
 - 2) Medical air compressor system.
 - 3) Medical-surgical vacuum system.
 2. Prepare written reports documenting testing procedures and results. Maintain records of all reports on site, submit completed verification reports as they are completed, and submit with O&Ms.
 - E. Medical Gas Systems: Inspect, test and verify systems and equipment in accordance with NFPA 99. Submit documentation of inspection, testing, and verification results.
 - F. Protect cleaned piping before and during installation.
 - G. Joints shall be brazed within 8hrs of being assembled.
 - H. After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.
 - I. Check each station outlet of every piping system to determine test gas is dispensed only from outlet of system under investigation. Measure pressure with gauge attached to specific adaptor. Do not use universal adaptors.
 - J. Disconnect test gas and connect proper gas to each system. Purge entire system to remove test gas. Check with analyzer suitable for gas installed.

3.03 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training for additional requirements.
- C. Train operating personnel in operation and maintenance of the following:
 1. Air compressors.
 2. Vacuum pumps.
 3. Alarm systems.

BL000B - BL027 Swain West, BL070 Simon Hall, BL071 Chemistry,
BL072 Chemistry Addition - Research Labs Renovation
Bloomington, Indiana
IU Project No. 20240397 / BSA Project No. 00360477

D. Provide services of manufacturer's field representative to conduct training.

END OF SECTION

**SECTION 119000
LOCAL VACUUM NETWORK SYSTEM**

PART 1 - GENERAL

1.1 WORK DESCRIPTION

A. Work included:

1. Local vacuum network system, including the following components:
 - a. Pumps.
 - b. Controls.
 - c. Valves.
 - d. Interconnecting tubing.
 - e. Inlets.
 - f. Identification.
 - g. Supports.
 - h. Accessories

1.2 QUALITY ASSURANCE

- A. Compliance: Materials, equipment, installation, testing and certification shall be in strict accordance with NFPA 45.
- B. System Verification Testing For Local Vacuum Networks: Testing shall be conducted by installer under the guidance of manufacturer, and with oversight by the Owner or Owner's agent.
- C. Qualifications:
 1. General: Company specializing in design, manufacture, installation, testing, certifying and servicing the products and systems specified with a minimum of 5 years documented experience
 2. Manufacturers: Firms regularly engaged in manufacture of vacuum systems equipment and products, of types, material and sizes similar to systems and products specified herein, whose products have been in satisfactory use in similar service for not less than 5 years. Submit references if requested.
 3. Equipment suppliers: The vacuum systems equipment supplier shall provide the services of a manufacturer authorized product specialist to periodically coordinate with the installing Contractor during initial installation of piping and vacuum systems.
 4. Service organizations:
 - a. Service by in-house facility personnel.
 - b. Service performed by manufacturer-authorized repair facility to which components of system will be shipped.
 5. Installers: Minimum of 2 years' experience with successful installation experience on project with vacuum systems.

- D. Single Source Requirements: Pumps, valves, inlets, alarms, controls, tubing and associated components shall be supplied by a single manufacturer to the greatest extent possible and shall be fully compatible with one another.
- E. Identification:
 - 1. Valves: Manufacturer's name shall be marked on valve bodies.
 - 2. Equipment: Manufacturer's name, address and contact information shall be permanently marked on equipment.
- F. Tubing Connections: Consist of vacuum compression fittings. Connections tested with a vacuum gauge of sufficient resolution to determine that the completed network conforms to manufacturer's specifications for effective vacuum pressures.

1.3 REFERENCES

- A. American National Standards Institute (ANSI): ANSI/ASQ/ISO Q9001 - Quality Management Systems Requirements Standard.
- B. International Standards Organization (ISO): ISO 14001 - Environmental management systems - Requirements with guidance for use.
- C. International Electro-technical Commission (IEC): IEC 60529 - Degrees of protection provided by enclosures (IP Code).
- D. National Electrical Manufacturers Association (NEMA).
- E. National Fire Protection Association (NFPA):
 - 1. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals.
 - 2. NFPA 70 - National Electric Code.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Manufacturer's descriptive literature, illustrations and installation instructions for all components included within this project.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods.
- C. Shop Drawings: Provide dimensional drawings indicating details of construction and installation. Include templates for coordination with adjacent work.
- D. Operations and Maintenance Data: Servicing and testing requirements, inspection data, installation instructions, replacement part numbers and availability, location and contact numbers of service depot.

E. Record Documents:

1. Installation Contractor for local vacuum networks shall record actual locations of pumps, valves, and distribution and exhaust piping.
2. Record of test procedures and the results of all tests indicating room and area designations, dates of the tests, and names of persons conducting tests.
3. Documentation and description of manufacturer's warranties.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations and industry standards. Protect from damage, theft, vandalism, exposure to precipitation, freezing temperatures and direct sunlight.
- B. Store products in manufacturer's unopened, labeled packaging, until ready for installation.
- C. Each length of tube shall be delivered packaged by manufacturer and kept sealed until being prepared for installation.
- D. Loose fittings, valves, gauges and other components shall be delivered sealed and labeled and kept sealed until installation.
- E. Where contamination has occurred, materials must be removed and replaced with materials that have been cleaned and sealed by the manufacturer or supplier.
- F. Provide equipment and personnel necessary to handle equipment and components with methods approved by manufacturer to prevent damage to products or packaging. Provide additional protection so as to protect products or surrounding areas from damage.
- G. Lift components only at designated lifting points, and in accordance with operating manual lifting procedures

1.6 SEQUENCING AND SCHEDULING

- A. Schedule work to ensure installation is complete tested and certified prior to substantial completion.
- B. Sequence installation of PTFE plastic vacuum tubing so that it will not be subjected to damage from the heat of brazing, soldering or welding adjacent tubing.
- C. Pre-drill at casework manufacturer's factory all bench lab tops with penetrations needed for on-site mounting of vacuum valves.
- D. Furnish valves, tubing, fittings and controls to fume hood manufacturer and flexible laboratory furniture manufacturer for factory installation. Coordinate with each manufacturer to provide material in a timely manner to avoid delays. All shipping costs shall be by the vacuum system manufacturer.

1.7 WARRANTY

A. Manufacturer's Standard Warranty:

1. Warranty period for defects in materials and workmanship: Two (2) years under normal use from date of system start-up.
2. Warranty period for vacuum network: Two (2) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: VACUUBRAND Inc., which is located at: 11 Bokum Rd.; Essex, CT 06426-1506; Toll Free Tel: 888-882-6730; Tel: 860-767-5341; Fax: 860-767-2563; Email: request info (info@vacuubrand.net); Web:www.vacuu-lan.com
- B. Local Contact: John Kalinowski, jkalinowski@vacuubrand.net or John Kalinowski jkalinowski@brandtech.com , 1(440) 552-2375
- C. Substitutions: Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 DESCRIPTION

- A. Local Vacuum Network System: VACUU-LAN system components as manufactured by VACUUBRAND GMBH + CO KG of Germany, system designed and supplied by VACUUBRAND INC. of the USA
 1. General: Materials shall meet or exceed applicable referenced standards, federal, state and local requirements and conform to codes and ordinances of authorities having jurisdiction.
 - a. VACUU-LAN components are not approved for operation in potentially explosive atmospheres
 - b. Local vacuum networks shall be equipped with demand-responsive electronic controls which enable the server pumping unit to provide vacuum when needed, while moving to standby mode in the absence of immediate vacuum demand.
 2. System: Local vacuum networks with oil-free, diaphragm vacuum pumps with corrosion-resistant flow-paths made of fluoropolymers such as PTFE or FFKM, vacuum valves with fluoropolymer check valves and PTFE tubing with chemical resistant compression connectors and fittings.
 3. Shut-off valves: At each workstation.
 4. Venting: Duct exhaust for local vacuum networks via PTFE tubing through fume hoods.
 5. Technical data:
 - a. Leak rate: 1×10^{-2} mbar³/l/s per component.
 - b. Maximum gas temperature (< 5 min.): 176 degrees F (80 degrees C).
 - c. Maximum gas temperature (continuous): 140 degrees F (60 degrees C).

6. Electronic controls: Demand-responsive operation of pumps for VACUU-LAN local vacuum networks as recommended by the Manufacturer for the size of the lab indicated and number of fixture locations.
 - a. Controllers: CVC 3000, or as recommended by the Manufacturer.
 - b. Controllers: VACUU-BUS accessory components or as recommended by the Manufacturer.
 - c. Controllers: VACUU-CONTROL PC Software or as recommended by the Manufacturer.

- B. Local Vacuum Network Pumps: VACUU-LAN Series manufactured by VACUUBRAND GMBH + CO KG of Germany, sized and supplied by VACUUBRAND Inc of the USA.
 1. Design: Oil-free, dry-running pumps featuring corrosion resistant diaphragms, heads and valves; with chemical resistant flow-path of fluoropolymers such as PTFE and FFKM, 120 V, 60 Hz power supply plugged into NEMA 5-15 conventional grounded outlet. Rotary vane, liquid ring and scroll designs are not acceptable.
 2. Description: Including inlet and outlet catchpots to collect condensed vapors.
 - a. Each vacuum pump shall have an end (ultimate) vacuum of better than 29.6 inches Hg gauge (7.6 Torr absolute, or better), based on a barometric pressure of 29.92 inches Hg, unless otherwise specified for special applications.
 - b. Each vacuum pump shall operate totally oil-free, eliminating all need for oil changes, and require diaphragm changes at approximately 10,000 operating hour intervals when used as designed for particulate-free and liquid-free vapor streams.
 3. Electronically controlled units: Electronically controlled vacuum pumping units may be equipped with liquid level sensors on inlet or outlet catchpots.
 - a. Install liquid level sensors on inlet catchpots.
 4. Pump ventilation: Vacuum pumps shall be air cooled and have no water requirements, unless water-cooled condensers are specified for emissions capture.
 - a. Ventilation method: Active ventilation though fan-assisted ventilation lines with extraction at upper back of cabinet and cabinet door louvered at lower level, as provided by others.
 5. Pumping units/systems: PC 3012 VARIO Chemistry Pumping Units, or as suggested by the manufacturer for zone use.
 - a. Locate vacuum pumps as indicated on the drawings. Provide one pump in each vacuum pump cabinet (VC) labeled “house vac”.

- C. Local Vacuum Network Tubing: Interconnecting PTFE tubing and compatible joints and fittings as provided by VACUUBRAND INC.
 1. Size: 10 mm OD / 8 mm ID.
 2. Composition: PTFE (polytetrafluoroethylene), such as Teflon or manufacturer approved equal.
 3. Straight unions, t-unions, elbow unions, offsets and fittings: Chemical resistant PVDF plastic.

4. Minimum turn radius without compression fittings: 8 inches (200 mm).
 5. Corrosion resistant PVDF plastic compression fittings: In locations where turning radius for PTFE tubing is less than 8 inches.
 6. Condensate removal: Access fittings; T-Connectors.
 - a. Exhaust tubing shall be free of dips and loops that could trap condensate. Where such low points are unavoidable an access fitting (T-connector) or drip leg and blind fitting shall be installed to provide means of removing collected condensate that is not removable with blow-through techniques.
 7. Condensate removal: Drip leg and blind fitting.
 8. Supply sufficient quantity of tubing to fume hood manufacturer and flexible laboratory furniture system manufacturer for factory installation of valves and outlets in the fume hoods pre-piped to one connection point 6" above the fume hood.
- D. Local Vacuum Network Modules: Service inlets as manufactured by VACUUBRAND GMBH + CO KG of Germany and supplied by VACUUBRAND, INC. of the USA.
1. General: Compatible with other components of VACUU-LAN local vacuum network. Modular design. Inlets flush-mounted on lab benches for attachment to concealed piping. Factory assembled, tested, cleaned and supplied with protective packaging.
 2. Vacuum line gauges and controllers: Shall register mbar, Torr and hPa and shall be scaled from 1 atmosphere to 1 mbar and equivalents, with resolution to 1 mbar and equivalents.
 - a. Digital vacuum gauges and controllers shall include analog and digital representations of vacuum pressures with sufficient resolution to confirm performance of VACUU-LAN local vacuum network.
 3. Source, main, riser and service line valves: Equipped with compression fitting connections.
 4. Valve inlets: Consist of barbed tubing fitting designed to be compatible with flexible vacuum tubing.
 5. Shut-off valves: Ball-type valve, corrosion resistant designed for vacuum to 29.86 inches Hg (1.5 Torr) with integral check valve; operated with lever-type handle requiring only a quarter turn from fully open position to fully closed.
 6. Manual flow control valves: Corrosion resistant, designed for vacuum to 29.86 inches Hg (1.5 Torr) with integral check valve; manually variable flow.
 7. Solenoid operated in-line valves:
 - a. Operating cycles per minute: Maximum of 50.
 - b. Power draw: 6 W.
 - c. Maximum permissible range of supply voltage: 24 V DC +/- 10 percent.
 - d. Current draw: Approximately 0.22 A.
 - e. Degree of Protection IEC 529: IP 65.
 - f. Maximum permissible differential pressure: 1.5 bar, pressure gradient in direction of flow through.
 - g. Control provided by CVC 3000 vacuum controller, via VACUU-BUS connection
 8. Bench/wall/ Ceiling Service Panels modules: VACUU-LAN VCL 02 Shut-off/Manual Flow Control Modules or as appropriate for location.
 - a. Mounting bases: A5, Flush mount, concealed tubing.

- b. Provide modules and mounting bases to flexible laboratory furniture manufacturer for factory installation.
9. Modules in fume hoods: VACUU-LAN VCL AR Manual Flow Control Modules.
- a. Mounting bases: Flush mount, concealed tubing.
 - b. Provide modules to fume hood manufacturer for factory installation.

PART 3 - EXECUTION

3.1 PREPARATION

- A. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.
- B. Do not proceed with installation until substrates have been properly prepared and deviations from manufacturer's recommended tolerances are corrected. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Commencement of installation constitutes acceptance of conditions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's written instructions and recommendations. Prevent oil or grease from being introduced into tubing. Do not install components that have become contaminated internally
- B. Vacuum network tubing shall be of PTFE of appropriate diameter and finish, as supplied by the vacuum network contractor. Tubing connections shall consist of compression fittings, with connections tested with a vacuum gauge of sufficient resolution to determine that the completed network conforms to manufacturer's specifications for effective vacuum pressures.
- C. Locate and sequence installation of PTFE plastic vacuum tubing so that it will not be subjected to damage from the heat of brazing, soldering or welding adjacent tubing.
- D. Locate equipment with adequate space for service, air circulation, tubing bends and access to condensate catchpots for routine operation. Provide no less than minimum as recommended by manufacturer.
- E. Pumps may be contained within cabinets but only with manufacturer-approved provisions made for adequate air circulation to ensure that ambient operating temperatures do not exceed 104 degrees F (40 degrees C). Periodically confirm that operating temperatures are within manufacturer recommended limits in the course of network operation to avoid invalidation of warranty.
- F. Pre-drill casework at casework manufacturer's factory to the greatest extent possible. Bench penetrations shall be in accordance with system design, and shall conform to component manufacturer's drilling templates.

- G. Pre-punch/drill fume hood penetrations at fume hood manufacturer's factory to the greatest extent possible. Penetrations shall be in accordance with system design, and shall conform to component manufacturer's drilling templates.
- H. Tubing shall be free of dips and loops that could trap condensate. Where such low points are unavoidable an access fitting (T-connector) or drip leg and blind fitting shall be installed to provide means of removing collected condensate that is not removable with blow-through techniques.
- I. Vacuum exhausts from multiple pumps within the same room shall be connected individually to fume hood exhaust lines to minimize backpressure.
- J. Minimum Turn Radius for PTFE Tubing:
 - 1. Without compression fittings: 8 inches (200 mm).
 - 2. For turns with radius of less than 8 inches (200 mm): Accomplish with corrosion resistant PVDF plastic compression fittings, elbow ('L') connectors to prevent kinks or blockages.

3.3 TESTING AND INSPECTION

- A. Inspection and testing shall be performed on all new vacuum systems, additions, renovations, temporary installations, or repaired systems. Assure facility, by means of documented procedure, that system integrity has been achieved or maintained
- B. Inspection and testing of local vacuum network server pumps shall be performed at the factory. Following installation of local vacuum network pumps, tubing, connectors and valves, the entire network shall be tested to confirm that design vacuum pressures are obtained, that the system is functioning properly and that system integrity has been achieved or maintained. Such test shall be conducted by turning on network server pump, and testing vacuum at the pump and at the most distant valve from the pump on the vacuum network with a gauge of 1 mbar resolution to confirm vacuum pressure at pump and throughout network are consistent with design specification.
- C. Installer shall perform initial vacuum tests before third party system verification.
- D. Do not use water or air pressure to test system integrity.
- E. System verification tests shall be performed after installer-performed tests have been completed. Equipment vendor or installing Contractor may not perform system verification, final testing or certification, except as directed by Architect or Owner.
- F. System verification tests shall confirm that vacuum network pumps contained within cabinets have sufficient air circulation to ensure that ambient air temperatures do not exceed 104 degrees F (40 degrees C).
- G. Certifications shall clearly state that the system is approved for laboratory use. Any exceptions or limitations shall be clearly stated on the same certification documentation

3.4 FIELD QUALITY CONTROL

- A. An authorized vendor of the equipment manufacturer shall periodically check with the installing Contractor during initial installation of VACUU-LAN local vacuum networks and shall assist the Contractor in final checking. Equipment manufacture to provide instruction of mutually agreeable duration and detail, not to exceed 4 hours, to Owner's personnel in the use of the vacuum system.

3.5 CLEANING, MAINTENANCE AND PROTECTION

- A. Remove dirt, dust, construction debris and all foreign materials from installed equipment and components. Finishes shall be free from all rust, scratches, dents or other damage
- B. Protection: Protect installed work from damage due to subsequent construction activity on the site.

END OF SECTION 11 90 00