ADDENDUM 1

DATE: February 05, 2014
PROJECT: CABIR Chemical Hoods Level 6
ITB NO: 744-1413-CABIR Chemical Hoods Level 6
OWNER: University of Texas Health Science Center
Houston, Texas
TO: Prospective Proposers

This Addendum forms part of and modifies Proposal Documents dated, January 16, 2014, with amendments and additions noted below.

1. We have processed an addendum to the drawings and specifications.
   - M200
   - M200A1
   - M300
   - M400
   - M500
   - E100
   - E100A1
   - P100A1
   - P300 (Additional Drawing)

2. Contractor is responsible for removing and returning to owner the lab bench and overhead cabinet located where the hoods will be installed.

END OF ADDENDUM 1
SECTION 23 09 10 – LABORATORY TRACKING SYSTEMS AND CONSISTANT VOLUME VALVES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section –20 01 00 Basic Mechanical Requirements.

C. Section –25 11 10 BAS Basic Materials, Interface Devices and Sensors.

D. Section – 25 11 10 BAS Communication Devices.

E. Section – 23 05 93 System Testing, Adjusting and Balancing.

1.02 LABORATORY AND / OR ANIMAL HOLDING ROOM AIRFLOW CONTROL SYSTEMS - PHOENIX™ CONTROLS SYSTEM

A. The system described in this section is provided under a Special System Proposal Bid Package. Installation of the air valves is by Division 23. Wiring, pneumatic piping and interface to the BAS is to be furnished by Section 25 05 51. Start up and commissioning to be furnished by this section.

B. Description:

1. A Laboratory Air Control System (LACS) is a microprocessor-based airflow control system that is used for research laboratories and other critical room environments. The LACS shall have a BACnet™ interface for bi-directional communication with the Building Automated System (BAS). The LACS shall provide data values, alarms, and set points used in each room-environment control scheme to the BAS, and also provide remote diagnostics and comprehensive reports and trends through the BAS.

2. The LACS shall use LonWorks as its distributed digital control architecture to perform all critical room pressurization control, temperature control, humidity control, occupancy mode control, and emergency mode control.

3. The exhaust air volume from a laboratory fume hood or if applicable a biological safety cabinet shall be controlled to maintain a constant average face velocity through the hood’s open sash area.
4. The supply air distribution system shall use linear actuated supply air valves to meter the temper the air into the laboratory or animal holding room, and linear actuated exhaust air valves are to be provided for metering air out of the laboratory or animal holding room. Duct mounted hot water reheat coils using electric actuated control valves will provide the necessary heat to temper the supply air. Corrosion resistant air valves are required to be used as part of the hood exhaust control system if corrosive liquid or gases are used in the fume hoods. The Air Pressurization Monitor (APM) for the room and all interconnecting wiring, and auxiliary controllers and components are to be provided a completely tested, and operational.

5. A single point of responsibility shall provide all the necessary laboratory and/or animal room components, APM and system gateway. The sole manufacturer is the Phoenix™ Controls Corporation, which is a subsidiary of Honeywell International, Inc.

C. Warranty:

1. Warranty shall commence upon the date of owner acceptance and extend for a period of twenty-four months, whereupon, any defects in materials or system performance shall be repaired by manufacturer at no cost to the owner.

2. During the warranty period, if a service contract for the routine care, calibration, parts replacement, or upgrade of the system is required or recommended by the manufacturer, or such a contract is to be offered to the owner during or after the warranty period, such contract and services shall also be included during the warranty period at no cost to the owner.

D. Fume Hood Controller:

1. A linear controller shall be installed on the sash mullion of each hood and shall provide user interface/alarm functions and a linear control system, which translates the sash position into a proportional control signal to modulate the hood’s exhaust air valve. Hood airflow shall thus be varied to maintain a nominally constant face velocity at the hood opening. No air velocity sensors shall be employed. Hood airflow shall be varied to maintain a constant face velocity over no less than a 5 to 1 change in the sash open area (change in sash position).

2. Fume hood control system shall respond to and maintain the face velocity setpoint to insure fume hood containment. Response time shall be less than one second with no more than a 5% overshoot or undershoot. System shall achieve 90% of its commanded volume within one second of the sash reaching 90% of its final value. Sash raise time shall be one second with a minimum 5 to 1 change in the sash area.

3. A fume hood controller shall be provided to receive a sash position signal from the sash sensor, process this signal and then output an exhaust airflow control signal to the hood exhaust valve.

4. The face velocity and minimum exhaust flow level of the fume hood shall be set at the fume hood monitor via trim pot adjustments. Accurate adjustments
of the face velocity shall be provided at the minimum and maximum sash positions.

5. An emergency exhaust switch with an audible and dedicated visual alarm shall be provided on each fume hood monitor to override the sash sensor and command maximum exhaust airflow. Dedicated push to start, push to stop, pushbutton switches shall force the hood exhaust volume control device to its full flow position and force the supply valve to its specified minimum or maximum position.

6. Fume hood controller shall have a visual and an audio enunciator to alarm the occurrence of a low face velocity. Muting of the enunciator will not cancel the visual alarm until the low flow condition is no longer present. The fume hood alarm shall be initiated by:

a. A differential pressure switch located across a hood exhaust valve that senses a reduction in airflow of approximately 20% of setpoint.

b. When the airflow value sent to the hood exhaust valve by the control unit is different then the actual airflow feedback value.

c. The sash being raised above a specified height and/or specified area for fume hoods not sized for 100% opening. Systems not relying on direct sash sensing shall furnish and install sash switch(es) for positive position feedback.

d. The alarm wire being disconnected.

7. Fume hood controller shall include an LCD readout to indicate face velocity of hood; green LED indication for normal operation, yellow LED and audible alarm for an unsafe flow condition, yellow LED and audible alarm for night energy waste alert and red LED and audible alarm to indicate emergency exhaust operation.

8. A pushbutton switch shall be provided to mute the audible alarms. The mute mode is automatically reset when the alarm condition ceases.

9. A zero to 10-volt analog output signal with digital contact shall be provided to indicate if the sash is above a preset adjustable threshold position. Each of the flows and system “offset” shall be adjustable.

10. A set of input contacts shall be provided inside the hood controller to remotely command the Emergency Exhaust mode from an external SPST contact.

11. Momentary or extended losses of power shall not change or affect any of the control system’s setpoints, calibration settings, or emergency exhaust mode status. After power returns the system shall continue operation exactly as before without need of operator intervention. Under no circumstances shall loss of power command the exhaust system to full flow upon return of power.

12. Control power for the hood controller shall be provided from the supply air control panel.
13. The hood controller shall be a Phoenix™ FHM610 Series. Coordinate hood installation provisions with the project hood supplier.

E. Hood Sash Position Sensors:

1. A sash sensor shall be provided to measure hood sash position and output a sash position signal to the hood controller. The sash sensor shall consist of a precision; ten turn potentiometer mechanically coupled to a constant tension spring reel. A stainless steel, vinyl-coated cable shall be attached to the spring reel. Expected lifetime based on manufacturer’s component data and tests shall be over 200,000 full height sash movements.

2. The hood sash position sensor shall be designed to meet the UL 913, Class 1, Division 1, Groups C and D, and methane standard for intrinsically safe equipment used in hazardous locations.

3. Coordinate the placement and installation of the sash position sensor with project hood supplier or manufacturer.

F. Type VA1 Corrosion Resistant, Hood Exhaust Valves – Phoenix™ Model EXV300 Series:

1. Corrosion resistant, linear actuated, pressure independent hood exhaust valve shall be provided to control the exhaust volume of each hood in response to input from the hood controller.

2. Airflow control valve shall be of venturi control type utilizing a venturi section into which a cone shaped element slides to create a smoothly varying, ring shaped orifice. Valve shall be constructed such that the venturi body’s shape logarithmically necks down to the orifice area and then logarithmically re-expands to full valve inlet size to insure a static regain with minimal pressure loss. Valve shall have an Equal Percentage flow characteristic to provide accurate control at low flow values.

3. Valve shall be Medium pressure independent over a .6” to 3.0” WC drop across the valve or Low pressure independent over 0.3” to 3.0” WC drop across the valve. Integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure.

4. Airflow accuracy shall be ± 5% of reading (not full scale) regardless of inlet or exit duct configuration over an airflow turndown range of not less than 8 to 1 and will not exceed 2000 FPM velocity.

5. Valves shall be of a corrosive resistant design using at least two baked coats of Heresite P403 or Phenolflex 957 coating material to cover the aluminum valve body and cone assembly. The valve’s shaft, pivot arm, shaft support brackets and internal mounting hardware shall be made of 316L stainless steel. Due to the presence of strong acids, all 316L stainless steel materials shall have two additional coats of a corrosion resistant phenolic coating. Uncoated hardware and general 300 series stainless steel materials are unacceptable. All bearing surfaces shall be made of a composite Teflon or Teflon infused (versus coated) aluminum. Duct connections to the valve shall...
have circular bolt pattern flanges on each end. Flanges shall be factory butt welded or spun onto the valve.

6. Valves shall be supplied as an assembly complete with pneumatic digital high speed actuator, feedback pot, and linear compensation electronics, E/P transducer and duct static pressure switch all mounted on a common bracket. Constant volume valves do not require actuators.

7. Valves shall use electronic based closed loop position feedback and control to regulate air volume linearly proportional to a 0 to 10 volt electronic control signal or LON-Works communication. Valve shall generate a 0 to 10-volt feedback signal linearly proportional to valve airflow for internal volume control, monitoring, or airflow tracking control. Signal shall be factory calibrated to a stated CFM per volt scale factor using NIST traceable instrumentation directly from the valve’s control arm or shaft position.

8. Valves shall achieve 90% of its commanded volume within one second of being commanded to its new volume setpoint (irrespective of system stability) with less than a 5% undershoot or overshoot.

9. A reduction in airflow of approximately 20% below the setpoint shall be sensed and alarmed by a static pressure switch factory mounted to each hood exhaust and constant volume exhaust valve. The switch shall operate by measuring the pressure drop across the valve’s variable orifice venturi. A signal from this switch shall be transmitted to the hood controller and BAS.

10. Loss of pneumatic supply air control power shall cause the exhaust valve to fail open and the supply valve to fail closed in laboratory areas. In Vivarium or animal rooms, the system shall have the ability to alter fail-safe positions if the rooms are to remain positive with respect to adjacent areas.

G. Make-up Air Control Unit:

1. A Make-up Air Control Unit equal to the MAC300 offered by Phoenix™ Controls shall be supplied to control the airflow balance of the laboratory room. The Make-up Air Control Unit shall be panel or valve mounted. Provide one Make-up Air Control Unit per laboratory.

2. The Control Unit shall be of electronic design with analog signal inputs and outputs. The inputs shall accept signals proportional to fume hood and Biological Safety Cabinet exhaust airflow. The control panel shall also receive input signals from a room temperature sensor and the unoccupied mode-indicating relay. These signals shall initiate room air volume reset for temperature control and unoccupied mode/occupied mode operation as described in the sequence of controls.

3. The Control Unit shall output control signals to control supply air volume, general exhaust air volume, and the supply air heating coil control valve.

4. Integral field adjustable trimpots shall be provided for all required calibration and scaling adjustments.
5. In the event of an emergency exhaust or low flow alarm conditions in one of the connected hoods, the Control Unit shall reduce the supply airflow as if the indicated hood were exhausting its minimum flow.

6. The Control Unit shall maintain a constant adjustable offset between the sum of the room’s total exhaust and the make-up/supply air volumes. This offset shall be independent of the exhaust volume magnitude and represent the volume of air that will enter the room from the corridor or other room.

7. The Control Unit shall generate 0 to 10-volt analog signals linearly proportional to all airflow sources, sash sensors, and flow alarms (0 to 12v alarm). The signals shall be available for direct connection to the facilities Direct Digital Control/Energy Management System. As a minimum, the following signals (points) shall be available.
   
   a. Fume Hood Exhaust Flow (CFM, 0-10v).
   b. Supply/Make-up Airflow (CFM, 0-10v).
   c. General Exhaust Flow (CFM, 0-10v).
   d. Total Lab Exhaust Flow (CFM, 0-10v).
   e. Total Lab Supply Flow (CFM, 0-10v).
   f. Room Offset (CFM, 0-10v).
   g. Fume Hood Exhaust Low Flow Alarm (0 or 12v).
   h. Fume Hood Sash Position (0-10v).
   i. Common Fume Hood Low Flow Alarm (Digital Contact).

8. The Control Unit shall also accept direct input signals from the facilities Direct Digital Control/Energy Management System. As a minimum, the following inputs shall be available.
   
   a. Electronic Temperature Override (0-10v).

9. An integral power supply for the MAC300 panel mounted unit, or a valve mounted power supply for the MAC300 valve mount unit, shall be included to power the complete laboratory airflow control system from one dedicated 120VAC line connection.

H. Type VR2 Supply Air Terminal Units - Model MAV-100 Series:

1. Supply air terminal units shall be fully factory-fabricated and shall consist of a linear actuated supply air valve or valves (as required to suit terminal unit maximum CFM).
2. Airflow control valve shall be of venturi control type utilizing a venturi section into which a cone shaped element slides to create a smoothly varying, ring shaped orifice. Valve shall be constructed such that the venturi body’s shape logarithmically necks down to the orifice area and then logarithmically re-expands to full valve inlet size to insure a static regain with minimal pressure loss. Valve shall have an Equal Percentage flow characteristic to provide accurate control at low flow values.

3. Valve shall be pressure independent over a .6” to 3.0” WC drop across the valve for medium pressure applications and 0.3” to 3.0” WC drop for low pressure applications. Integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure.

4. Airflow accuracy shall be ± 5% of reading (not full scale) regardless of inlet or exit duct configuration over an airflow turndown range of not less than 8 to 1 and will not exceed 2000 FPM air velocity.

5. Supply air valve bodies shall be constructed of 16-gauge aluminum. All bearing surfaces shall be made of a composite Teflon or Teflon infused (versus coated) aluminum. The valve’s shaft, pivot arm, shaft support brackets, and internal mounting hardware shall be made of 316L stainless steel.

6. Valves shall be supplied as an assembly complete with pneumatic actuator, electronic, feedback pot, and linear compensation electronics, E/P transducer and duct static pressure switch all mounted on a common bracket. Constant volume valves do not require actuators.

7. Valves shall use electronic based closed loop position feedback and control to regulate air volume linearly proportional to a 0 to 10-volt electronic control signal. Valve shall generate a 0 to 10-volt feedback signal linearly proportional to valve airflow for internal volume control, monitoring, or airflow tracking control. Signal shall be factory calibrated to a stated CFM per volt scale factor using NIST traceable instrumentation directly from the valve’s control arm or shaft position.

8. Valves shall achieve 90% of its commanded volume within one second of being commanded to its new volume setpoint (irrespective of system stability) with less than a 5% undershoot or overshoot.

9. A reduction in airflow of approximately 20% below the setpoint shall be sensed and alarmed by a static pressure switch factory mounted to each supply air valve. The switch shall operate by measuring the pressure drop across the valve’s variable orifice venturi. A signal from this switch shall be transmitted to the hood controller and BAS.

10. Loss of pneumatic supply air control power shall cause the valve to fail closed. In Vivarium or animal rooms, the system shall have the ability to alter fail-safe positions if the rooms are to remain positive with respect to adjacent areas.

I. Terminal Unit Inlet Connections: Single valve terminal unit duct inlet connections shall consist of round inlet connections suitable for flanged and bolted connection to
rigid round duct as detailed on the Drawings. Where multiple valves are employed, a common inlet plate suitable for slip connection to a single rectangular duct inlet duct shall be factory installed on the terminal unit using a press fit and silicone seal connection.

J. Terminal Unit Outlet Connection: Terminal unit duct outlet connections shall consist of sheetmetal duct flanges suitable for slip connection of rectangular sheetmetal ductwork.

K. Type VA1 General Exhaust Valves - Model EXV-100 Series:

1. General exhaust valves shall be fully factory-fabricated and shall consist of a general exhaust valve or valves (as required to suit overall unit capacity) with single inlet and outlet duct connections. These exhaust valves are designated on the Drawings as Series VA1 terminal units that serve general exhaust air devices.

2. Airflow control valve shall be of venturi control type utilizing a venturi section into which a cone shaped element slides to create a smoothly varying, ring shaped orifice. Valve shall be constructed such that the venturi body’s shape logarithmically necks down to the orifice area and then logarithmically re-expands to full valve inlet size to insure a static regain with minimal pressure loss. Valve shall have an Equal Percentage flow characteristic to provide accurate control at low flow values.

3. Valve shall be pressure independent over a .6” to 3.0” WC drop across the valve for medium pressure applications and 0.3” to 3.0” WC drop for low pressure applications. Integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure.

4. Airflow accuracy shall be ± 5% of reading (not full scale) regardless of inlet or exit duct configuration over an airflow turndown range of not less than 8 to 1 and will not exceed 2000 FPM air velocity.

5. General exhaust air valve bodies shall be constructed of 16-gauge aluminum. All bearing surfaces shall be made of a composite Teflon or Teflon infused (versus coated) aluminum. The valve’s shaft, pivot arm, shaft support brackets, and internal mounting hardware shall be made of 316L stainless steel. Exhaust valve outlet connections shall consist of circular bolt pattern flanges for round outlet duct connections as shown on the Drawings. Where multiple valves are employed, a common rectangular outlet plate with bolt pattern flange connection shall be field installed on the terminal unit as shown on the Drawings for field bolted connection to a rectangular to round ductwork transition. Exhaust valve inlet shall consist of round bolt pattern flanges for round inlet duct connections as shown on the Drawings. Where multiple valves are employed, a common rectangular inlet plate for drive and slip connection to a rectangular inlet duct shall be provided as shown on the Drawings. Flanges shall be factory butt welded or spun onto the valve (round flanges only) or press fit and silicone seal (multiple valves only).

6. Valves shall be supplied as an assembly complete with pneumatic-electronic actuator, feedback pot, and linear compensation electronics, E/P transducer
and duct static pressure switch all mounted on a common bracket. Constant volume valves do not require actuators.

7. Valves shall use electronic based closed loop position feedback and control to regulate air volume linearly proportional to a 0 to 10-volt electronic control signal. Valve shall generate a 0 to 10-volt feedback signal linearly proportional to valve airflow for internal volume control, monitoring, or airflow tracking control. Signal shall be factory calibrated to a stated CFM per volt scale factor using NIST traceable instrumentation directly from the valve’s control arm or shaft position.

8. Valves shall achieve 90% of its commanded volume within one second of being commanded to its new volume setpoint (irrespective of system stability) with less than a 5% undershoot or overshoot.

9. A reduction in airflow of approximately 20% below the setpoint shall be sensed and alarmed by a static pressure switch factory mounted to each general exhaust valve. The switch shall operate by measuring the pressure drop across the valve’s variable orifice venturi. A signal from this switch shall be transmitted to the hood controller and BAS.

10. Loss of pneumatic supply air control power shall cause the valve to fail open. In vivarium or animal rooms, the system shall have the ability to alter fail safe positions if the rooms are to remain positive with respect to adjacent areas.

11. Constant volume airflow control valves equal to the CVV (non-pressure controlled spaces) or EXV-SLV (pressure controlled spaces) series valve offered by Phoenix™ Controls shall be supplied to maintain the volume (non-pressure controlled spaces) out of a laboratory room.

L. BAS ANALOG Interface: The room controllers shall be capable of direct communications with the existing BAS system via analog and digital inputs and outputs. The BAS shall be interfaced to allow remote monitoring of specified controller outputs and inputs and shall be capable of resetting room temperature setpoint. The BAS interface must be installed and fully operational before the control system will be accepted.

M. BAS DDC Interface: The room controllers shall be capable of direct communications with the existing BAS system via BACnet SIP open protocol. The BAS shall be interfaced to allow remote monitoring of specified controller outputs and inputs and shall be capable of resetting room temperature setpoint. The BAS interface must be installed and fully operational before the control system will be accepted.

N. Calibration:

1. Each airflow control valve shall be factory calibrated to the job specific airflows as detailed on the plans and specifications. Valve shall be electronically calibrated/characterized at the factory by certified NIST traceable airstations. The valve’s characterization shall be determined at eight unique airflows including a test of the valve’s pressure independence at three different static pressures. A total of nineteen airflow checks shall be performed and recorded for each air valve.
2. Field adjustment shall not be required other than minor changes as required by the balancing contractor. Accuracies and performance shall be guaranteed as specified irrespective of field conditions.

3. Each airflow control valve shall be individually marked with valve specific factory calibration data. As a minimum, it should include valve tag number, serial number, model number, eight point valve characterization information, and quality control inspection numbers. All information shall be stored on computer diskette in ASCII format for future retrieval or for hard copy printout.

4. Air shall be maintained plus or minus 5% of the design air quantity setting (subject to valve maximum and minimum CFM limits) over an inlet static pressure rate of 0.6 to 3.0 inches SP.

5. Air shall be maintained plus or minus 5% of the design air quantity setting (subject to valve maximum and minimum CFM limits) over an inlet static pressure rate of 0.3 to 3.0 inches SP.

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<tr>
<th>Air Valve Size</th>
<th>Minimum CFM</th>
<th>Maximum CFM</th>
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<td>312M</td>
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</table>

O. Wiring and Piping Diagrams: The lab tracking system manufacturer shall provide complete point-to-point wiring and pneumatic piping diagrams for each room configuration.

PART 2 NOT USED

PART 3 EXECUTION

3.01 PROJECT MANAGEMENT:

A. Provide a project manager who shall, as a part of his duties, be responsible for the following activities:

1. Coordination between this Contractor and all other trades, Owner, local authorities and the design team.
2. Scheduling of manpower, material delivery, equipment installation and checkout.

3. Maintenance of construction records such as project scheduling, manpower planning, and AutoCAD drawings for project coordination and as-built drawings.

3.02 CONDUIT AND WIRING SYSTEM

A. Cabling for these systems shall be either fiber optic, 24 AWG shielded twisted copper pair, or a mix of both. The Owner will consider exceptions to this requirement only if the laboratory tracking systems and constant volume valves manufacturer provides technical documentation, demonstrating that (1) this system will not function unless a different type of cable is used or (2) the National Electrical Code requires cables to be shielded.

END OF SECTION
SECTION 23 31 00 – DUCTWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform Work required to provide and install ductwork, flexible duct, hangers, supports, sleeves, flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any supplementary items necessary for proper installation.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASHRAE - Handbook of Fundamentals; Duct Design.
2. ASHRAE - Handbook of HVAC Systems and Equipment; Duct Construction.
3. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
5. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
6. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
7. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
8. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
10. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
12. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements.
13. SMACNA – HVAC Duct Construction Standards.
15. SMACNA – Round Industrial Duct Construction Standards.
17. UL 181 - Factory-Made Air Ducts and Connectors.
19. Assembly and Installation of Spiral Ducts and Fittings, UMC.
20. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.

1.04 DEFINITIONS

A. Low Pressure

1. 2 inch W.G. Pressure Class: Ductwork systems up to 2 inch w.g. positive or negative static pressure with velocities less than or equal to 1500 fpm.

B. Medium Pressure

1. 6 inch W.G. Pressure Class: Ductwork systems over 2 inch w.g. and up to 6 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.

C. High Pressure

1. 10 inch W.G. Pressure Class: Ductwork systems over 6 inch w.g. and up to 10 inch w.g. positive or negative static pressure with velocities greater than 2500 fpm.

1.05 SUBMITTALS

A. Product Data:

1. Provide the following information for each sheet metal system furnished on the Project:
   a. System name and type.
   b. Duct system design pressure.
   c. Duct material.
   d. Duct gage.
   e. Transverse joint methods.
   f. Longitudinal seam type.
g. Sealant type.

h. SMACNA rectangular reinforcement type.
i. SMACNA intermediate reinforcement type.
j. SMACNA transverse reinforcement type.

B. Record Documents:

1. Submit Shop Drawings on all items of ductwork, plenums, and casings including construction details and accessories specified herein in accordance with Division 01. Ductwork construction details and materials used for duct sealant, flexible connections, etc. shall be submitted and approved prior to the fabrication of any ductwork.

2. Draw ductwork Shop Drawings on minimum 1/4 inch equal to one foot scale building floor plans and shall indicate duct sizes, material, insulation type, locations of transverse joints, fittings, ductwork bottom elevation, offsets, ductwork specialties, fire and fire/smoke dampers, and other information required for coordination with other trades. Clearly designate fire and fire/smoke partitions on the Shop Drawings. Detail Drawings for mechanical rooms and air handling unit locations shall be submitted at a minimum scale of 1/4 inch equal to one foot.

3. Coordinate with all other trades and building construction prior to submitting Shop Drawings for review. Indicate location of all supply, return, exhaust, and light fixtures from approved reflected ceiling plans on Shop Drawings.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the Project Site and store and protect products under provisions of Division 01 and Section 20 01 00.

B. Protect materials from rust both before and after installation.

1.07 WARRANTY

A. All ductwork shown on the Drawings, specified or required for the air conditioning and ventilating systems shall be constructed and erected in a first class workmanlike manner.

B. The Work shall be guaranteed for a period of one (1) year from the Project Substantial Completion date against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Owner at Contractor’s expense.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
### APPLICATION

**A.** Ductwork systems shall be constructed in accordance with the following Materials as a minimum standard. Refer to Drawings for any deviation from this Table.

<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>MATERIAL</th>
<th>MINIMUM PRESSURE CLASSIFICATION (1)</th>
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</thead>
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<td>Supply and Return Systems:</td>
<td></td>
<td></td>
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<tr>
<td>Untreated Outside Air Intake (Louver) to AHU Plenum</td>
<td>304 Stainless Steel</td>
<td>Low Pressure</td>
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<tr>
<td>Treated Outside Air to AHU</td>
<td>Galvanized Steel</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Single Zone ECU Supply</td>
<td>Galvanized Steel</td>
<td>Low Pressure</td>
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<tr>
<td>Single Zone AHU Supply</td>
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<td>Medium Pressure</td>
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<td>Medium Pressure</td>
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<td>Terminal Unit Connection</td>
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<td>Exhaust Systems:</td>
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<tr>
<td>Exhaust Air Device to Exhaust Distribution</td>
<td>Galvanized Steel (2)</td>
<td>Low Pressure</td>
</tr>
<tr>
<td>Exhaust Air Distribution</td>
<td>Galvanized Steel</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>General Exhaust Vertical Riser to Fan</td>
<td>Galvanized Steel</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Low Pressure Radioactive Exhaust</td>
<td>316L Stainless Steel</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>High Pressure Radioactive Exhaust</td>
<td>316L Stainless Steel</td>
<td>High Pressure</td>
</tr>
<tr>
<td>General Lab Exhaust Air Device to Main Distribution</td>
<td>Galvanized Steel</td>
<td>Low Pressure</td>
</tr>
<tr>
<td>Hood/Biosafety Cabinet Exhaust to Main Distribution</td>
<td>304 Stainless Steel (See Alternates)</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Lab/Hood/Biosafety Cabinet Exhaust Main Distribution</td>
<td>304 Stainless Steel (See Alternates)</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Lab Exhaust Vertical Riser</td>
<td>304 Stainless Steel (See Alternates)</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Riser to Filter Housing/Exhaust Plenum</td>
<td>316L Stainless Steel</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Exhaust Plenum to Fan (All ductwork exposed to outdoor environment)</td>
<td>316L Stainless Steel</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Fan to Exhaust Stack</td>
<td>316L Stainless Steel</td>
<td>Medium Pressure</td>
</tr>
<tr>
<td>Emergency Generator Exhaust</td>
<td>Double Wall or Black Steel</td>
<td>As Specified</td>
</tr>
<tr>
<td>MRI Cryogen Vents</td>
<td>316L Stainless Steel or 6061 Aluminum</td>
<td>As Specified</td>
</tr>
<tr>
<td>Perchloric Hood Ductwork</td>
<td>316L Stainless Steel</td>
<td>Medium Pressure</td>
</tr>
</tbody>
</table>

**B. Notes to Table:**

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E&C No. 3093.00  
DUCTWORK  
Addendum #1 02/04/2014
1. Positive pressure unless noted otherwise in Table.

2. Air device connections may be made with insulated flexible duct as specified herein.

3. Verify minimum pressure classification per NFPA 96 requirements.

4. Applies to exhaust system for general laboratory exhaust, fume hoods, and biosafety cabinets. Refer to Drawings for construction of any additional exhaust systems.

5. All joints to be welded included connection to hood, unless noted otherwise by hood manufacturer.

2.03 DUCTWORK MATERIAL AND CONSTRUCTION

A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein.

B. Ductwork shall be constructed of G-90 coated galvanized steel of ASTM A653 and A924 Standards.

C. Minimum gage of round, oval or rectangular ductwork shall be 26 gage per SMACNA Standards.

D. All duct sizes shown on the Drawings are clear inside dimensions. Allowance shall be made for internal lining, where specified, to provide the required free area.

E. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.

F. Except for specific duct applications specified herein, all sheet metal shall be constructed from prime galvanized steel sheets and/or coils up to 60 inches in width. Each sheet shall be stenciled with manufacturer's name and gage. Coils of sheet steel shall be stenciled throughout on ten foot (10') centers with manufacturer's name and must be visible after duct is installed. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."

G. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."

H. Where ducts are exposed to view (including equipment rooms) and where ducts pass through walls, floors or ceilings; furnish and install sheet metal collars around the duct.

I. Spin-in fittings shall be as specified under Section 23 33 00 – Ductwork Accessories.

J. Duct Sealing: All ductwork, regardless of system pressure classification, shall be sealed in accordance with Seal Class A, as referenced in SMACNA Standards. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.
1. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3 inches wide open weave fiberglass scrim tape. Sufficient additional sealant shall then be applied to completely embed the cloth.

2. Sealant shall be water based, latex UL 181B-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be similar to Hard Cast Iron Grip 601, Ductmate Pro Seal or Design Polymerics DP 1010.

3. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count, similar to Hardcast FS-150.

4. Sealer shall be rated by the manufacturer and shall be suitable for use at the system pressure classification of applicable ductwork.

5. Except as noted, oil or solvent-based sealants are specifically prohibited.

6. For exterior applications, “Uni-Weather” (United McGill Corporation) solvent-based sealant shall be used.

2.04 RECTANGULAR AND ROUND DUCTWORK

A. Metal gages listed in SMACNA HVAC Duct Construction Standards, Metal and Flexible Duct, are the minimum gages which shall be used. Select metal gage heavy enough to withstand the physical abuse of the installation. In no case shall ductwork be less than 26 gage per SMACNA Standards.

B. All longitudinal seams for rectangular duct shall be selected for the specified material and pressure classification. Seams shall be as referenced in SMACNA Standards.

C. Longitudinal seams in laboratory hood exhaust ducts shall be welded.

D. All transverse joints and intermediate reinforcement on rectangular duct shall be as shown in SMACNA Standards. Transverse joints shall be selected consistent with the specified pressure classification, material, and other provisions for proper assembly of ductwork.

E. Spiral round duct and fittings shall be as manufactured by United McGill Sheet Metal Company or approved equivalent. All fittings shall be factory fabricated, machine formed and welded from galvanized sheet metal.

F. Joints in spiral duct and fittings shall be assembled, suspended, sealed, and taped per manufacturer's published assembly and installation instructions.

G. Contractor may use DUCTMATE or Ward Industries coupling system, as an option, on rectangular ductwork. The DUCTMATE or Ward Industries system shall be installed in strict accordance with manufacturer’s recommendations.

2.05 FLAT OVAL DUCTWORK AND FITTINGS

A. Oval ducts shall be spiral flat oval or welded flat oval equivalent to those of United McGill Sheet Metal Company with gage and reinforcing as recommended by the manufacturer. Duct may be shop fabricated of completely welded construction in accordance with SMACNA Standards.
B. Oval ducts greater than 24 inch x 72 inch shall be longitudinal seam, flat oval duct, rolled, welded and provided in standard lengths of 5 and 10 feet. Transverse joints shall be factory welded or field connected with flanges or slip couplings. Duct will be fabricated from galvanized steel meeting ASTM A 527 standards.

C. Duct reinforcing angles shall be of sizes specified for same size rectangular duct. Galvanized angles shall be used where standing seams are specified for rectangular duct.

D. Oval fittings shall comply with requirements, sealing, etc., similar to that specified for round ductwork. Manifolding taps may be permitted without increasing the length of run in the branch duct system.

E. Elbows in oval ducts may be smooth long radius or 5-piece 90-degree elbows and 3-piece 45-degree elbows. Joints in sectional elbows shall be sealed as specified for duct sealing.

2.06 CONICAL BELLMOUTH FITTINGS AND TAPS

A. Conical bellmouth fittings shall be made from 26-gage G-90 coated galvanized steel. Two-piece construction with a minimum overall length of 6 inches and factory sealed for high-pressure requirements. Average of loss coefficient for sizes 6, 8 and 10 shall be less than 0.055.

B. Provide each fitting with minimum 24-gage damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper form rotating around shaft. Shaft shall be extended to clear insulation.

C. Provide a flange and gasket with adhesive peel-back paper for ease of application. The fittings shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on center with a minimum of four (4) screws per fitting.

D. Conical bellmouth fittings shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc. or Buckley Air Products, Inc., “AIR-TITE”.

2.07 CASINGS AND PLENUMS - 2 INCH W.G. PRESSURE CLASS

A. All 2 inch w.g. pressure class casings and plenums for mixed air plenums shall be constructed in accordance with SMACNA Standards.

B. All casings shall enclose the filter and automatic dampers as shown on the Drawings. Casings shall be fabricated of galvanized sheet metal erected with three-foot center maximum standing seams reinforced with ¼-inch bars. The casing shall be stiffened on three-foot centers maximum with angle iron tack welded in place.

C. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be installed as indicated on the Drawings and shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches and #370 hinges that can be operated from both the inside and the outside.

D. Casings shall be anchored by the use of angle irons sealed and bolted to the curb and floor of the apparatus casing. Casings shall be tested and provided tight at a pressure of three inches water column.

E. Insulate per Section 15290.
2.08 CASINGS AND PLENUMS – 6 INCH W.G. PRESSURE CLASS

A. Shall enclose filters and automatic dampers at air handling unit systems. Casings shall be constructed of cellular, standing seam panels with 3 inch deep reinforced “hat” sections as manufactured by metal deck manufacturers and as described in SMACNA Standards.

B. All openings to the casing shall be properly sealed to prevent air leakage. Install access doors for easy access to equipment. Access doors shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches that can be operated from both the inside and outside. Hinges shall be equivalent to Ventlok #370.

C. Anchor casing by the use of galvanized angle irons sealed and bolted to the curb and floor of the apparatus casing as indicated in SMACNA Standards.

D. A fan discharge diffuser plate shall be located on the fan discharge and shall be constructed of 10 gage steel perforated plate installed in 6 inch channel iron frames (8.2#) rigidly supported to withstand the fan discharge velocity. Perforations shall be 3/8 inch (0.375 inch) staggered on 11/16 inch centers (27 percent open area). One section shall be hinged to provide an access door between the discharge side of the fan and the entering side of the coils. After fabrication of the diffuser plate, coat with rust-resistant paint. After installation, touch up diffuser plate and paint channel iron frames with rust-resistant paint.

E. Provide sufficient access openings to allow access for maintenance of all parts of the apparatus. Access door size shall be as large as feasible for the duty required.

F. Insulate per Section 15290.

2.09 ELBOWS RECTANGULAR DUCTS

A. Construct elbows as follows in order of preference:

1. Long radius, unvaned elbows.

2. Short radius, single thickness vaned elbows.

3. Rectangular, double thickness vaned elbows.

B. Long radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width.

C. Contractor shall have the option to substitute short radius vaned elbows, but shall request the substitution at the time of submittal of Product Data.

D. Provide turning vanes in all rectangular elbows and offsets.

E. Job fabricated turning vanes, if used, shall be fabricated of the same gage and type of material as the duct in which they are installed. Vanes must be fabricated for same angle as duct offset. Submit Shop Drawings on factory fabricated and job fabricated turning vanes.
F. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.

G. In 90-degree turns that are over 12 inches wide in the plane of the turn, provide and install double thickness vanes on integral side rails. For ducts under 12 inches in width, use single thickness vanes. The installation of the turning vanes shall be as described for single thickness vanes. On other types of turns or elbows, single thickness trailing edge vanes shall be used.

2.10 FLEXIBLE DUCT

A. Flexible duct shall be used where flexible duct connections are shown on the Drawings to air distribution devices and terminal units and as scheduled under “Ductwork System Applications.

Flexible ductwork shall NOT be used for changes in direction of air flow except in vertical drops to diffusers and grilles. Lateral changes in direction are not permitted.

B. Acoustical Flexible Duct to Diffusers, Grilles, and Terminal Units:

1. Maximum length 6'-0” (six feet), installed with no more than 90 degrees of bend. Where longer duct runs or more bends are necessary, provide rigid round ductwork.

2. Acoustical flexible duct shall be manufactured with an acoustically rated CPE inner film as the core fabric, mechanically locked by a corrosion-resistant galvanized steel helix.

3. Core shall be factory pre-insulated with a total thermal performance of R-3.5 or greater. Outer jacket shall be a fire retardant polyethylene vapor barrier jacket with a perm rating not greater than 0.10 per ASTM E 96, Procedure A.

4. Duct shall be rated for a minimum positive working pressure of 6 inches w.g. and a negative working pressure of 4 inches w.g. minimum.

5. Temperature range shall be –20 degrees F to 250 degrees F.

6. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter’s Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread less than 25; smoke developed less than 50.

7. Acoustical flexible duct shall be similar to Flexmaster Type 8M for construction and acoustical performance standards.

C. Metal Flexible Duct:

1. May be used for terminal unit connections from sheet metal ductwork where shown on the Drawings.

2. Maximum length 2'-0” (two feet), installed in straight runs only. Where longer duct runs or direction changes are necessary, provide rigid round ductwork.
3. Duct shall be constructed of 0.005 inch thick 3003-H14 aluminum alloy in accordance with ASTM B209. Duct shall be spiral wound into a tube and spiral corrugated to provide strength and flexibility.

4. Core shall be factory pre-insulated with a total thermal performance of R-3.5 or greater. Outer jacket shall be fire retardant metalized vapor barrier jacket of fiberglass reinforced aluminum foil, with a permeance rating not greater than 0.05 per ASTM E96, Procedure A.

5. The duct shall be rated for a minimum positive and negative working pressure of 10 inch w.g.

6. Temperature range shall be –40 degrees F to 250 degrees F.

7. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter's Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread less than 25; smoke developed less than 50.

8. Metal flexible duct shall be similar to Flexmaster triple lock Type TL-M.

2.11 STAINLESS STEEL DUCTWORK

A. Applies to general laboratory exhaust, fume hood, biosafety cabinet, radioisotope hood, and moisture exhaust systems as specified herein.

B. Stainless steel shall be 304 and/or 316-L, as listed within table listed in 2.02 above with welded longitudinal seams and welded transverse joints. Welds on exposed ductwork shall be positioned for minimum view and shall be ground and polished. Duct sealant shall not be used to seal this ductwork.

C. All ductwork risers shall be installed as vertical as possible within the constraints of the design indicated on the Drawings.

D. Metal gages shall be not less than the following:

<table>
<thead>
<tr>
<th>DUCT SIZE</th>
<th>GAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-inch diameter or less</td>
<td>18</td>
</tr>
<tr>
<td>31-inch to 60-inch diameter</td>
<td>16</td>
</tr>
<tr>
<td>61-inch diameter or greater</td>
<td>14</td>
</tr>
<tr>
<td>Greater than 60 x 42 (rectangular or oval)</td>
<td>Comply with SMACNA</td>
</tr>
</tbody>
</table>

E. The joining of stainless steel ductwork with galvanized ductwork where indicated in the Drawings shall use ductwork construction methods specified herein for galvanized ductwork.

F. Connections to Cabinets or Hoods:

1. Where approved by Owner, flexible stainless steel ducting can be used in lieu of hard pipe stainless steel.

2. Flexible ducting shall be 316 Ti stainless steel; pressure rated for 12 inches w.g. positive and negative; UL 181, Class 0 air duct rated; Velocity Rated for 5500 fpm. Similar to Flexmaster Type SS-NL-TL.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Cleanliness:
   1. Before installing ductwork, wipe ductwork to a visibly clean condition.
   2. During construction, provide temporary closures of metal or taped polyethylene on open ductwork and duct taps to prevent construction dust or contaminants from entering ductwork system. Seal ends of ductwork prior to installation to keep ductwork interior clean. Remove closures only for installation of the next duct section.
   3. For ductwork supplying Clean Rooms, Operating Rooms and other Critical Care areas, sanitize ductwork with a biocidal agent EPA approved for HVAC systems immediately prior to sealing ductwork.
   4. During duration of construction, maintain the integrity of all temporary closures until air systems are activated.

D. Provide openings in ductwork where required to accommodate thermometers, controllers and other devices. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring. Sleeve of pitot tube opening shall be no more than one inch long. Opening shall be one inch wide to accept pitot tube.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

G. All visible welds in ductwork between biosafety cabinets, canopy hoods and fume hoods and the ceiling shall be ground and polished.

H. Slope duct toward grilles for moisture-laden ducts. Provide drain and trap at elbow of main moisture exhaust duct system.

I. Flexible Duct:
   1. The terminal ends of the duct core shall be secured by compression coupling or stainless steel worm gear type clamp.
   2. Fittings on terminal units and on sheet metal duct shall have flexible duct core slipped over duct and coupling or clamp tightened, then connection sealed with sealant. Insulation of flexible duct shall be slipped over connection to point where insulation abuts terminal unit or insulation on duct.
3. These insulation connections shall be sealed by embedding fiberglass tape in the sealant and coating with more sealant to provide a vapor barrier.

J. Support flexible ducts as per SMACNA standards to prevent sags, kinks and to have 90 degree turns.

K. Hangers and Supports:
   1. All ductwork supports shall be in accordance with Table 4-1 (rectangular duct) and Table 4-2 (round duct) of the SMACNA Standards, with all supports directly anchored to the building structure.
   2. Rectangular duct shall have at least one pair of supports on minimum 8'-0" (eight feet) centers. All horizontal round and flat oval ducts shall have ducts hangers spaced 10'-0" (ten feet) maximum.
   3. Lower attachment of hanger to duct shall be in accordance with Table 4-4 of the SMACNA Standards.
   4. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2 inch x 1-1/2 inch x 1/4 inch angles for duct widths up to 60 inches. Above 60 inches in width, the angles must be increased in strength and sized on an individual basis considering space requirements.
   5. Hanger straps on duct widths 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the sides.
   6. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8 inch bolts minimum.

3.02 DUCTWORK SYSTEM CLEANING

A. If the system has been operated without scheduled filters or if the integrity of temporary closures has been compromised, Contractor shall have ductwork cleaned according to National Air Duct Cleaners Association (NADCA) Standards by a Certified Regular Member of the NADCA.
   1. For ductwork supplying Clean Rooms or patient care areas, also sanitize the ductwork interior per NADCA standards with a biocidal agent approved by the EPA for use in HVAC Systems.

B. Before turning the installation over to the Owner, Contractor shall certify that the air handling systems have only been operated with scheduled filters in place. Otherwise, Contractor shall present evidence that the ductwork was cleaned as required above.

3.03 TESTING

A. Ductwork systems 3 inch w.g. pressure classification and above (positive or negative) shall be pressure tested according to SMACNA test procedures (HVAC Air Duct Leakage Test Manual). Notify Owner minimum seven (7) calendar days in advance of leakage testing.
   1. Design pressure for testing ductwork shall be determined from the maximum pressure generated by the fan at the nominal motor horsepower selected.
2. Total allowable leakage shall not exceed 1 percent of the total system design airflow rate.

3. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

4. Leaks identified during leakage testing shall be repaired by:
   b. Thorough cleaning of the joint surfaces.
   c. Installation of multiple layers of sealing materials.

5. The entire ductwork system shall be tested, excluding connections upstream of the terminal units (i.e. ductwork shall be capped immediately prior to the terminal units, and tested as described above).

6. After testing has proven that ductwork is installed and performs as specified, the terminal units shall be connected to ductwork and connections sealed with extra care. Contractor shall inform the Owner when joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage exists in the terminal unit connections/joints after the systems have been put into service, leaks shall be repaired as specified for other leaks.

B. Ductwork systems 2 inch w.g. pressure classification and below (positive or negative) shall be inspected for visible and audible signs of leakage.

1. Leaks identified by inspection shall be repaired by:
   b. Thorough cleaning of the joint surfaces.
   c. Installation of multiple layers of sealing materials.

2. Discrepancies found during testing and balancing between duct traverses and diffuser/grille readings shall result in re-inspection, repair and retest until discrepancies are eliminated.

C. At the option of the Owner, if documented in writing, Contractor may be allowed to eliminate testing of terminal units by capping the supply ductwork prior to the terminal units, then inspecting the connection to the terminal units when complete. This option may only be exercised by the Owner, only if documented in writing prior to testing.

D. Ductwork leakage testing and/or inspection shall be performed prior to installation of external ductwork insulation.

END OF SECTION
**DRAWING NOTES:**

1. Relocated 12" exhaust valve and ductwork (AS can be reused). Reconnect to existing tap. Make transition as required to new hood connection.

2. Provide reprogramming of zone along with sash sensor and other equipment necessary for the reprogramming. Supply air valve shall remain to vary with existing hood and reheat to maintain temperature. Make-up for new hood at hood open shall be through new damper, track sash height, but no tracking supply. Hood min = 375CFM, Hood max = 650CFM. (18" SASH STOP, 100 FPM.)

3. Provide new approx 12x12x3 air pressure in room. Approximate size shall be 14" long and 16" tall (3 blades tall). Provide plenum off of damper, tap with 10" and reconnect to existing transfer grille.

4. New riser maximum CFM. VAV exhaust shall automatically adjust with SP in Riser.
DRAWING NOTES:

1. INSTALL NEW 24x16 DUCT OFF OF 144x72 RISER IN CHASE. MAKE TRANSITIONS AROUND EXISTING ITEMS ABOVE CEILING AS NEEDED. RECONNECT WITH 16x16 DUCT AND EXISTING HOOD TRAP.

2. RELOCATE 12" VALVE AND DUCTWORK (AS CAN BE REUSED). MAKE TRANSITIONS TO NEW HOOD AS REQUIRED. PROVIDE NEW SASH SENSOR AND ALL OTHER HARDWARE AND SOFTWARE CHANGES AS NEEDED FOR VAV OF HOOD WITH SASH OPENING. MIN = 375CFM, MAX = 650CFM. 18" SASH STOP, 100°F MAX.

3. PROVIDE NEW 12" HOOD VALVE LOW PRESSURE. TAG THE NEW VALVE TO FOLLOW BUILDING NAMING PROTOCOL. COORDINATE WITH THE OWNER. PROVIDE HOOD WITH SASH OPENING. MIN = 375CFM, MAX = 650CFM. COORDINATE EXACT ROUTING OF DUCTWORK IN FIELD SOME OF DUCT MAY NEED TO BE ROUTED UNDER THE CEILING BEHIND THE HOOD PANEL DUE TO THE HEIGHT OF THE NEW 12" DEEP DUCT. MAKE NECESSARY TRANSITIONS TO HOOD CONNECTION. 18" SASH STOP, 100°F MAX.

4. REPROGRAM EXISTING SUPPLY VALVE FOR CONSTANT 925 CFM AND HEATING COIL TO CONTROL ROOM TEMPERATURE. DAMPER SHALL CONTROL ROOM PRESSURE. EXISTING HOOD VALVE TO REMAIN AS PROGRAMMED.

5. PROVIDE NEW APSX123 AIR PRESSURE STABILIZER DAMPER IN WALL ABOVE CEILING. SIZE FOR 0.01" TO 0.02" PRESSURE IN ROOM. APPROXIMATE SIZE SHALL BE 30" LONG AND 20" TALL (4 BLADES). PROVIDE PLenum OFF OF DAMPER, TAP WITH 2-12" CONNECTIONS TO NEW TRANSFER GRILLES.

6. NEW RISER MAXIMUM CFM. VAV EXHAUST SHALL AUTOMATICALLY ADJUST WITH SP IN RISER.
02 TYPICAL HORIZONTAL VARIABLE VOLUME EXHAUST CONTROL VALVE

03 TYPICAL HORIZONTAL AIR FLOW CONTROL VALVE MOUNTING DETAIL

01 TYPICAL PIPE AND DUCT SUPPORT ATTACHMENT

EXHAUST AIR VALVE SCHEDULE

<table>
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<th>UNIT</th>
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<th>VALVE GROUP OFFSET</th>
<th>MAXIMUM CFM</th>
<th>MINIMUM CFM</th>
<th>INLET/OUTLET</th>
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<td>HOOD EXHAUST</td>
<td>SEE NOTES</td>
<td>650</td>
<td>375</td>
<td>12&quot;</td>
<td>PHOENIX LOW PRESSURE</td>
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<td>AVHE-12-6-13</td>
<td>HOOD EXHAUST</td>
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<td>650</td>
<td>375</td>
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</tr>
</tbody>
</table>

04 TYPICAL DUCT FITTINGS

The University of Texas
Health Science Center
Houston - CABIR - Hoods Level 6

E&C PROJECT #1000.00
01
TYPICAL ROUND/oval duct fittings
not to scale

02
TYPICAL CHEMICAL FUME HOOD
installation and connections
not to scale

03
TYPICAL DUCT MOUNTED SINGLE
BLADE BALANCING DAMPERS
not to scale

The University of Texas
Health Science Center
Houston - CABIR - Hoods Level 6
SUPPLY/2 HOOD EXHAUST LAB TRACKING SYSTEMS:

A. The supply air valve shall control from maximum air flow to minimum air flow as required to track the existing hood and maintain 100 cfm offset with that hood.

B. When heating is required to maintain setpoint, the modulating two-way heating control valve shall modulate to maintain the room temperature setpoint.

C. Both the existing and new hoods exhaust shall vary to maintain the constant velocity (100 fpm) through the sash opening as scheduled. The hood shall also monitor a motion sensor that shall allow the hood to reduce to the minimum setpoint when there is no movement in front of the hood.

D. The Phoenix gateway control panel shall provide room temperature (with alarm), humidity (with alarm), and supply and hood exhaust airflow (with alarm), the hood motion sensors and the two-way valve control and position back to the building automation system.

When the motion sensor notes no occupant in front of the hood, the face velocity shall reduce from 100 fpm to 60 fpm down to the minimum scheduled airflow.

ALTERNATE #1 - SUPPLY/3 HOOD EXHAUST LAB TRACKING SYSTEMS:

A. The supply air valve shall maintain a constant volume of supply.

B. When heating is required to maintain setpoint, the modulating two-way heating control valve shall modulate to maintain the room temperature setpoint.

C. The existing and 2 new hoods exhaust shall vary to maintain the constant velocity (100 fpm) through the sash opening as scheduled. The hood shall also monitor a motion sensor that shall allow the hood to reduce to the minimum setpoint when there is no movement in front of the hood.

D. The Phoenix gateway control panel shall provide room temperature (with alarm), humidity (with alarm), and supply and hood exhaust airflow (with alarm), the hood motion sensors and the two-way valve control and position back to the building automation system.

When the motion sensor notes no occupant in front of the hood, the face velocity shall reduce from 100 fpm to 60 fpm down to the minimum scheduled airflow.

The University of Texas
Health Science Center
Houston - CABIR - Hoods Level 6
E&C PROJECT #090.00

E&C Engineers & Consultants Inc.
7140 Riggs Road, Suite 650
Los Angeles, Texas 77012
Tel 713-590-8800
Fax 713-590-4888
www.josecog.com
**01 ELECTRICAL RENOVATION PLAN**

**Scale:** 1/8' = 1' - 0"

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**GENERAL NOTES:**

A. RE: E000 FOR ADDITIONAL GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS.

B. WHERE ELECTRICAL DEVICES ARE INDICATED TO BE REMOVED OR IN WALLS SHOWN TO BE REMOVED, ALL DEVICES, BOXES, CONDUIT, AND WIRING SHALL BE REMOVED BACK TO THE PANEL FEEDING THE DEVICE OR TO THE NEXT JUNCTION BOX FEEDING OTHER DEVICES NOT BEING REMOVED.

C. ALL ABANDONED DEVICES, BOXES, CONDUIT, AND WIRING SHALL BE REMOVED TYPICAL TO GENERAL NOTE B.

D. ALL WIRING SHALL BE 2'A, 12G, 3/4"C, UNLESS NOTED OTHERWISE.

**DRAWING NOTES:**

1. REMOVE ALL ELECTRICAL DEVICES LOCATED ON WALL SECTION TO BE COVERED BY NEW FUME HOOD. REFER TO GENERAL NOTE B. REUSE CIRCUIT FEEDING RECEPTACLE TO BE REMOVED TO FEED NEW FUME HOOD.

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**The University of Texas**
**Health Science Center**
**Houston - CABIR - Hoods Level 6**

E&C PROJECT #109.00
GENERAL NOTES:

A. REFER TO E000 FOR ADDITIONAL GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS.

B. WHERE ELECTRICAL DEVICES ARE MARKED TO BE REMOVED OR IN WALLS SHOWN TO BE REMOVED, ALL DEVICES, BOXES, CONDUIT, AND WIRING SHALL BE REMOVED BACK TO THE PANEL FEEDING THE DEVICE OR TO THE NEXT JUNCTION BOX FEEDING OTHER DEVICES NOT BEING REMOVED.

C. ALL ABANDONED DEVICES, BOXES, CONDUIT, AND WIRING SHALL BE REMOVED TYPICAL TO GENERAL NOTE B.

D. ALL WIRING SHALL BE 2"ID, #12G, 3/4"C, UNLESS NOTED OTHERWISE.

DRAWING NOTES:

1. REMOVE ALL ELECTRICAL DEVICES LOCATED ON WALL SECTION TO BE COVERED BY NEW FUME HOODS. REFER TO GENERAL NOTE B. REUSE CIRCUITS FEEDING RECEPTACLES TO BE REMOVED TO FEED NEW FUME HOODS.
PLUMBING RENOVATION PLAN
ALTERNATE #1

SCALE: 1/8" = 1'-0"

DRAWING NOTES:

1. CONNECT NEW 1/2" CW TO EXISTING 1/2" CW.
2. EXTEND EXISTING SPECIAL GAS FROM TANKS REGULATOR TO NEW HOOD GAS CONNECTION.
3. CONNECT NEW 3/4" LV TO EXISTING 3/4" LV.
4. CONNECT NEW 2" LAB WASTE FROM NEW HOOD TO EXISTING 2" LAB WASTE ABOVE CEILING OF LEVEL 5.
5. CONNECT NEW 2" LAB VENT TO EXISTING 2" LAB VENT ABOVE CEILING.
6. NEW HOODS CUP SINK 2" LAB WASTE DN, 2" LAB VENT UP AND 1/2" CW DN TO HOOD PRE-PIPED UTILITIES.
7. NEW 1/2" LV & N2, CA & G DN TO HOOD PRE-PIPED UTILITIES.
8. CONNECT NEW 3/4" CA & G TO EXISTING 1" CA & 1 1/2" G.
9. NATURAL GAS EMERGENCY SHUTOFF VALVE IN A VALVE BOX. MATCH EXISTING.