INVITATION FOR BIDS
CCK-2438-20, Project #2446.1
Facilities Renewal, Modernization and Deferred Maintenance –
Chemistry/Physics 3rd Floor, BP2A, SC-26A Controls
ADDENDUM # 2
9/03/2019

ATTENTION: This is not an order. Read all instructions, terms and conditions carefully.

IMPORTANT: BID AND ADDENDUM MUST BE RECEIVED BY 09-12-2019 @ 3:00 P.M. LEXINGTON, KY TIME

Bidder must acknowledge receipt of this and any addendum as stated in the Invitation for Bids.

1. Please refer to and incorporate within the Offer the attached Addendum Number Two dated August 27, 2019 from Omni Architecture.

2. Also, refer to the attached Phoenix Responsibility Matrix.

Mike Mudd / (859) 257-5409
Typed or Printed Name

University of Kentucky
Purchasing Division
322 Peterson Service Building
Lexington, KY 40506-0005
An Equal Opportunity University
<table>
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<th>Product</th>
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<td>Control Subcontractor</td>
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ADDENDUM NUMBER TWO

Bidders shall conform to the following changes, as same shall become binding on the Contract to be issued in response to this Invitation to Bid.

PROJECT INFORMATION
1. **Existing Drawings** – Existing drawings of the building have been provided for bidders convenience. Bidders are advised that these drawings may not be comprehensive.

2. **Existing Building Structure** – The load capacity of the existing building is noted on the original construction documents. Bidders are advised to confirm these limitations when planning to use heavy equipment in or on the building. Bidders are responsible for confirming the existing building’s capacity to support construction activities not expressly indicated in the bid documents.

3. **UK Design Standards** – All work in all trade packages must comply with the University of Kentucky Design Standards. A copy of the Design Standards is available for download at the following website: https://www.uky.edu/cpmd/design-

CLARIFICATIONS
4. **Commissioning Requirements** – Bidders are reminded that the commissioning process applies to systems that are included in the additive Alternate 1.

5. **Window SF27** – Window frame SF27 is shown with a group of aluminum framed storefront windows. This particular opening is a sliding glass transaction window as shown in the details and as specified in Section 12 1000 Building Accessories.

CORRECTIONS / CHANGES
6. **Specification Section 09 5113 Acoustical Panel Ceilings** –

   Revise Article 2.6 to read “Acoustical Panels (APC-4)” in lieu of “Metal Acoustical Panels (APC-4)”.

   Revise Article 2.6, A to read as follows: Provide panels the same as APC-1 except in a custom color to be chosen by Architect.

   Revise Article 2.9, A to read as follows: Provide suspension system the same as APC-1 except in a custom color to be chosen by Architect. Provide manufacturer’s standard hold-down clips on all cross tees to compress gaskets and hold each individual panel in place.

7. **Specification Section 20 2100 Valves and Cocks** - An incorrect version of the Specification Section 20 2100 Valves and Cocks was issued with the bid documents. Replace the section in its entirety with the attached specification (7 pages).

8. **Specification Section 20 2200 Insulation** - An incorrect version of the Specification Section 20 2200 Insulation was issued with the bid documents. Replace the section in its entirety with the attached specification (7 pages).

9. **Specification Section 20 3100 Testing, Balancing, Lubrication and Adjustments** - An incorrect version of the Specification Section 20 3100 Testing, Balancing, Lubrication and Adjust was issued with the bid documents. Replace the section in its entirety with the attached specification (4 pages).

10. **Specification Section 23 1200 Sheet Metal & Flexible Duct** - An incorrect version of the Specification Section 23 1200 Sheet Metal & Flexible Duct was issued with the bid documents. Replace the section in its entirety with the attached specification (17 pages).

11. **Keynote Correction** – Change all instances of drawing keynotes that read “05 7313-02 Stainless Steel Guardrail” to read as follows: “05 7313-02 Glazed Decorative Metal Railing”.

Addendum No. 2 - 1
12. **Site Revisions** - Refer to attached Site addendum items (3 pages) for additional revisions.

13. **MEP Revisions** - Refer to attached MEP addendum items (29 pages) for additional revisions.

END OF ADDENDUM NO. 2
SECTION 20 2100 - VALVES AND COCKS

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions - Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. The Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include, but may not be limited to all valves of all types including balancing cocks, air cocks, lubricated plug cocks, packed plug cocks, special valves for special systems, etc., for all Mechanical Systems.

C. All valves shall be designed and rated for the service to which they are applied.

D. The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.

E. Each type of valve shall be of one manufacturer, i.e., gate valves, one manufacturer, globe valves, one manufacturer, silent check valves, one manufacturer, etc. The following valve manufacturers shall be acceptable: Lunkenheimer, Tour & Anderssen, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Victaulic, Bell & Gossett, Flow Design, Watts.

F. All valves shall comply with current Federal, State and Local Codes.

G. All valves shall be new and of first quality.

H. Contractor shall provide discs on ceiling tile where valves are located above ceiling. Refer to Specification 20 2400. Provide access panels where valves are located above hard ceiling.

2. LOCATION OF MAINTENANCE VALVES

Maintenance valves and unions, installed so as to isolate equipment from the system shall be installed at the following locations:

A. At each plumbing fixture.

B. At each air handling unit, and make–up air unit.

C. At each heating or cooling coil.

D. At all other locations indicated on the drawings.

3. WORKMANSHIP AND DESIGN

A. Handwheels for valves shall be of a suitable diameter to allow tight closure by hand with the application of reasonable force without additional leverage and without damage to stem, seat and disc. Seating surfaces shall be machined and finished to insure tightness against leakage for service specified and shall seat freely. All screwed valves shall be so designed that when the screwed connection is properly made, no interference with, nor damage to the working parts of the valve shall occur. The same shall be true for sweat valves when solder or brazing is applied.
4. TYPES AND APPLICATION – HYDRONIC WATER SYSTEMS  

(All Chilled Water Valves connected to the campus chilled water system shall be rated for 250 psig):

A. Chilled Water Valves
   (1) All Chilled Water Valves connected to the campus chilled water system shall be rated for 250 psig.
   (2) All valves located above 8'-0" a.f.f. shall be provided with chain operators.
   (3) 3-4" chilled water valves shall be resilient seated, lug style butterfly valves with bubble tight, bi-directional shutoff at 250 psig pressure. Ductile iron body with locking handle, lever operators, 150 ANSI bolt pattern.
   (4) 6" and larger chilled water valves shall be resilient seated, lug style butterfly valves with bubble tight, bi-directional shutoff at 250 psig pressure. Ductile iron body with gear operator and hand wheels, 150 ANSI bolt pattern.

B. Hot Water Valves
   (1) All valves located above 8'-0" a.f.f. shall be provided with chain operators.
   (2) 4" and less shall have 150 lb, gate flanged or screwed cast iron valves.
   (3) Gate Valve (2 1/2" and smaller): Gate valve shall have bronze body, union bonnet, non-rising stem solid wedge and handwheel. Gate valve shall be rated for 200 psi working pressure.
   (4) Gate Valve (2-1/2" and larger): Gate valve shall have cast iron body with cast iron bolted bonnet, non-rising stem, solid cast iron wedge and handwheel. Gate valve shall be rated for 200 psi working pressure (250 psi for chilled water valves). Threaded end valve allowed for sizes 3" or less only.

C. Gate Valve (2 1/2" and smaller): Gate valve shall have bronze body, union bonnet, non-rising stem solid wedge and handwheel. Gate valve shall be rated for 200 psi working pressure (250 psi for chilled water valves).

D. Gate Valve (2-1/2" and larger): Gate valve shall have cast iron body with cast iron bolted bonnet, non-rising stem, solid cast iron wedge and handwheel. Gate valve shall be rated for 200 psi working pressure (250 psi for chilled water valves). Threaded end valve allowed for sizes 3" or less only.

E. OS&Y Gate Valves: OS&Y gate valve shall have cast iron body with cast iron bolted bonnet, bronze rising stem, solid cast iron wedge and handwheel. From viewing stem, valve position shall be capable of being determined. Valve shall be rated for 200 psi service (250 psi for chilled water).

F. Globe Valve (2" and under): Globe valve shall have bronze body, bonnet and disc holder. Globe valve shall have union bonnet, integral seat, teflon or stainless steel renewable disc and be rated for 200 psi working pressure (250 psi for campus chilled water).

G. Globe Valves (2-1/2" and over): Globe valve shall have cast iron body, bolted bonnet, bronze disc, renewable seat and have outside screw and yoke. Handwheel to be cast iron. Globe valve to be rated for 200 psi working pressure (250 psi for campus chilled water). Threaded ends valve allowed for sizes 3" and less only.

H. Check Valves (2" and less): Check valve shall have bronze body, disc and hinge. Check valve shall be Y-pattern type horizontal swing, renewable disc and rated for 200 psi working pressure (250 psi for chilled water).

I. Check Valves (2-1/2" and larger): Check valve shall have cast iron body and cast iron bolted bonnet the disc and seat ring shall be bronze. Check valve shall be horizontal swing with renewable seat and disc. Valve shall be rated for 200 psi working pressure (250 psi for chilled water). Threaded ends valve allowed
for sizes 3" and less only.

J. Ball Valves (2” and under): Ball valve shall have bronze body, ball and reinforced, watertight seat. Valve shall be 3-piece, swing-out, construction to facilitate inspections and repair. Valve shall be "full port" type. Valve handle shall only require quarter turn to go from full open to full close. The handle shall be removable with vinyl grip. Valve shall be rated for 250 degrees F water temperature and 200 psi working pressure (250 psi for campus chilled water). Provide extended handles for all ball valves installed in a chilled water system.

K. Ball Valve (2-1/2" to 6"): Ball valve shall have a cast iron body, with Teflon fused solid ball, blow-out proof stainless steel stem, and reinforced Teflon seats. Valve shall be “full port” type and the handle shall only require a quarter turn to go from full open to full close. The handle shall be removable with a vinyl grip. Valve shall be rated for a 200 psi working pressure (250 psi for campus chilled water) and 350°F temperature. Valves installed in chilled water systems shall be insulated up to the handle to eliminate condensation. Extend the handle as required.

L. Strainers (2" and under): Watts 77S Series "Y" type strainer with cast iron body and threaded ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with cleanout plug and be rated for 200 psi working pressure (250 psi for campus chilled water).

M. Strainers (2½" and larger): Watts 77F Series "Y" type strainer with semi-steel body and flanged ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with bolted cleanout and be rated for 200 psi working pressure (250 psi for campus chilled water).

N. Balancing Valve (4" and less): Balancing valve shall have bronze or cast iron body. Valves to have differential pressure readout ports across valve seat area with integral check valves. Valve shall be equipped with memory stop. Valves to have threaded ends for sizes 3" and less, flanged ends for larger sizes. Valve to be provided with performed molded insulation casing. Design working pressure and temperature to be 200 psi at 250 degrees F balancing valve shall be similar to Bell & Gossett Model CB. Provide with balancing valves, one (1) water gpm readout kit to be turned over to Owner which shall include a differential pressure meter with full scale overrange protection, hoses, readout probes, filters, carry and calculator. Valves shall be rated for 250 psi at 60 degrees F for campus chilled water.

O. Triple Duty Valve: Triple duty valve shall be straight pattern type with flange ends and be constructed for cast iron. Valve to be designed to perform as a non-slam check valve, calibrated balancing valve and shut-off valve. Valve to be provided with (2) brass readout ports with integral check valve to obtain flow measurement. Triple duty valve shall be rated for 175 psi working pressure (250 psi for campus chilled water) and 250°F. Valve to be similar to Bell & Gossett Model 3DS. Locate a triple duty valve at the discharge of each base mounted pump or where indicated on the drawings. The maximum water pressure drop thru a triple duty valve at rated gpm shall be 5.0 feet.

P. Flexible Connection: Pumpsaver SMP or equal braided stainless steel pump connector(s). Construction to be of annular corrugated stainless steel close-pitch hose with stainless steel overbraid. The corrugated metal hose, braid(s), and a stainless steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full-penetration TIG weld. End fittings shall be flat-face plate steel flanges with 150# ANSI drilling and outside diameter. Fittings must be attached using a 100% circumferential TIG weld. Braided stainless steel pump connector(s) must be suitable for operating temperatures up to 850°F (455°C). The rated working pressure of the braided metal hose must have a minimum 4:1 safety factor. Each braided stainless steel pump connector shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure. Flanged pump connectors shall be prepared for shipment using cut-to-length spacers, securely positioned between the flanges to prevent axial compression damage and maintain the manufactured length. Spacers must be removed prior to system start up.

Q. Air Eliminator: Amtrol automatic air eliminator with cast iron body and bronze pilot. Unit to be rated for
150 psi working pressure and 250 degrees F working temperature (250 psi for campus chilled water). Pipe discharge to nearest floor drain.

R. Automatic Air Vent: Armstrong Model 79 automatic air vent for vertical mounting with brass body and polypropylene float. Vent to be rated for 150 psi working pressure and 240 degrees F working temperature (250 psi for campus chilled water). Pipe discharge to nearest floor drain.


5. TYPES AND APPLICATION - STEAM AND CONDENSATE:

A. All valves, strainers, check valves, steam traps, globe valves, ball valves, PRV’s, etc. on high pressure system shall be cast steel construction rated for 300 PSI 500°F. Triple rotary valves shall be provided for the steam valves in the main mechanical room where the steam entrance is located and the penthouse.

B. Gate Valves (2" and smaller): Gate valve shall have bronze body, union bonnet, non-rising stem, split wedge and handwheel. Gate valve shall be rated for 150 psi working pressure for low and medium pressure steam and 300 psi for high pressure steam. 150 lb screwed bronze gate valves for low pressure condensate return.

C. OS&Y Gate Valves (2-1/2" and larger): OS&Y gate valve shall have cast steel body with cast iron bolted bonnet, outside screw & yolk, solid wedge, bronze rising stem, valve position shall be capable of being determined. Valve shall be rated for 150 psi for low pressure steam and 300 psi for high pressure steam.

D. Check Valves (2" and less): Check valve shall have bronze body, disc and hinge. Check valve shall be Y-pattern type horizontal swing, renewable disc and rated for 150 psi working pressure for low pressure steam and 300 for high pressure steam.

E. Check Valves (2-1/2" and larger): Check valve shall have cast iron body and cast iron bolted bonnet the disc and seat ring shall be bronze. Check valve hall be horizontal swing with renewable seat and disc. Valve shall be rated for 150 psi working pressure for low pressure steam and 300 for high pressure steam.

F. Triple Rotary Valve (2-1/2" and larger):

This specification covers the design and testing of quarter turn valves for tight shutoff with metal to metal seats.

1.0 APPLICABLE STANDARDS

The following standards apply:

- ASME B16.5: Pipe Flanges and Flanged Fitting
- ASME B16.47: Pipe Flanges and Flanged Fitting 26” and larger.
- ASME B16.34: Valves – Flanged and Butt welding End
- MSS-SP-25: Standard Marking System for Valves, Fitting, Flanges and Unions
- MSS-SP-6: Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
- API 598: Valve Inspection and Testing (Low Pressure Closure Test)
- ISO 5752: Face to Face Dimensions; Series 13 (150); Series 14 (300 / 600)
- API 609: (Fifth edition) Butterfly Valves: Double-Flanged, Lug and Wafer Type
- ASTM: Materials of Construction
2.0 DESIGN REQUIREMENTS

A. Valves shall be quarter turn, metal to metal seated, incorporating “inclined conical” geometry creating triple offset design. Valves shall be torque seated. Valves will provide bi-directional bubble tight shut-off and be designed in accordance with ASME B16.34 and B31.3. The design of the valve components shall take into account the maximum output torque of the operating mechanism required to operate the valve against the maximum differential pressure as per the specified class. All recommended spare parts must be interchangeable for same size and pressure rating.

B. Valve bodies shall be double flanged, cast carbon steel, able to withstand induced pipe loads without distortion and affect on the movement of the disc. Face to face dimensions shall conform to ISO 5752, series 13 for class 150, series 14 for class 300/600.

C. Valve disc shall be single piece cast 316 (CF8M) stainless steel. Threaded connections on the disc shall not be allowed. Disc attachment to the shaft shall be by means of parallel keys (splined connection for 600 class). Pins of any kind shall not be used for torque transmission.

D. The valve shaft diameter shall provide adequate strength to operate the valve at full rated design conditions. Shaft shall be one piece. A thrust bearing shall be provided to absorb thrust in both directions and provide blowout protection. The shaft diameter shall be reduced at the actuator connection so as to put the weakest point outside the valve above the packing. The shaft surface roughness at the packing area shall be 0.8 \( \mu \)m or smoother.

E. The seal ring shall consist of laminations of 316SS and graphite (min. 4-stainless/3 graphite). The seal ring seating surface shall be machined on the inside diameter and shall secured by means of a retainer to insure no movement. The replaceable seal shall be located in the body to be fully protected from the flow stream and shall not require indexing or special positioning. Retainer bolting on internal rotating parts is not allowed. To prevent leakage behind the seal ring, a static graphoil gasket shall be used. Dynamic gaskets are not allowed.

F. The packing gland shall be provided with a minimum of four studs for precision adjustment and compression of the packing. A minimum of five packing rings shall be provided.

G. Valves will incorporate solid metal, press fit shaft bearings which are sealed from the ingress of particulate or contaminants. Sufficient differential hardness between the shaft and bearing surfaces shall be provided to insure smooth, non-galling rotation.

H. Gear operated valves shall be provided with self-locking gears. The actuator mounting bracket shall be rigidly dowel pinned to the body to absorb torque loads and shall be centered by machined register between bracket and body.

I. Valves shall be tested in accordance with ASME B16.34-1996 and API 598-1996. When specified, the valves shall be tested for seat leakage from both sides of the disc. Written test certificates shall be available upon request.

J. The following visual inspections shall be carried out:
   - verification of the primary dimensions
   - verification of the absence of defects in castings (per MSS-SP-55)
   - verification of the nameplate and marking (per MSS-SP-25)

K. Painting of non-stainless steel components shall be in accordance with customer specifications or manufacturer standards suitable for the operating conditions and environment. A written painting procedure must be available.
L. When all final testing is completed the valves shall be prepared for shipment. The external surface of the valves shall be free of grease or oil. The machined surfaces shall be protected with anticorrosive preparation. Valves shall be packaged adequately for transportation by surface or airfreight shipment as specified.

7. VALVE CLASSIFICATION SCHEDULE

<table>
<thead>
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<th>VALVES 2 1/2&quot; AND SMALLER</th>
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<tbody>
<tr>
<td>SERVICE</td>
</tr>
<tr>
<td>Chilled Water</td>
</tr>
<tr>
<td>*Rated for 250 psig WOG working pressure</td>
</tr>
<tr>
<td>Domestic Hot and Cold Water</td>
</tr>
<tr>
<td>Heating Water</td>
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<tr>
<td>Low and Medium Pressure Steam and Low Pressure Steam Condensate</td>
</tr>
<tr>
<td>High Pressure Steam</td>
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<td>High Pressure Steam Condensate</td>
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*Designed for 500 deg steam at 300 psig

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<th>VALVES OVER 2 1/2&quot;</th>
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<tbody>
<tr>
<td>SERVICE</td>
</tr>
<tr>
<td>Chilled Water</td>
</tr>
<tr>
<td>*Valves with ANSI 125/150 bolt pattern may be used if flanges and valves meet the 250 psig WOG design pressure</td>
</tr>
<tr>
<td>Domestic Hot and Cold Water</td>
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<tr>
<td>Heating Water</td>
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<tr>
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</tr>
<tr>
<td>High Pressure Steam</td>
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<tr>
<td>High Pressure Steam Condensate</td>
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**Rated for 500 deg steam (cast steel)

7. DOMESTIC WATER APPLICATIONS:

a. GATE VALVE (3" AND UNDER): Use ball valves as specified.
b. GATE VALVE (4" AND LARGER): Gate valve shall have bronze body, bonnet and solid wedge. Gate valve shall be rising stem with bolted bonnet and solid wedge. Valve shall have rated for 150 psi working pressure. Gate valve shall be Nibco T-134 for threaded ends or Nibco S-134 for solder ends.
c. GLOBE VALVES (2" AND UNDER): Globe Valves shall have bronze body, bonnet and disc holder. Globe valve shall have union bonnet, integral seat, teflon or stainless steel renewable disc and be rated for 150 psi working pressure. Globe valve shall be Nibco T-235 for threaded ends or Nibco S-235 for solder ends.
d. CHECK VALVE (2" AND UNDER): Check valve shall have bronze body, disc and hinge. Check valve shall be Y-pattern type, horizontal swing, renewable disc and rated for 150 psi working pressure. Check valve shall be Nibco T-413 for threaded ends or Nibco S-413 for solder ends.
e. BALL VALVES (2½"-3½’): Ball valve shall have bronze body, ball and reinforced, watertight seat. Valve shall be "full port" type. Valve handle shall only require quarter turn to go from full open to full close. The handle
shall be removable with vinyl grip. Valve shall be rated for 250 degrees F water temperature and 200 psi working pressure. Ball valve shall be Nibco S-FP-600 for threaded ends and Nibco T-FP-600 for solder ends.

f. THREE PIECE BALL VALVE (2" AND UNDER): Ball valve shall have bronze body, ball and reinforced, water tight seat. Valve shall be three piece, swing-out, construction to facilitate inspection and repair. Valve shall be "full-port" type. Valve handle shall only require quarter turn to go from full open to full close. The handle shall be removable with vinyl grip. Valve shall be rated for 180 degrees F water temperature and 150 psi working pressure. Ball valve shall be Nibco T-595 for threaded ends and Nibco S-595 for solder ends.

g. STRAINERS (2" AND UNDER): Watts 77S Series "Y" type strainer with cast iron body and threaded ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with cleanout plug and be rated for 200 psi working pressure.

h. STRAINERS (2½" AND LARGER): Watts 77F Series "Y" type strainer with semi-steel body and flanged ends. Screen shall be 20 mesh stainless steel. Strainer shall be provided with bolted cleanout and be rated for 200 psi working pressure.

i. PRESSURE REDUCING VALVES: Watts #U5B water pressure reading valve with bronze body, bolted bonnet, integral stainless steel strainer and outlet water pressure gauge. Internal disc, diaphragm and stainless steel seat shall all be removable. Valve shall be rated for inlet water pressures up to 300 psi. Water pressure reducing valves shall be provided for all equipment where water pressure exceeds the equipment manufacturer’s ratings.

j. VACUUM BREAKERS: Watts #288A atmospheric type vacuum breaker with brass body. Vacuum breaker shall be rated for 210 degrees F and 125 psi working pressure and shall meet ASSE Standard 1001.

8. NATURAL GAS APPLICATIONS:

a. GAS BALL VALVE (2" AND LESS): Nibco TFP600N gas ball valve. Valve shall forged two-piece brass, CSA/CGA CR 91-002 certified, 5 psig rating, lever handle, full port ball valve, lubricated shaft, PTFE seats, blowout proof stem and threaded ends.

b. GAS LUBRICATED PLUG VALVE, (2½" AND GREATER): Homestead lubricated industrial plug valve, Model 611/612, 100% round port, leak-proof, spring loaded ball and lubricant sealed check valve. Provide with threaded ends and lever handle.

END OF SECTION 20 2100
SECTION 20 2200 - INSULATION - MECHANICAL

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.

C. Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

2. MANUFACTURERS

A. Insulation shall be as manufactured by Manville, Knauf, CertainTeed, Owens-Corning, Armacell or other approved equivalent. Insulation sundries, adhesives, and jackets/covers shall be as made by Benjamin Foster, Zeston, Speedline, Proto, Childers, Vimasco or approved equivalent.

3. FIRE RATINGS AND STANDARDS

A. Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50.

B. Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.

C. All products and their packaging shall bear a label indicating above requirements are not exceeded.

4. GENERAL APPLICATION REQUIREMENTS

A. Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping, ductwork or equipment until tested, inspected and released for insulation.

B. All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe and ductwork are to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full thickness of insulation specified. If necessary, extra fittings and pipe are to be used. No noticeable deformation of insulation or discontinuity of vapor seal, where required, will be accepted.

C. "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

D. Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.
E. Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!

F. All insulation shall be installed with joints butted firmly together.

G. The Contractor shall insure that all insulation (piping, ductwork, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

H. Insulation on domestic water piping in a wall shall be continuous to the back of the drywall prior to entering a cabinet/casework under a sink.

5. PIPING SYSTEMS

A. GENERAL

(1) Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.

(2) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to insure no condensation drip or collection.

(3) Factory molded fittings may be installed in lieu of built-up fittings. Jackets to be the same as adjoining insulation. Insulated fittings must have same or better K factors than adjoining straight run insulation.

(4) Valves, flanges and unions shall only be insulated when installed on piping whose surface temperature will be at or below the dew point temperature of the ambient air.

(5) Insulation shall not extend through fire and smoke walls. A UL-listed penetration system shall be used for each fire or smoke wall penetration in accordance with KBC. Materials used such as caulk, sleeves, etc. shall be manufactured by 3M, Hilti, or equal.

B. INSULATION SHIELDS

(1) Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180-degree arc. Insulation shields shall be the following size:

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>SHIELD GAUGE</th>
<th>SHIELD LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; AND LESS</td>
<td>20</td>
<td>12&quot;</td>
</tr>
<tr>
<td>2 1/2&quot; TO 4&quot;</td>
<td>18</td>
<td>12&quot;</td>
</tr>
<tr>
<td>5&quot; TO 10&quot;</td>
<td>16</td>
<td>18&quot;</td>
</tr>
<tr>
<td>12&quot; AND GREATER</td>
<td>14</td>
<td>24&quot;</td>
</tr>
</tbody>
</table>

C. INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL, or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .23 at
75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket approved manufacturers are listed in section 2. Manufacturers. The jacket shall have an inside foil surface with self sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturers’ recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

(1) Domestic Cold Water
   a. Piping 1” or less – use ½” thick insulation
   b. Piping 1¼ or greater – use 1” thick insulation

(2) Hydronic System Fill Lines from Domestic Cold Water - 1” thick.

(3) Domestic Hot Water and Recirculating Hot Water.
   a. Piping 1 ½” or less – use 1 ½” thick insulation
   b. Piping 2” or greater – use 2” thick insulation

(4) Hydronic Water – Hot Water and Chilled Water
   a. Piping 1 thru 2” – use 1” thick insulation
   b. Piping 2 ½” thru 4” – use 1 ½” thick insulation
   c. Piping 5” and larger - use 2” thick insulation

(5) Horizontal Roof Leaders.
   a. Piping 3” or less – use ½” thick insulation
   b. Piping 4” or greater – use 1” thick insulation

(6) Sanitary Sewer and plumbing fixture P-traps to waste stack – see schedule below. Insulate horizontal runs which receive air conditioning condensate and which are not located below slab or grade.
   a. Piping 3” or less – use ½” thick insulation
   b. Piping 4” or greater – use 1” thick insulation

(7) Condensate Drain Lines (off condenser coils/HVAC equipment).
   a. Piping 1 ½” or less – use ½” thick insulation
   b. Piping 2” or greater – use 1” thick insulation

(8) Refrigerant Liquid and Suction Lines - Interior & Exterior

IMCOA, Nomaco, or Armacell closed cell polyethylene, 1.5 Lbs/Ft³ density, 0.24 BTU-Hr.-Ft³-°F/in at 75°F thermal conductivity, zero vapor permeance, 25/50 flame and smoke spread per NFPA 90 requirements. Elastomeric closed cell insulations that meet the above requirements are also allowed. Install insulation per the manufacturer’s requirements.
a. All pipe sizes: 1 ½” thick

(9) High Pressure Steam (76 PSI and Above)
   a. 2” and less pipe size: 2 ½” thick
   b. 2 ½” thru 4” pipe size: 3” thick
   c. 5” thru 10” pipes: 3 ½” thick
   d. 12” and larger: 4” thick

(10) Medium Pressure Steam (21 PSI-75 PSI)
   a. 1” and less pipe size: 2” thick
   b. 1 ¼” thru 4” pipe size: 2 ½” thick
   c. 5” thru 10” pipe size: 3” thick

(11) Low Pressure Steam (Up to 20 PSI)
   a. 2” or less pipe size: 1 ½” thick
   b. 2 ½” thru 6”: 2” thick
   c. 6” thru 10”: 2.5” thick
   d. 12” and larger: 3” thick

(12) Steam Condensate
   a. 1 ½” and less pipe size: 1 ½” thick
   b. 2” thru 6”: 2” thick
   c. Above 6”: 2.5” thick

(13) Steam Vent- Insulate with 2” thick insulation

(14) Direct Bury Exterior Pipe (Steam, Steam Condensate/Pump Discharge, Chilled Water, Etc.
   a. Refer to Pipe Specifications Section 20 1300.

D. JACKETS

(1) Exposed
   a. Provide 8 oz. canvas jacket with fire retardant lagging as indicated below.
   b. Exposed piping in boiler, chiller, mechanical rooms, penthouse, etc. shall have an 8-ounce canvas jacket applied over the fiberglass factor ASJ/SSL jacketing to further protect the insulation from abuse. This jacketing must be properly applied with lagging adhesive, such that the outer surface is smooth and free of wrinkles. The canvas jacketing in all mechanical areas is to be prepared for painting, and then painted according to the University of Kentucky standard piping color coding. All chilled water piping insulation shall be completely sealed so that a perfect vapor barrier is achieved. This applies to all new piping.

(2) Exposed (Exterior)
   In addition to the insulation specified for the exterior pipe, provide .016” aluminum jacket. The jackets shall be installed as recommended by the manufacturer to maintain water tight seal. All longitudinal and transverse seams to be sealed water tight.
6. STEAM/STEAM CONDENSATE & HOT WATER PIPING REMOVABLE JACKETING INSULATION

A. All steam pressure reducing stations shall be installed with removable jacketing insulation to allow service to the station. This includes all fittings, valves, etc. on the steam pressure reducing stations and valves in mechanical room and penthouse. All steam condensate pumps shall be installed with removable jacketing insulation over reservoir. All steam traps 2 1/2” and larger shall have removable jacket insulation. All steam control valves shall be installed with removable jackets for maintenance. Provide removable jacket for hydronic hot water valves over 4” located in the mechanical room and penthouse.

B. Insulation shall meet at minimum the following specification:

1. Non-Asbestos Glass mat, type E needle fiber.
2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
3. Jacket Material: Silicon/fiberglass compressed as required to give maximum 130F surface temperature depending on fluid medium in piping.
4. Construction: One-piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket.
   a. Sewn lock stitch with a minimum 4 to 6 stitches per inch. The thread must be able to withstand the skin temperatures without degradation.
   b. Hog rings, staples and wire are not acceptable methods of closure. Velcro straps alone are not acceptable unless written permission from UK (hook & loop method required).
   c. No raw cut jacket edges shall be exposed.
   d. Jackets shall be fastened using hook and loop (Velcro) straps
   e. Provide a permanently attached Aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.
   f. The insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
   g. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.
   h. Insulation thickness: As required for Touch Temperature Exterior of all jacket < 130F.

7. DUCTWORK SYSTEMS

A. GENERAL

1. Duct sizes indicated are the net free area inside clear dimensions; where ducts are internally lined, overall dimensions shall be increased accordingly.

2. Duct insulation shall extend completely to all registers, grilles, diffusers, and louver outlets, etc., to insure no condensation drip or collection. The backs of all supply diffusers, plenums, grilles, etc. shall be insulated.

3. All flexible duct connections on insulated ductwork shall be externally insulated.

4. All duct outside of building envelope, including rooftop duct, duct in unconditioned attic spaces above the insulation, etc. shall have two layers of specified insulation. This shall apply to supply air, exhaust air where air is run through energy recovery unit, outside air, return air, and combustion air intake ducts.

B. EXTERNAL INSULATION
(1) Supply Air Duct. Sound attenuators located in the supply airstream shall be insulated similar to supply air ductwork.

(2) Outside Air Duct: Insulate OA duct up to the AHU.

(3) Relief/Exhaust Air Ductwork: Only insulate relief air and relief air plenum.

(4) Material: Owens/Corning “Faced Duct Wrap - Type 100”, or approved equal, 2" thick fiberglass duct wrap, 1 pcf. density factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. Flame spread 24, smoke developed 50, vapor barrier performance 0.02 perms per inch. K factor shall not exceed .26 at 75°F. mean temperature. Minimum R-value of the 2” thick insulation shall be 6.0 (installed or 7.4 out of the package) when the ductwork is on the interior of the building and 8 when the ductwork is on the exterior of the building. An thinner product (1.5”) will be acceptable provided the R values can be achieved.

Special Notes:

a. Note: Coordinate with sheetmetal contractor. Where double wall supply ductwork is called for, it does not require insulation or a canvas wrap.

b. Do not provide externally insulated duct per the above specification for any duct that is to be painted. Insulated duct that is to be painted shall be dual wall ductwork per specification Section 231200, Sheet Metal and Flexible Duct.

c. Where supply, return, and outside air ductwork is routed through an unconditioned attic or any other space outside of the building thermal envelope, the ductwork shall be provided with a minimum of 2 layers of duct wrap for a minimum R value of 11.0.

C. EXTERNALLY INSULATED DUCT- OUTDOORS

(1) 2" semi-rigid fiberglass industrial board with foil scrim kraft vapor barrier facing or PSK Facing, 3.0 PCF density, K=.23 @ 75°F. Minimum R-value of 8.7. Owens/Corning, or approved equivalent industrial installation type 703.

(2) Provide a field applied aluminum jacket meeting the following specification:

   Aluminum Jacket Material: Smooth finished sheets manufactured from 0.024-inch-thick aluminum alloy complying with ASTM B209 and having an integrally bonded 10mil thick, heat-bonded polyethylene and kraft paper moisture barrier over entire surface in contact with insulation.

   Aluminum Jacket Applications: Apply aluminum jacketing to all external ductwork that is externally insulated. Cover all fittings and specialties with aluminum jacketing. Provide a 2-inch overlap at longitudinal seams and end joints. Secure jacket with stainless-steel sheet metal screws 6 inches o.c. and at end joints. Overlap longitudinal seams arranged to shed water and seal end joints with weatherproof mastic.

D. LAB EXHAUST RATED WRAP
1. The insulation shall be tested per UL 1978, ASTM E 119 and comply with the International Mechanical Code. The product shall be 1.5” thick with a nominal density of 6 pcf. The wrap shall be scrim encapsulated with a flame spread below 25 and smoke development rating below 50.

2. Acceptable manufacturers are FyreWrap, 3M Fire Barrier Duct Wrap, or equal.

E. DUCT SOUND ABSORBER / DUCTWRAP

1. 1” THICK Kinetics KBC-100RBQ (or Sound Seal BBC-1 B-10FS QFA-1) limp barrier material (1.3 lb/sq ft), reinforced with a fiber glass screen, loaded with barium sulphate, with a quilt faced fiber glass absorber on one side. Install per manufacturer’s instructions. Minimum Sound Transmission Loss per octave band shall be:

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>ST Loss (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 Hz</td>
<td>10</td>
</tr>
<tr>
<td>250 Hz</td>
<td>16</td>
</tr>
<tr>
<td>500 Hz</td>
<td>22</td>
</tr>
<tr>
<td>1000 Hz</td>
<td>30</td>
</tr>
<tr>
<td>2000 Hz</td>
<td>39</td>
</tr>
<tr>
<td>4000 Hz</td>
<td>43</td>
</tr>
</tbody>
</table>

8. MECHANICAL EQUIPMENT

A. FLOOR DRAIN SUMPS (Applies to all Floor Drains which Receive Air Conditioning Condensate and which are Installed in Locations Other Than Slab on Grade)

1. Owens-Corning Model 475-FR or approved equivalent rigid board insulation with exterior vapor barrier jacket formed to bottom of sump basin. Insulation shall have a K factor of .22 at 75°F mean temperature. Insulation shall be 1” thick. Insulation shall be formed to roof drain sump. Vapor barrier shall remain continuous.

B. EXPANSION TANK, COMPRESSION TANK, AIR SEPARATOR, HEAT EXCHANGER, SIDESTREAM/LOOP FILTERS, FLASH TANKS, AND HOT WATER STORAGE TANKS, ETC

1. Owens-Corning "Tank Wrap I" or approved equivalent. Insulation shall be constructed of non-combustible, flexible wool. Insulation shall be 2” thick. K factor shall be .29 at 100°F mean temperature. Insulation shall be attached in strict accordance with the manufacturer’s recommendations. All insulation shall be jacketed with 6 oz. canvas with fire retardant lagging. Coordinate with mechanical contractor to extend all piping connections, blowdown ports, etc. outside of the insulation. Additionally, for loop filters and other equipment requiring periodic service, provide removable insulated covers.

END OF SECTION 20 2200
SECTION 20 3100 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

1. GENERAL

A. The General Conditions, Instructions to Bidders, Section 20 0100, and other Contract Documents are a part of this specification and shall be binding on all Mechanical Contractors. It shall be each Contractor’s responsibility to apprise himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.

B. The Engineer, or his authorized representative, shall be notified by the Contractor twenty-four (24) hours in advance of any tests called for in these specifications or required by others. Any leaks or imperfections found shall be corrected and a new test run to the satisfaction of the Engineer or his authorized representative. Upon completion of a test, a written approval of that part of the work will be given to the Contractor. Only after written approval, signed by the Engineer, shall the Contractor apply insulation or paint or allow his work to be furred-in. This written approval, however, does not relieve the Contractor of the responsibilities for any failure during the guarantee period. The expense of all tests shall be borne by the Contractor, along with all temporary equipment, materials, gauges, etc. required for tests.

C. Functional Performance Tests

1) Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Section 01 9113 Commissioning.

2. PLUMBING

A. Piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.

B. Water piping systems shall be subjected to a hydrostatic test of one hundred fifty pounds. The system shall be proven tight after a twenty-four (24) hour test.

C. The house drain line, interior storm sewers, interior rain water conductors, and all soil, waste and vent piping shall be subjected to a hydrostatic test of not less than a 10-foot head or an air test of not less than 5 lbs. per sq. inch using a mercury column gauge and shall hold for 15 minutes.

D. Exterior sewer lines to the termination point outside the building shall be subject to a ten-foot hydrostatic test or an approved smoke test. These lines shall be subjected to a second test after 2 feet of backfill has been properly installed.

E. After fixtures have been installed, the entire plumbing system, exclusive of the house sewer, shall be subjected to an air pressure test equivalent to one inch water column and proven tight. The Contractor responsible shall furnish and install all of the test tees required, including those for isolating any portion of the system for tests.

F. Thermometers and gauges shall be checked for accuracy. If instruments prove defective, they shall be replaced.

G. The Contractor shall perform all additional tests that may be required by the Kentucky Department of Health or other governing agency.

H. Set temperature control on water heaters and adjust tempering valves as required.

I. Balance the water flow rate of each domestic hot water recirculating pump. Set the flow rate for each balancing valve in the recirculating hot water system. If flow rates are not indicated, contact the engineer for each balance valve GPM.
J. Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.

K. The compressed air system shall be tested for leaks for eight (8) hours at 250 PSI.

L. The vacuum pump system shall be tested for leaks for eight (8) hours at 250 PSI.

M. Chilled water piping shall be test at 250 psi for one (1) hour.

N. All steam piping, buried and exposed, shall be tested per the Kentucky Boiler Code. The outer jacket of the steam piping shall be tested at 10 psi.

3. HEATING, VENTILATING AND AIR CONDITIONING

A. The test and balance of this system shall be by a contractor who employs only the services of a certified AABC or independent NEBB firm whose sole business is to perform test and balance services. The test and balance contractor shall report all deficiencies to the engineer.

B. The Mechanical Contractor shall test all piping before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory. Water piping systems shall be subjected to a hydrostatic test of not less than one hundred pounds and shall be proven tight after a twenty-four (24) hour test.

D. All motors, bearings, etc. shall be checked and lubricated as required during start-up procedures. All automatic, pressure regulating and control valves shall be adjusted. Excessive noise or vibration shall be eliminated. Provide all start-up documents to Designer prior to any test and balance services.

E. System balancing, where required, shall be performed only by persons skilled in this work. The system shall be balanced as often as necessary to obtain desired system operation and results.

F. All fan belts shall be adjusted for proper operation of fans.

G. All deficiencies observed by the Test and Balance Contractor shall be reported immediately to the Engineer and Mechanical Contractor.

H. For the purpose of placing the heating, ventilating and air conditioning system in operation according to design conditions and certifying same, final testing and balancing shall be performed in complete accordance with AABC Standards for Total System Balance, Volume Six (2002), for air and hydronic systems as published by the Associated Air Balance Council. The following systems shall be test and balance:

(1) The supply, return and outside air duct systems associated with AHU-9, 10, 11, 12, and 13 which is an alternate bid. Provide static pressure profiles thru each system. Static pressure profiles shall include all sections from the return duct inlet and supply duct outlet of the air handling unit. Show accurate representation of return, relief, outdoor and economizer damper locations. On units equipped with return air fans; show location and profile of the return fan.

(2) Verify that the temperature control systems supply and return air flow stations on AHU-10, 11, and 12 are calibrated corrected. Test at 25%, 50%, 75% and 100% flow rated.

(3) AHU-9, 10, 11, 12, 13(alternate) supply duct and all exhaust air leakage testing.

(4) Verify calibrations of the duct static pressure sensors.
(5) Review the static setpoint of supply and exhaust fans and assist the Engineer and Commissioning agent in determining if the setpoint can be reduced.

(6) Balance the fume hood exhaust plenum to 2.1 inches negative static pressure for the main manifold and the radiological manifold as well.

(7) Determine the VFD speed required to maintain the lab exhaust plume height required by the Engineer. Current height shall be 55 feet.

(8) Rebalance AHU-8 and adjust the static setpoint.

(9) Refer to control sequences for minimum OA damper position.

(10) The chilled water pumps and chilled water coils.

(6) The hot water pumps and hot water coils. Record water flow, incoming and leaving temperature for water and air at the maximum design airflow.

(7) Set the minimum and maximum air flow rates for each VAV and CAV box including verifying the airflow quantities for the lab airflow control valves.

(8) Balance all supply, return and exhaust air grilles to within 10% of design airflow rate.

(9) Balance all supply, return and exhaust air grilles to within 5% for critical rooms such as labs.

(10) Balance all exhaust air fans and record inlet static pressure.

(11) Balance domestic hot water return system including all balance valves and record settings and flows.

(12) Adjust all adjustable diffusers to minimize air drafts and eliminate suspended light fixture sway. Furthermore, adjustable diffusers in spaces with ceilings taller than 9 feet shall be adjusted to eliminate air stratification during heating season.

(13) Verify airflows of the smoke evacuation fans prior to final independent testing.

(14) Balance water flow on the computer room air handling and pumping system.

(15) Balance the energy recovery loop at the coils and pump and record system pressures at each device.

H. Provide a preliminary test report to the mechanical engineer immediately after the system is air balanced, or any initial phases are balanced. This report may be hand written. Anticipate visiting the site again after the engineer has reviewed the report. The engineer may request up to 15 additional static pressure measurements for any air handling system to help resolve any balancing deficiencies. Include five additional static pressure measurements for each exhaust air system.

I. The Test and Balance agency shall provide lifts, scaffolding, etc. as required to balance devices in areas with high ceilings such as lecture halls, atriums, etc. The Test and Balance agency may coordinate with the General Contractor or Mechanical Contractor to arrange for these items to be provided to access high devices, however, it is emphasized the Contractor is finally responsible for providing the means required to balance all devices.

J. Instruments used for testing and balancing of air and hydronic systems shall have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.
K. Test and Balance agency is to provide sizing of fan or motor sheaves required for proper balance. The Mechanical Contractor will purchase and install all sheaves and belts as required. This includes new and existing equipment.

L. Four (4) copies of the complete test reports shall be submitted to the Consulting Engineer prior to final acceptance of the project. Preliminary test reports shall be submitted when requested.

M. The Contractor shall provide and coordinate his work in the following manner:

   (1) Provide sufficient time before final completion date so that tests and balancing can be accomplished.

   (2) Provide immediate labor and tools to make corrections when required without undue delay.

N. The Contractor shall put all heating, ventilating and air conditioning systems and equipment and fumehood system into full operation and shall continue the operation of same during each working day of testing and balancing.

O. The test and balance contractor shall be present during the Engineer’s final inspection of the building, or a separate project review date. The Engineer may request confirmation of the air balance report by asking for new measurements to be taken at that time. Any information in the test and balance report may be asked to be reconfirmed.

P. Balance all water and air systems. Be sure to include:

   (1) Domestic Hot Water Recirculating System.

   (2) RO/DI Water System.

4. FIRE PROTECTION SYSTEM

   A. Test the fire pump, wet system, and chemical suppression system in accord with local Fire Marshall requirements and/or requirements or recommendations of NFPA Regulations.
SECTION 23 1200 - SHEET METAL AND FLEXIBLE DUCT

1. GENERAL

   A. The Contractor’s attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

   B. This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's HVAC Duct Construction Standards, Metal and Flexible, and its subsequent addenda. HVAC duct systems shall be fabricated and installed in accordance with the SMACNA duct construction standards (SMACNA-HVAC and SMACNA-Seismic) including Appendix B of the Seismic Restraint Manual Guidelines for Mechanical Systems. These references and plate numbers shall be used by the Engineer for required sheet metal thicknesses and final acceptance of methods of fabrication, hanging, accessories, etc. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.

2. PRESSURE VENTS

   A. Provide a pressure relief vent in the supply air ductwork at each air handling unit. It shall be located between the fan outlet and the first manual or automatic (i.e., fire, fire smoke, or any motorized) damper or closure device. It shall be sized to relieve the duct air pressure below the rated pressure construction of the ductwork and above the working pressure of the fan. Provide a vacuum relief vent in the return and/or outside air ductwork at each air handling unit. It shall be located between the air handling unit casing and the first manual or automatic damper or closure device. It shall be sized to relieve the duct vacuum below the rated construction of the ductwork and above the working negative pressure of the fan. Automatic fan shutdown upon damper closure shall not be an acceptable protection for either overpressure or vacuum conditions. All duct relief dampers shall be of the automatic resetting type unless otherwise noted.

3. FILTER RACKS

   A. If separate filter grilles are specified for an HVAC unit the Contractors shall remove any unit mounted filters and blank off the unused filter access opening with sheet metal and seal air tight.

4. WALL PENETRATIONS

   A. Where ducts penetrate interior or exterior walls, the walls shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.

5. PROTECTION DURING CONSTRUCTION

   A. All ductwork openings shall be covered during construction to prohibit dust and dirt from entering the installed ductwork, air handling unit, terminal devices, etc. Provide temporary filters on all return grilles and duct openings if the units are running prior to the building being satisfactorily cleaned. The Contractor shall pay for duct cleaning if precautionary measures are not taken.

6. LOW PRESSURE DUCTWORK

   A. General (Low Pressure)
(1) Double turning vanes shall be installed in all square turns and in any other locations indicated.

(2) Provide "spin-in" type fittings for all round ducts serving supply air diffusers where the duct branches off the rectangular duct main. The spin-in fitting shall not penetrate farther than 40% into the duct width.

(3) Cross-break all ducts where any duct section dimension or length is 18" or larger.

(4) Air volume dampers shall be installed in each duct branch takeoffs and/or where indicated, whichever is more stringent. All such dampers shall be accessible without damage to finishes or insulation and shall be provided where required for proper system balance.

(5) Splitter dampers shall be provided in all rectangular supply air duct tees. Damper blade operator shall extend a minimum two inches thru the insulation.

(6) Unless otherwise dimensioned on the drawings, all diffusers, registers and grilles shall be located aesthetically and symmetrically with respect to lighting, ceiling patterns, doors, masonry bond, etc.

(7) Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. There shall be no less than one set of hangers for each section of ductwork. Where ductwork contains filter sections, coils, fans or other equipment or items, such equipment or items shall be hung independently of ductwork with rods or angles. Do not suspend ducts from perlins or other weak structural members where no additional weight may be applied. If in doubt, consult the structural engineer.

(8) Provide approved flexible connectors at inlet and outlet of each item of heating and cooling equipment whether indicated or not. Install so as to facilitate removal of equipment as well as for vibration and noise control.

(9) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with "Duct Seal 321". Apply per manufacturer's recommendations.

(10) Duct dimensions indicated are required inside clear dimensions. Plan duct layouts for adequate insulation and fitting clearance.

(11) All angular turns shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct.

(12) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed at the inlet and discharge of all centrifugal fans, coils, VAV boxes, fan sections of air handling units, at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

(13) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panel at each fire damper located and sized so as to allow hand reset of each fire dampers. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. All access doors shall be 16"x16" or as high as ductwork permits and 16" in length.
(14) The Contractor who installs the sheet metal shall furnish to the Air Balancing Contractor, a qualified person to assist in testing and balancing the system.

(15) Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.

(16) All fans and other vibrating equipment shall be suspended by independent vibration isolators.

B. Materials (Low Pressure)

(1) Ductwork, plenums and other appurtenances shall be constructed of the following:


   b. Exposed ductwork in finished spaces such as gymnasiums, etc., shall be dual wall ductwork.

(2) Ductwork, plenums and other appurtenances shall be constructed of the materials of the minimum weights or gauges as required by the IMC and SMACNA HVAC Duct Construction Standards - Metal and Flexible, or as follows whichever is more stringent.

<table>
<thead>
<tr>
<th>DIA., INCHES</th>
<th>ROUND DUCT GAUGE</th>
<th>RECTANGULAR DUCT WIDTH, INCHES</th>
<th>GAUGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 TO 12</td>
<td>26</td>
<td>UP TO 12</td>
<td>26</td>
</tr>
<tr>
<td>12 TO 18</td>
<td>24</td>
<td>13 TO 30</td>
<td>24</td>
</tr>
<tr>
<td>19 TO 28</td>
<td>22</td>
<td>31 TO 54</td>
<td>22</td>
</tr>
<tr>
<td>29 TO 36</td>
<td>20</td>
<td>55 TO 84</td>
<td>20</td>
</tr>
<tr>
<td>37 TO 52</td>
<td>18</td>
<td>85 AND ABOVE</td>
<td>18</td>
</tr>
</tbody>
</table>

(3) Flexible ductwork which is uninsulated shall be corrugated aluminum. Use flexible ductwork only where indicated. No sections shall be greater than five feet in length. Ductwork shall be UL rated and in accordance with IMC.

(4) Insulated Flexible Duct (Use Only Where Indicated)

   a. Flexible duct shall be a factory-fabricated assembly consisting of an all steel or aluminum material. Plastic with spiral wire flexible duct is not permitted.

   b. All supply flexible duct shall be insulated with 1 ½ inch blanket of glass wool with an outer moisture barrier. The insulation assembly shall have a flame spread of not more than 25 and a smoke development rate of not over 50.

   c. Flexible duct shall be rated for 10 inches W.G. static pressure.

   d. A single length of flexible duct shall not exceed 4'0".
e. The minimum bend radius shall be 1 ½ times the duct diameter. The radius shall be measured to the inside edge of the flexible duct.

f. Total offset in any run of flexible duct shall not exceed 90 degrees.

g. Provide a minimum of one hanger of each run of flexible duct. The hanger must be strapped around the flexible duct and secured to the structure above. Hangers shall not be attached to other mechanical or electrical objects. Hangers may be attached to an approved trapeze. Ceiling grid shall not be used to fabricate a trapeze. Support hangers shall be installed horizontal. Screws shall not be used to penetrate the flexible duct to attach the hanger.

h. Flexible duct shall be secured to the rigid duct and appliance with a nylon adjustable, self-locking, strap and a minimum of three sheet metal screws. The flexible duct shall be sealed airtight at each connection with self-adhesive aluminum tape. Fiber or cloth duct tape is not permitted to seal rigid or flexible duct.

C. Double Wall Low Pressure Ductwork

(1) Install Double Wall Ductwork in the following areas:
   a. Above areas with partial ceilings or clouds
   b. Anywhere supply ductwork is installed exposed to view in spaces (other than mechanical rooms)
   c. At all other locations indicated on drawings.

(2) Prior to purchase/shipment of the ductwork, manufacturer shall provide as part of the submittal process scaled, field coordinated Autocad drawings of the complete system to be furnished. Drawings will indicate all system components including fittings, ductwork and manifolds. Drawings shall be available in an electronic format.

(3) Furnish and install where indicated double wall duct. The double wall duct shall be Eastern Sheet Metal, United McGill, Semco or approved equivalent. The duct shall have an inner shell, a 1-inch layer of fiberglass insulation and an outer pressure shell.

(4) Ductwork outer shell shall be spiral, lock-seam construction fabricated from galvanized steel meeting ASTM-527 standard. Any ductwork exposed to view shall be constructed of G90 galvanized steel, 20 gauge, and shall be supported as required with aircraft cables and self-tightening locks. Ductwork shall be constructed as specified in LOW VELOCITY DUCTWORK.

(5) Inner shell for spiral pipe shall be a perforated inner liner. The inner liner shall have 3/32” perforation with an overall open area of 23%.

(6) Inner shell for spiral pipe shall be solid galvanized steel.

(7) Inner shell for fittings shall be galvanized steel. All fittings shall be manufactured by the same manufacturer as the spiral pipe. Fittings shall be constructed a minimum of 22 Ga.

(8) The fiberglass liner shall have a maximum thermal conductivity (k) factor of 0.27 btu per hour per square foot per degree Fahrenheit per inch thickness at 75 degree F ambient temperature.

(9) All double wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange which shall consist of a 1.5 outer flange and an inner secondary flange which shall keep the
inner flange concentric and eliminate inner wall connections. Flanges requiring inner couplings will not be allowed, no insulation shall be exposed to the airstream at the connections.

(10) All grille and register taps shall be factory manifolded. Field installed taps will not be allowed. Manifolded taps may be tack welded and caulked for appearance. Only taps for grilles and registers may be provided this way. All other fittings shall be full body welded.

D. Miscellaneous (Low Pressure)

(1) Flexible Connectors: Duro-Dyne, Ventfabrics, Inc., U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A; neoprene coated glass fabric; 20 oz. for low velocity ducts secured with snap lock.

(2) Turning Vanes: Barber-Colman, Titus, Waterloo, or equivalent; fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.

(3) Air Extractors: Metalaire Model 102-1 Carnes, Titus, Barb-Air or approved equivalent. Provide with operating hardware by Ventfabrics, Inc. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

(4) Splitter Damper: Splitter damper shall be constructed of 16-gauge galvanized steel. Provide with operating hardware by Ventfabrics, Inc. to include damper blade bracket, ball joint bracket and operator shaft. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.

E. Combination Fire Smoke Damper

PART 1 GENERAL

1.1 WORK INCLUDED

1.2 QUALITY ASSURANCE
A. Dampers shall meet requirements for combination fire smoke dampers in accordance with:

B. Dampers shall be tested, rated, and labeled in accordance with:
   1. UL 555 (Seventh Edition), Listing R13317
   2. UL 555S (Fourth Edition), Listing R13317

1.3 DELIVERY, STORAGE, AND HANDLING
A. Delivery: Deliver Materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions.
C. Handling: Handle and lift dampers in accordance with manufacturer’s instructions. Protect materials and finishes during handling and installation to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Greenheck, Ruskin, United Enertech

2.2 COMBINATION FIRE SMOKE DAMPERS

A. Ratings:

Dampers shall have a UL 555 fire resistance rating of 1½ hours.

1. Fire Closure Temperature:

   Each combination fire smoke damper shall be equipped with a factory installed heat responsive device rated to close the damper when the temperature at the damper reaches 165°F.

2. Leakage:

   Dampers shall have a UL555S leakage rating of Leakage Class II in low velocity ductwork and Class I in medium or high velocity ductwork.

3. Differential Pressure:

   Dampers shall have a minimum UL 555S differential pressure rating of 4 in. wg.

4. Velocity:

   Specifier Notes: Airflow velocity rating levels of 2000, 3000 and 4000 fpm are allowed by UL Standard 555S. It is recommended that the lowest level consistent with the project’s HVAC system design be specified. If a lower velocity rating level such as 2000 fpm is appropriate for all dampers except those installed in one or two specific systems in the project, it is recommended that the lower minimum levels be specified with higher appropriate minimum levels required only for the system or systems requiring the higher ratings. Specifier, select from the following appropriate performance rating levels:

   Dampers shall have a minimum UL 555S velocity rating of 3000 fpm

B. Construction:

1. Frame:

   Damper frame shall be 16 ga. galvanized steel formed into a 5” x 1” structural hat channel. Top and bottom frame members on dampers less than 17” high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½” (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

2. Blades:

   Blades: Damper blades shall be 16 ga. galvanized steel with full length structural reinforcement and a double skin airfoil shape. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.
3. Blade Stops:
   Each blade stop (at top and bottom of damper frame) shall occupy no more than ½” of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

4. Seals:
   a. Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.

5. Linkage: Concealed in jamb.

6. Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer’s UL listing.


8. Bearings: Axle bearings shall be sintered bronze sleeve type rotating in polished extruded holes in the damper frame.

9. Sleeve: Damper shall be supplied as a single assembly with a factory sleeve.

C. Actuators:

   1. Type:
      Electric, 120V AC, 2-position

   2. Mounting:
      External

2.3 SOURCE QUALITY CONTROL

   A. Factory Tests: Factory cycle damper and actuator assemblies to assure proper operation.

PART 3 EXECUTION

3.1 EXAMINATION

   A. Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

   A. Install dampers in accordance with manufacturer’s UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer’s UL Installation Instructions must be approved prior to installation.

   B. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

   C. Install dampers square and free from racking.
D. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

E. Do not compress or stretch the damper frame into the duct or opening.

F. Attach multiple damper section assemblies together in accordance with manufacturer’s instructions. Install support Mullions as reinforcement between assemblies as required.

G. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

H. Install connections to electric actuators as required.

F. Access Doors; In Ductwork: In ducts where indicated or where required for serving equipment, fabricated according to SMACNA recommendations and be equivalent to those manufactured by Air Balance, Vent Products or other approved equivalent. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position. Access doors shall also be provided on each side of duct coils (water, electric, steam, etc.), and downstream side of VAV boxes and CAV boxes. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length.

G. Access Doors; In Ceilings or Walls: Titus, Krueger, Milcor or approved equivalent with key locks.
   a. In mechanical, electrical or service spaces. 14 gauge aluminum brushed satin finish, 1" border.
   b. In finished areas.
      14 gauge primed steel with 1" border. To accept the architectural finishes specified for the space.

   Provide where required to access equipment, dampers, valves, filters, etc.

(1) Volume Dampers (Rectangular): Ruskin, Model MD35 or Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air volume dampers. Frames shall be 4" x 1 "x 16 gauge galvanized steel. Blades shall be 16 gauge galvanized steel, maximum of 6" wide. Maximum single section size shall be 48" wide and 72" high. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(2) Volume Dampers (Round): Ruskin, Model MDRS25 or, Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air Round Damper. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20 gauge steel, 7" long. Damper blades shall be 20 gauge galvanized steel. Axle shall be 3/8" diameter steel. Provide with Ventfabrics 1" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

(3) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3 hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16 gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. All fire dampers shall be dynamic. Static fire dampers are not allowed. Provide velocity level and pressure level as required.
for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2 hour rating or Ruskin Type DIBD 23 for a 3 hour rating. Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. Provide an access door for fire damper reset at all fire damper locations.

(4) Motor Driven Smoke Dampers: Dampers shall comply with IMC and the following, whichever is more stringent. Provide Ruskin Model SD36 (Class II) or approved equivalent smoke damper where required by the locations of smoke partitions or as shown on the plans, whichever is more stringent. All smoke dampers shall be three inches larger than HVAC duct in each direction. Frame shall be a minimum of 18 gauge galvanized steel formed into a structural hat channel shaper with tabbed corners for reinforcement. The blades shall be single skin 16 gauge minimum galvanized with three longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type.

Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be leakage Class II.

As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close under HVAC system operating conditions, with pressures of at least the maximum possible of the HVAC system in the closed position, and the system maximum duct air velocity in the open position).

In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350°F. Appropriate electric/pneumatic actuators shall be installed by the damper manufacturer. Refer to building fire alarm and HVAC controls for exact type. Damper and actuator shall be supplied as a single entity which meets all applicable UL555S qualifications for both dampers and actuators. Provide factory supplied caulked sleeve, 20 gauge on dampers through 84 wide and 18 gauge above 84” wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. Actuator to be mounted outside of air stream.

Provide pressure relief doors in the duct to prohibit duct damage in the event the damper closes. Shutting off the fan shall not preclude the requirement for pressure relief doors.

Provide smoke detector compatible with other systems (fire alarm, HVAC controls, etc.) as required for each damper, per IMC.

7. PVC Coated Galvanized Ductwork- All Lab Exhaust Duct up to Exhaust Fan unless otherwise noted

   a. All exhaust ductwork shown on the plans shall be low velocity 4 milx 4mil PVC Coated galvanized duct. Ductwork shall meet all SMACNA requirements for 6” pressure class ductwork. The duct shall be transported, stored, and installed in accordance with SMACNA Advanced Cleanliness standards. Any scratches or imperfections observed in the PVC coating shall be repaired per the manufacturers recommended procedure or removed from the jobsite. No flexible duct shall be allowed on Exhaust systems.

   b. All devices located within the exhaust air stream shall be stainless steel or PVC Coated. This includes sound attenuators, screws, dampers, etc.

   c. Lab Exhaust Duct from the fan to the point of discharge shall be 316 Stainless Steel.

8. STAINLESS STEEL EXHAUST DUCT

Stainless steel ductwork shall be used for the following:
- All laboratory exhaust ductwork serving reagent chemical locations called out on the plans.
- Radiological Hood exhaust shall be stainless steel from the hood to the manifold.

Ducts shall be constructed of 304 stainless steel with liquid tight continuous external weld of all seams. All ductwork for systems shall be rated at SMACNA 6” negative W.G. Standard. Stainless duct work shall be Shop fabricated. Field fabrication is not acceptable.

All devices located within the exhaust air stream shall be stainless steel.

9. ALUMINUM EXHAUST DUCT
   A. Exhaust ductwork directly upstream of sterilizer condensate hood locations shall be aluminum and sloped minimum \(\frac{1}{4}”\)/foot down to condensate hood connection. Aluminum construction shall extend thru phoenix valve to exhaust duct main.

10. MEDIUM PRESSURE DUCTWORK
   A. Application (MEDIUM PRESSURE)
      (1) All Variable Air Volume system supply ductwork between the air handling unit and all Variable Air Volume terminals shall be high velocity single wall ductwork. Branch supply takeoffs serving single Variable Air Volume terminals shall be permitted to be high velocity single wall ductwork.

   B. General (Medium Pressure)
      (1) Provide flexible connectors at inlet and outlet of air handling equipment to accommodate a minimum of three times the operating pressure of the system.

      (2) Duct dimensions indicated are required inside clear dimensions.

      (3) All ductwork connections, fittings, joints, etc., shall be sealed. Seal with Hardcast "DT" tape and Hardcast "RTA-50" adhesive installed in strict accordance with manufacturers recommendations.

      (4) Ductwork shall be installed per SMACNA Medium or High Pressure Manual, whichever is applicable. (Latest Edition shall apply.)

      (5) All hanger straps shall be 18 ga. minimum with reinforcement angles installed in strict accordance with SMACNA. Flat oval ducts shall be installed with 2"x2"x1/4" angles on top and bottom ducts 18” wide and larger. Use 1”x1”x3/16” angles on ducts under 18” wide.

      (6) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA or the duct manufacturer, and/or as indicated. Test openings shall be placed at the discharge of all air handling units and at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.

      (7) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panels at each fire damper located and sized so as to allow hand reset of each fire damper. All such fire dampers and access panels shall be readily accessible without damage.
to finishes. Refer to Architectural Plans for locations of fire rated walls. Where access doors are installed in insulated ductwork, the access door shall be the insulated type.

C. Materials (Medium Pressure Single Wall)

(1) All round and oval high velocity ductwork shall be United McGill "Uni-Seal" or "Uni-Weld" ductwork or Semco, Dixie, Eastern Sheet Metal, Langdon, or approved equivalent as required by pressure rating of the system.

(2) Ductwork shall be spiral, lock-seam type and be constructed of galvanized steel.

<table>
<thead>
<tr>
<th>DIAMETER (Or Equivalent Round Diameter For Oval Ducts)</th>
<th>METAL THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-14 Inches</td>
<td>26 Ga.</td>
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<tr>
<td>15-26 Inches</td>
<td>24 Ga.</td>
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<tr>
<td>27-36 Inches</td>
<td>22 Ga.</td>
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<tr>
<td>37-50 Inches</td>
<td>20 Ga.</td>
</tr>
<tr>
<td>52-60 Inches</td>
<td>18 Ga.</td>
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</tbody>
</table>

All duct fittings shall be fabricated by duct manufacturer. Duct fittings shall be minimum 20 gauge. All fittings shall be a minimum of one gauge heavier than the pipe size.

D. Materials (Medium Pressure Double Wall)

(1) Furnish and install where indicated by drawings or specifications high velocity double wall duct. The double wall duct shall be United McGill Acoustic K27, SEMCO, Dixie or approved equivalent. The duct shall have a perforated inner liner, an intermediate layer of fiberglass insulation minimum 1 ½” thick and an outer pressure shell. Duct shall be of spiral lockseam construction fabricated from galvanized steel meeting ASTM-A527 standard. The duct insulation shall have minimum R-value of 6.0. High pressure double wall fittings shall have the same construction features as the double wall duct. Duct shall be constructed of G90 Galvanized steel. Outer shell of ductwork shall be constructed of the minimum gauges specified above for single wall high velocity ductwork.

(2) All double wall ductwork will be furnished with factory installed flanges equal to Eastern Sheet Metal Flange which shall consist of a 1.5 outer flange and an inner secondary flange which shall keep the inner flange concentric and eliminate inner wall connections. Flanges requiring inner couplings will not be allowed, no insulation shall be exposed to the airstream at the connections.

E. Miscellaneous (Medium Pressure)

(1) Flexible Connectors: Duro-Dyne, Ventfabrics, U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A or IMC, whichever is more stringent; neoprene coated glass fabric; 30 oz. for high velocity ducts secured with bolted angles.

(2) Fire Dampers: Fire dampers shall comply with IMC and be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1, 2 or 3 hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers in duct systems that are not equipped with any type of fire or smoke shutdown shall be Dynamic type. Fire dampers in duct systems that will shut
down during a fire or smoke emergency shall be Static type. Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be installed in wall and floor openings utilizing 16 ga. steel sleeves, angles, other materials, and practices required to provide an installation equivalent to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. Fire dampers shall be Ruskin Type IBD2, Style C, for a 1½ hour rating or Ruskin IBD 23 for a 3 hour rating. Other acceptable manufactures are Air Balance, Prefco, Creative Metals, National Controlled Air or Safe Air. Provide an access door for fire damper reset at all fire damper locations.

F. Combination Fire Smoke Damper

PART 1 GENERAL

1.2 WORK INCLUDED

1.3 QUALITY ASSURANCE
   A. Dampers shall meet requirements for combination fire smoke dampers in accordance with:
   B. Dampers shall be tested, rated, and labeled in accordance with:
      1. UL 555 (Seventh Edition), Listing R13317
      2. UL 555S (Fourth Edition), Listing R13317

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Delivery: Deliver Materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, and location of installation.
   B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions.
   C. Handling: Handle and lift dampers in accordance with manufacturer’s instructions. Protect materials and finishes during handling and installation to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURER
   A. Greenheck, Ruskin, United Enertech

2.2 COMBINATION FIRE SMOKE DAMPERS
   A. Ratings:

      Dampers shall have a UL 555 fire resistance rating of 1½ hours.

      1. Fire Closure Temperature:
         Each combination fire smoke damper shall be equipped with a factory installed heat responsive device rated to close the damper when the temperature at the damper reaches 165°F.
2. Leakage:
Damper shall have a UL555S leakage rating of Leakage Class II in low velocity ductwork and Class I in medium or high velocity ductwork.

3. Differential Pressure:
Damper shall have a minimum UL 555S differential pressure rating of 4 in. wg.

   Dampers shall have a minimum UL 555S velocity rating of 3000 fpm

B. Construction:
1. Frame:
   Damper frame shall be 16 ga. galvanized steel formed into a 5” x 1” structural hat channel. Top and bottom frame members on dampers less than 17” high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½” (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

2. Blades:
   Blades: Damper blades shall be 16 ga. galvanized steel with full length structural reinforcement and a double skin airfoil shape. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.

3. Blade Stops:
   Each blade stop (at top and bottom of damper frame) shall occupy no more than ½” of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

4. Seals:
   a. Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.

5. Linkage: Concealed in jamb.

6. Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer’s UL listing.


8. Bearings: Axle bearings shall be sintered bronze sleeve type rotating in polished extruded holes in the damper frame.

9. Sleeve: Damper shall be supplied as a single assembly with a factory sleeve.

C. Actuators:

   1. Type:
      Electric, 120V AC, 2-position
   2. Mounting:
      External

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Factory cycle damper and actuator assemblies to assure proper operation.
PART 3  EXECUTION

3.1 EXAMINATION
   A. Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION
   A. Install dampers in accordance with manufacturer’s UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer’s UL Installation Instructions must be approved prior to installation.

   B. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

   C. Install dampers square and free from racking.

   D. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

   E. Do not compress or stretch the damper frame into the duct or opening.

   F. Attach multiple damper section assemblies together in accordance with manufacturer’s instructions. Install support mullions as reinforcement between assemblies as required.

   G. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

   H. Install connections to electric actuators as required.

G. Access Doors; In Ceilings and Walls: Titus, Krueger, Milcor or approved equivalent; 14 gauge aluminum brushed satin finish; 1" border; all doors are to be furnished and installed by the Mechanical Contractor. Provide with required to access air distribution equipment, dampers, etc., unless specified in architectural portion of the specifications.

H. Access Doors; In Ductwork: All access doors in round or oval high velocity ductwork shall be screw and gasketed type. Screws shall be maximum 4 inches on centers. Access door sizes shall be as follows:

<table>
<thead>
<tr>
<th>DUCT DIAMETER</th>
<th>OPENING SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4 inches</td>
<td>4&quot; x 10&quot;</td>
</tr>
<tr>
<td>5-6 inches</td>
<td>6&quot; x 10&quot;</td>
</tr>
<tr>
<td>7-24 inches</td>
<td>10&quot; x 16&quot;</td>
</tr>
<tr>
<td>26-36 inches</td>
<td>16&quot; x 16&quot;</td>
</tr>
<tr>
<td>Over 36 inches</td>
<td>16&quot; x 22&quot;</td>
</tr>
</tbody>
</table>

11. DUCT SCHEDULE
   A. Supply Ducts:
(1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, downstream of Terminal Units
   a. Pressure Class: Positive 2-inch wg Refer to Low Pressure requirements as outlined in section 2 of this spec.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

(2) Ducts Connected to Variable-Air Volume Air-Handling Units <AHU-12,13,8,9,10,11>:
   a. Pressure Class: Positive [4]-inch wg Refer to medium pressure standards as outlined in section 3 of this spec. The first 50 feet of ductwork on SA shall be rated for 6 inch and then transition to 4 inch rating except for AHU 8 which shall remain at 6 inch down to the ground floor.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

B. Return Ducts:

(1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, downstream of Terminal Units
   a. Pressure Class: Negative 2-inch wg Refer to Low Pressure requirements as outlined in section 2 of this spec.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

(2) Ducts Connected to Air-Handling Units
   a. Pressure Class: Negative 4-inch wg of AHU 12, AHU 13 (Alternate to replace ¾), and ductwork attached to AHU-8. Refer to Medium Pressure requirements as outlined in section 3 of this spec. AHU- 9, 10, and 11 shall be negative -2 inch and refer to section 2.
   b. Minimum SMACNA Seal Class: [A].
   c. SMACNA Leakage Class for Rectangular: [6].
   d. SMACNA Leakage Class for Round and Flat Oval: [3]

C. Exhaust/Relief Ducts:

(1) Ducts Connected to Exhaust Fans
   a. Pressure Class: Negative 2 inch wg Refer to [Low Pressure requirements as outlined in section 2 of this spec]
   b. Minimum SMACNA Seal Class: [C]
   c. SMACNA Leakage Class for Rectangular: [24]
   d. SMACNA Leakage Class for Round and Flat Oval: [12]

(2) Ducts Connected to Air-Handling Units
   a. Pressure Class: Positive or Negative 4, inch wg Refer [Medium Pressure requirements as outlined in section 3 of this spec].
   b. Minimum SMACNA Seal Class: [A].
   c. SMACNA Leakage Class for Rectangular: [6].
   d. SMACNA Leakage Class for Round and Flat Oval: [3].
(3) Ducts Connected to Laboratory Exhaust Fans:
   a. Pressure Class: Negative 6-inch wg Refer to Medium Pressure requirements as outlined in
      section 3 as well as requirements outlined in the Hazardous Exhaust duct section of this spec.
   b. Minimum SMACNA Seal Class: [A]
   c. SMACNA Leakage Class: 3.

D. Outdoor Air Ducts:

(1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, downstream of Terminal Units
   a. Pressure Class: Positive 2-inch wg Refer to Low Pressure requirements as outlined in
      section 2 of this spec.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

(2) Ducts Connected to Air-Handling Units
   a. Pressure Class: Positive or Negative 4-inch wg Refer to Medium Pressure requirements as
      outlined in section 3 of this spec.
   b. Minimum SMACNA Seal Class: [A].
   c. SMACNA Leakage Class for Rectangular: [6].
   d. SMACNA Leakage Class for Round and Flat Oval: [3].

E. Air Leakage Testing of the Ductwork Systems

(1) It is the intent of this section to insure the ductwork installed has minimal air leakage.

(2) Air leakage testing shall be accomplished by an AABC or NEBB certified company. Refer to the Test
    & Balance specifications.

(3) It is the intent to test all ductwork. The duct systems which will require testing are as follows:
   a. All supply air duct systems
   b. All return air duct systems.
   c. All exhaust air duct systems.

(4) Do not insulate the supply air systems prior to testing.

(5) The maximum allowable supply air leakage rate is 2.5% the systems design CFM when the ductwork is
    pressurized to 3.5” WG (Therefore, if a supply air system is tested, and the supply air fan rated capacity
    is 10,000 CFM, the allowable leakage is 250 CFM.) The maximum allowable return air and exhaust air
    leakage rate is 2.5% of the system design when the ductwork is pressurized to 1.50”WG.

(6) The entire supply air ductwork system shall be tested with some exceptions. On VAV systems, the
    high velocity ductwork upstream of the VAV boxes shall only be tested. Cap the duct at the inlet to the
    VAV box. On low velocity reheat system, all ductwork upstream of the hot water reheat coil shall be
    tested. The air volume damper and access door upstream of the reheat coil shall be included in the
    tested system.
(7) All return and exhaust air sheet metal ductwork associated with the system shall be tested. Flexible ductwork shall not be tested. Cap the main duct prior to the central equipment fan connection. Also cap the branch ducts which serve the diffusers, after the round branch air volume with sheet metal caps. Seal caps well to damper to avoid air loss at this location. This air loss, from the caps, is included in the noted leakage rate.

(8) The noted allowable leakage rate is the total allowable. It shall include leakage associated with the following:
   a. All ductwork as described in above paragraphs.
   b. Access doors
   c. Volume dampers
   d. Relief air doors
   e. Smoke dampers
   f. Fire dampers
   g. Fire smoke dampers
   h. End caps used to seal ducts

(9) If any duct system fails a test, the contractor shall reseal the system. It shall then be retested until the duct system meets the leakage allowance at no additional cost to the owner.

(10) Carefully select the ductwork construction requirements and the type of duct sealant to be used as required to meet the leakage allowances. The sheet metal duct pressure classification is a minimum only. The contractor shall select the appropriate sheet metal pressure classification, duct sealant class and duct sealant materials to meet the project air leakage allowances.

(11) A duct pre-installation conference shall be held prior to the installation of the ductwork. Present should be the owner’s representative, engineer, Test & Balance Contractor, General Contractor, Mechanical Contractor, Sheet Metal Contractor, Insulation Contractor and the manufacturer’s representative of the duct sealant to be used. At this meeting, the contractor shall advise all of the duct materials and sealant materials to be used to meet the air leakage allowances.

(12) Whenever the systems are being leak tested by the Test & Balance Contractor, a representative from the Mechanical Contractor shall be present to assist.

END OF SECTION 23 1200
**Erosion Prevention and Sediment Control Plan**

**General Notes:****
- The contractor is responsible for maintaining all erosion control features as per the plan and with details at the time of issuance of the contract.
- Erosion control features will be installed immediately following the issuance of the contract.
- Erosion control features are to be maintained until the project is complete or the areas are backfilled.

**Erosion Control Sequence Schedule:**
- Construction Access Drive
- Mass Grade Site
- Silt Fencing
- Storm Drainage System
- Outlet Sediment Trap
- Inlet Sediment Trap
- Mulch, Grading
- Pave Site

**Additional Notes:**
- The contractor shall coordinate all demolition activities and availability of the site with the owner.
- The contractor shall maintain all storm drainage systems to prevent contamination of existing site soils.
- The contractor shall maintain all inlet sediment traps and outlet sediment traps as per the plan.
- The contractor shall maintain all erosion control features to prevent erosion and sedimentation.
- The contractor shall coordinate all demolition activities and availability of the site with the owner.
- The contractor shall maintain all storm drainage systems to prevent contamination of existing site soils.
- The contractor shall maintain all inlet sediment traps and outlet sediment traps as per the plan.
- The contractor shall maintain all erosion control features to prevent erosion and sedimentation.

**Silt Fencing:**
- Silt fencing shall be installed prior to the beginning of construction/DEMOLITION operations and maintained until permanent vegetation is established.

**Storm Drainage System:**
- Storm drain system shall be maintained throughout the construction/DEMOLITION period and kept in place or turned over to the future maintenance department.

**Outlet Sediment Trap:**
- Outlet sediment trap shall be installed as soon as swales are created and maintained until end of demolition period.

**Inlet Sediment Trap:**
- Inlet sediment trap shall be installed when topsoil is stripped and stockpiled and maintained until the end of the demolition period.

**Maintenance Log:**
- The contractor shall maintain an on-site maintenance log of all erosion control features.
- Any such changes are subject to review by the landscape architect.

**General EPSC Plan Notes:**
- The contractor is responsible for maintaining all erosion control features as per the plan and with details at the time of issuance of the contract.
- Erosion control features will be installed immediately following the issuance of the contract.
- Erosion control features are to be maintained until the project is complete or the areas are backfilled.

**EPSC Plan Keynotes:**
1. Erosion Control Features
2. Storm Drainage System
3. Outlet Sediment Trap
4. Inlet Sediment Trap
5. Construction Access Drive
6. Pave Site

**EPSC Plan Legend:**
- Erosion Control Features
- Storm Drainage System
- Outlet Sediment Trap
- Inlet Sediment Trap
- Construction Access Drive
- Pave Site

**Contact Information:**
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- Civil Engineering
- Planning
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- Tel: 859.389.6533
- Fax: 859.389.6534
- www.element-site.com
UK Chemistry-Physics Third Floor Renovation
Bid Pack 2

ADDENDUM #2 - MEP
August 27, 2019

Item #1  Refer to the Mechanical Drawing, M8.2
A.  Refer to revised drawing for final AHU configurations.

Item #2  Refer to the Mechanical Drawing M9.0
A.  Refer to "MISCELLANEOUS CONTROLS"
   i.  In addition to those points listed, refer to plumbing drawings and provide control interface and pull in all points associated with Laboratory Gas Cylinder manifolds. Refer to Plumbing drawings for quantity/location of manifolds.

Item #3  Refer to the Mechanical Drawing, sheet M9.4
A.  Refer to Split System Controls Schematic:
   i.  In addition to the points listed, provide motorized damper for relief air damper. Refer to drawings. Provide status and command point for damper and interface with split system factory control with BAS interface to determine position of return air damper and OA damper. Modulate relief air damper proportionally with OA damper to achieve proper economizer operation.

Item #4  Refer to the Mechanical Drawing M-10.0
A.  Refer to "SCHEDULE – AIR HANDLING UNIT":
   i.  AHU-12 actual BOD weight is 47,100 lbs.
   ii. AHU-13 actual BOD weight is 49,000 lbs.
   iii. Remark 11: AHU-10 is to be all aluminum construction and shall be no heavier than 14,000 lbs. AHU 12 and 13 must meet the maximum weight limit of 50,000 lbs but are not required to be all aluminum construction if they can meet this maximum weight limit.
B.  Refer to "SCHEDULE – VENTILATION FAN"
   i.  Modify Remark 9 to read as follows: Fan data is listed per fan. Provide with integral plenum with motorized dampers and outdoor bypass intake dampers with rain hoods. Refer to control drawing sheet M9.6. Controls to be by others. Provide all motorized dampers integral to fan assembly to accomplish the sequence of control with motorized isolation dampers per fan as well as outside air bypass motorized dampers. Provide with sound attenuating "nozzels" or equal and meet noise requirement listed. All fan motors to be 1200 rpm motors.

Item #5  Refer to the Mechanical Specifications, Section 23 0200 – HVAC
A.  Refer to Section A, Custom Air Handling Units
   i.  Section 2.1, 1) – TMI, York, and Ventrol are acceptable.
   ii. Section 2.2 – General – Unit split locations / sizes are not critical for AHU-12/13 as these units are mounted on the building roof on structural steel framing – coordinate exact splits with structural engineer / structural framing contractor. AHU-09 splits must be arranged such that unit will fit into an 11’ wide by 11’ tall opening. AHU-10 splits must be arranged such that unit will fit into a 10’ wide by 11’ tall opening. AHU-11 splits must be arranged such that unit will fit into a 7’ wide by 9’ tall opening.
   iii. Section 2.3 – Replace Sections E-G with the following sections with additional detail about the construction of each air handler. Sections H and I shall remain but be relabeled K and L respectively.
E.  Full Length Service Vestibules
   a.  AHU-12-LAB-3 & AHU-13-LAB-2 shall be provided with a minimum 72’ wide, full length and full height service vestibule with floor and walls constructed the same as the unit air tunnel is specified. Bolt-on dog house style piping enclosures are not acceptable.
F. Floors – AHU-09-OFC-3N, AHU-10-OFC-3S, AHU-11-ATR-123
   a. Shall be fabricated of 3/16" aluminum tread plate. All floor sheets shall be mechanically fastened to the unit base structure and isolated from the base assembly with an EPDM thermal break gasket.
   b. Floors shall be insulated with a two-part polyurethane water impervious foam insulation. For AHU-09-OFC-3N and AHU-11-ATR-123 a 20-gauge G90 galvanized steel under liner shall be provided. For AHU-10-OFC-3S, a 16-gauge aluminum under liner shall be provided.

G. Floors – AHU-12-LAB-3 & AHU-13-LAB-2
   a. Shall be fabricated of 3/16" aluminum tread plate. All floor sheets seams shall be continuously welded and welded to the unit base structure with a 2" turned up lip at the perimeter.
   b. Floor seams at shipping splits shall be welded in the field by the installing contractor. The manufacture shall provide 3/16" aluminum tread plate strips to cover the floor seams (1/8" tread plate is acceptable if unit deflection requirements are met). The strip shall be continuously welded on both sides.
   c. All accessible sections without a drain pan shall have a 1.25" diameter floor drain piped through the unit base for drainage.
   d. Floors shall be insulated with a two-part polyurethane water impervious foam insulation. For AHU-12-LAB-3 a 20-gauge G90 galvanized steel under liner shall be provided. For AHU-13-LAB-2, a 16-gauge aluminum under liner shall be provided.

H. Wall and roof panels - AHU-09-OFC-3N, AHU-10-OFC-3S, & AHU-11-ATR-123
   a. Panels shall be 2" thick double wall construction. Panel joints shall be sealed with an industrial EPDM gasket to form a water and airtight seal. Air handling manufacturers using caulk to seal panels must include an owner witnessed field leakage test. The test shall require the unit to be field design air flow tested and cabinet leak tested for 1% at 1.5 times the operating pressure.
   b. Panels shall be individually removable for service without removing the roof or compromising the integrity of the cabinet wall. Panels shall be joined with 5/16" bolts that can be removed and refastened. Panel attachment with screws is not acceptable. All panels shall utilize thermal break construction between the exterior panel and the interior liner and between the panels and the base and roof frames.
   c. AHU-09-OFC-3N & AHU-11-ATR-123: For long term durability, exterior panels shall be a minimum 16-gauge G60 galvanized steel pre-painted with a baked-on polyester-ceramic paint system that passes a 1,000-hour ASTM B-117 salt spray resistance test and 3000-hour ASTM G-23 accelerated weathering test.
   d. AHU-09-OFC-3N & AHU-11-ATR-123: Interior liners shall be a minimum 20-gauge G90 galvanized steel. Interior liners in humidifier and cooling coil sections shall be a minimum 20-gauge 304 stainless steel. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.
   e. AHU-10-OFC-3S: For long term durability and weight reduction, exterior panels shall be a minimum 16-gauge, unpainted, stucco embossed high strength aluminum.
   f. AHU-10-OFC-3S: For weight reduction, interior liners shall be a minimum 16-gauge aluminum. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.

I. Wall and roof panels - AHU-12-LAB-3 & AHU-13-LAB-2
   a. Panels shall be 4" thick double wall construction. Panel joints shall be sealed with an industrial EPDM gasket to form a water and airtight seal. ALL AHU MANUFACTURERS SHALL PROVIDE FACTORY REPRESENTATIVE SUPPORT FOR REQUIRED FIELD LEAKAGE TESTING AND IF LEAKAGE TEST IN THE FIELD IS UNACCEPTABLE, EXAMINE THE CONDITIONS ON-SITE AND PROVIDE A LIST OF CORRECTIVE MEASURES TO THE INSTALLING CONTRACTOR. The test shall require the unit to be field design air flow tested and cabinet leak tested for 1% at 1.5 times the operating pressure.
b. Panels shall be individually removable for service without removing the roof or compromising the integrity of the cabinet wall. Panels shall be joined with 5/16" bolts that can be removed and refastened (screws are acceptable). All panels shall utilize thermal break construction between the exterior panel and the interior liner and between the panels and the base and roof frames.

c. AHU-12-LAB-3: For long term durability, exterior panels on outdoor units shall be 16-gauge G90 galvanized steel with a Tiger Drylac Series 38 Super Durable powder coat paint system that passes a 3000-hour ASTM B-117 salt spray resistance test, 3000-hour ASTM D-2247 humidify resistance test, ASTM D2244 natural weathering test (5-year color change test in Florida), and ASTM D523 natural weathering test (5-years gloss retention test in Florida). Color shall be selected from Tiger Drylac Series 38 Super Durable color chart.

d. AHU-12-LAB-3: Interior liners shall be a minimum 20-gauge G90 galvanized steel. Interior liners in humidifier and cooling coil sections shall be a minimum 20-gauge 304 stainless steel. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.

e. AHU-13-LAB-2: For long term durability and weight reduction, exterior panels shall be a minimum 16-gauge, stucco embossed high strength aluminum with a Tiger Drylac Series 38 Super Durable powder coat paint system that passes a 3000-hour ASTM B-117 salt spray resistance test, 3000-hour ASTM D-2247 humidify resistance test, ASTM D2244 natural weathering test (5-year color change test in Florida), and ASTM D523 natural weathering test (5-years gloss retention test in Florida). Color shall be selected from Tiger Drylac Series 38 Super Durable color chart.

f. AHU-13-LAB-2: For weight reduction, interior liners shall be a minimum 16-gauge aluminum. Panel liners shall be of a single piece construction and attached to the exterior panels with a full thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.

J. Insulation

a. All wall and roof panels shall be insulated with an injected foam insulation with an R value of 6.6/inch. Panels shall be designed to deflect no more than 1/200 of span under operating design conditions when measured at the panel seam. Insulation shall fill the panel without voids. The composite R-value of the 4" unit casing shall be no less than R-26.4. The composite R-value of the 2" unit casing shall be no less than R-13.2.

iv. Section 2.5, Fan Assemblies:

1. Refer to 1) b) Unloading: Alternate manufacturers may utilize unloading via VFD if desired. Fans must be able to achieve a minimum of no greater than 30% with VFD modulation.

2. Refer to 1) a) iii) – Spring isolators are not required for individual fans provided that manufacturer can meet the vibration requirements of BV-5 for all fans.

3. Refer to 2) A, B, C, D, E, F: Control of air handlers is to be accomplished by controls contractor. Refer to control drawings. It is not required that alternate manufacturers provide units with a central processor. It is required that all air handler manufacturers provide integral piezo-rings / airflow measurement devices and infrastructure required for each fan so that the controls contractor may obtain an airflow for each individual fan in the assembly. Backflow devices are provided for each fan in the fan array. It is not required that manufacturers provide a central processor or control factory mounted to measure backflow of air across fans in the array which are not operable provided that manufacturer provides infrastructure required for controls contractor to adequately meet the sequence of operation as indicated on the project drawings. If an alternate manufacturer were to provide such a processor, Paragon FAAATS-1000 is an approved equal. Coordinate with controls contractor to provide all information to allow the unit to meet the sequence of operation indicated on the control drawings. Refer to sheets M9.1 and M9.2. Fan surge detection, Fan vibration detection, and grease monitoring system is not required. MODBUS is not an acceptable form of BAS communication. Refer to controls specification for additional requirements.

v. Section 2.8, Coils – Replace sections C-E with the following sections C-G:
C. Center coil piping connections of staggered coil banks shall be brought to the outside of the casing with black steel pipe. The piping extensions shall be insulated in the field by the installing contractor.

D. All coils shall meet or exceed the capacities specified on the mechanical schedule and all water coil performances shall be certified in accordance with the AHRI Forced Circulation Air Heating and Air Cooling Coil certification program which is based on AHRI Standard 410. Face velocities shall not exceed those specified on the mechanical schedule.

E. All cooling coil, heat recovery coil, and humidifier sections shall include a double sloped drain pan constructed from 304L stainless steel. All corners shall be welded watertight. Coils shall rest on stainless steel supports. The pan shall have a minimum pitch of 2" from high point to the bottom of the drain outlet connection, providing at least a 1/8" per foot slope. The drain pan shall be insulated with a 2-part sprayed on polyurethane, water impervious foam. Insulation shall be applied to the entire under side of the drain pan and coil section base assembly. If multiple stacked coils are used, intermediate drain pans are required. Intermediate pans shall be insulated and drained with 3/4" copper down-comers to the main pan. Floor drain pans shall be covered with a removable aluminum grating that can we stand on for maintenance.

F. Water and glycol solution coils shall be of a staggered tube design with high efficiency die formed corrugated plate-type fins for maximum performance. All coils shall be tested with 400 psig compressed air under clear water. Coils shall be designed to operate at 300 psig internal pressure and up to 250°F. Tubes shall be 5/8" diameter, seamless 0.035" wall copper, mechanically expanded into full drawn fin collars for a continuous compression bond over the full finned length for high efficiency performance. Cooling coil and heat recovery coil casings shall be a minimum 16-gauge stainless steel. Heating coil casings shall be a minimum 16-gauge galvanized steel. Coil casing reinforcements shall be required for fin lengths over 42". Coils fins shall be 0.0095" thick aluminum. Coils shall be serviceable using 0.25" M.P.T. drain and vent taps on the supply and return headers. Threaded seamless red brass coil connections shall be brazed to copper supply and return headers.

G. L. J. Wing integral face and bypass coils with multiple alternating heating and bypass sections shall be provided where scheduled. Dampers shall be a wrap design that fully encases the coil elements when shut. Actuators shall be provided and mounted by the unit manufacturer. Coils shall be steam with capacities as listed in the mechanical schedule. Coils shall be suitable for continuous operation at 200 psig and 400°F. Coils shall utilize .035" copper tubes with mechanically bonded 0.0095" thick aluminum fins. Coils shall be ARI 410 Certified for performance.

vi. Section 2.11, Static air blenders – delete section, static air blenders are not required. Refer to revised air handler details, sheet M8.2, released as part of this addendum.

vii. Section 2.14, B. In addition to factory testing of unit cabinet, provide manufacturer’s support for leak testing of air handlers which is to be completed by the test and balance contractor after successful field installation is completed. If field leak testing fails unacceptable levels of leakage, manufacturer shall include in his bid the cost for having a representative review the installation and provide corrective measures to the installing contractor.

viii. Section 3.1: AHU-12 and 13 to sit on structural steel frame. Refer to structural drawings and coordinate exact framing location as required with structural engineer / installing contractor and final unit shop drawings. AHU-09 and AHU-10 will need to be provided with 10” tall base rail and will sit on the finished floor slab. AHU-11 will be set on a concrete pad and have a standard 8” tall base rail.

B. Refer to Section F, Laboratory Exhaust Fans:
   i. Part 2.1: EF-1, EF-2, EF-3, and EF-4 designations must be changed to EF-10, EF-11, EF-12, and EF-13 Respectively.
   ii. Minimum Plume Height of EF-10, 11, 12 is 57 ft. Minimum Plume Height of EF-14 is 29 ft.

C. Refer to Section G – Split system Indoor Unit
   i. Refer to section I, Controls, 2.a. – LONWORKS is not an acceptable form of BAS communication. Refer to controls specification for additional requirements.
A. Refer to fire alarm devices. The square box with an ‘F’ and a triangle should be wall mounted combination fire alarm audio speaker and visual (clear) notification appliance.
B. Refer to fire alarm devices. A square box with an ‘M’ and a triangle is a mass notification visual (amber) notification appliance.

Item #7 Refer to the Electrical Drawing E-3.0a
A. Fixture type WS2 shall be mounted at 8’-0” above finished grade, refer to sketch E-3.0aR1.
B. Move exit sign, refer to sketch E-3.0aR1.
C. Move light switch from behind caging, refer to sketch E-3.0aR1.
D. Move light switch from in Oxygen Storage, refer to sketch E-3.0aR1.
E. Add lighting to new Mech 31A, refer to sketch E-3.0aR1.

Item #8 Refer to the Electrical Drawing E-3.1a
A. Add exit sign at plan west end of Corridor 100H, facing plan east.
B. Add 2 occupancy sensors in Corridor 100H, space sensor throughout corridor per manufacturers recommendations.

Item #9 Refer to the Electrical Drawing E-3.1b
A. Add 1 exit sign at door leading from Corridor 100B to Corridor 100C.
B. Add 1 exit sign at door leading from Collaboration 100B1 to Corridor 100B.
C. Add 1 exit sign at plan south end of Corridor 100B, facing plan north.
D. Add 1 exit sign at door leading from Corridor 100F to Atrium addition.
E. Add 1 exit sign at plan north end of Corridor 100F with chevron facing plan west and arrow pointing plan north.

Item #10 Refer to the Electrical Drawing E-4.0a
A. Add 2 duplex receptacles to new Mech 31A. Put Tagged Note E4.
B. Move electrical connections for fire alarm control panels, to plan north end of cage in mechanical 30. Refer to correct location for panels on sheet E-5.0c.

Item #11 Refer to the Electrical Drawing E-5.0c
A. Add/remove fire alarm devices, refer to sketch E-5.0cR1.

Item #12 Refer to the Electrical Drawing E-5.0d
A. Add/remove fire alarm devices, refer to sketch E-5.0dR1.

Item #13 Refer to the Electrical Drawing E-5.1a
A. Add/remove fire alarm devices, refer to sketches E-5.1aR1 and E-5.1aR2

Item #14 Refer to the Electrical Drawing E-5.1b
A. Add/remove fire alarm devices, refer to sketch E-5.1bR1

Item #15 Refer to the Electrical Drawing E-5.1c
A. Add/remove fire alarm devices, refer to sketches E-5.1cR1a, E-5.1cR1b, E-5.1cR1c, and E-5.1cR1d.

Item #16 Refer to the Electrical Drawing E-5.1d
A. Add/remove fire alarm devices, refer to sketches E-5.1dR1 and E-5.1dR2.

Item #17 Refer to the Electrical Drawing E-5.2a
A. Add/remove fire alarm devices, refer to sketch E-5.2aR1.

Item #18 Refer to the Electrical Drawing E-5.2b
   A. Add/remove fire alarm devices, refer to sketch E-5.2bR1.

Item #19 Refer to the Electrical Drawing E-5.2c
   A. Add/remove fire alarm devices, refer to sketches E-5.2cR1a and E-5.2cR1b.

Item #20 Refer to the Electrical Drawing E-5.3a
   A. Add/remove fire alarm devices, refer to full sheet E-5.3a.

Item #21 Refer to the Electrical Drawing E-5.3b
   A. Add/remove fire alarm devices, refer to full sheet E-5.3b.

Item #22 Refer to the Electrical Drawing E-9.0
   A. Fixture type L basis of design shall be Focal Point Seem 1 in lieu of Focal Point Seem 4. Fixture shall be 1.5" wide.
   B. Mounting height for WS2 and WS3 shall be 9'-0" unless otherwise indicated on lighting plans.

Item #23 Refer to the ESS Drawing E-6.1
   A. Add/remove ESS devices, refer to full sheet E-6.1.

Item #24 Refer to the ESS Drawing E-6.6b
   A. Add/remove ESS Devices, refer to full sheet E-6.6b.

END OF ADDENDA ITEMS
TYP ALL SMOKE CONTROL DOORS
(TAGGED NOTE S37): T-SENSE IAM TO OPEN DOORS ON SMOKE EVAC AND MONITOR DOOR STATUS
GENERAL NOTES (SYSTEMS):

1. BEFORE PULL BOXES NEED TO BE PROVIDED.
2. AUDIO/VISUAL DEVICES, EXIT SIGNS, ETC.
3. THERMOSTATS, WALL MOUNTED OCCUPANCY SENSORS, FIRE ALARM RECEPTACLES, DATA OUTLETS, FIRE ALARM DEVICES, CARD READERS, HEIGHT AND SPECIFIC LOCATION REQUIREMENTS FOR DEVICES IN LABS.
4. STRINGS IN ALL NEW CONDUIT RUNS FOR SYSTEM CABLING INSTALLATION.
5. THE NEAREST CORRIDOR CABLING PATH (SEE "STUB"
6. REFER TO "SYSTEM INSTALLATION MATRIX" (ON SYSTEMS LEGEND SHEET)
7. SURFACE MOUNTED CABLING (WHERE POSSIBLE)
8. PROVIDE TELECOM DROPS IN DUAL CHANNEL OVERHEAD ACCORDANCE WITH MANUFACTURERS RECOMMENDATION.
9. GENERAL NOTES (SYSTEMS):

- PROVIDE EXHAUST HOSES ALONG PERIMETER OF WALLS.
- ELECTRICAL PANELS TO BE PROVIDED IN EACH LABORETORY.
- PROVIDE EXHAUST HOSES ALONG PERIMETER OF WALLS.
- GENERAL NOTES (SYSTEMS):

- PROVIDE EXHAUST HOSES ALONG PERIMETER OF WALLS.
- ELECTRICAL PANELS TO BE PROVIDED IN EACH LABORETORY.
- PROVIDE EXHAUST HOSES ALONG PERIMETER OF WALLS.
NOTE 1: THESE RISER DIAGRAMS ARE NOT INTENDED TO INDICATE EXACT INSTALLED METAL FRAMES, THE FRAME SUPPLIER IS TO PROVIDE WELDED BACKBOXES WITH CONDUIT KNOCKOUTS. FOR WALL MOUNTED ELECTRIFIED HARDWARE ITEMS, THE ELECTRICAL CONTRACTOR IS TO PROVIDE WIRE PATHS IN CONDUIT WITHIN THEIR ETC. FOR FRAME-MOUNTED ELECTRIFIED HARDWARE ITEMS IN ALUMINUM 4. FIRE ALARM INTERFACE REQUIRED.

NOTE 2: CONFIGURE SIZE OF AND LOCATION OF CARD READERS PER THE ORIGINS AND DESTINATIONS.

1. ELECTRIFIED EXIT DEVICE (MAY HAVE ELECTRICAL LATCH RETRACTION AND/OR MONITORING FEATURES)

2. EPT – ELECTRIC POWER TRANSFER (FRAME TO DOOR), CONCEALED IN FRAME OR IN FACE PLATE MORTISED INTO EITHER SIDE OR TOP JAMB

3. POWER SUPPLY

4. CONCEALED DOOR POSITION SWITCH, RECTANGULAR, WITH WIRE AND CONDUIT PATHS; THAT IS TO BE WORKED OUT BY THE VARIOUS TRADES.

TRIANGLES INDICATE ELECTRICAL SERVICES:

1. TO ACCESS CONTROL HEAD-END SYSTEM (FOR LOW VOLTAGE POWER, MONITORING OR CONTROL).

2. 115VAC, 60HZ MONITORING OR CONTROL).

3. ELECTRIC MORTISE LOCKSET.

4. CONDUIT STUB-UP WITH PULL STRING.

5. CARD READER (NARROW JAMB-MOUNT)

6. CARD READER (SINGLE-GANG OR JAMB-MOUNT: SEE SECURITY SPECIFICATIONS)

7. CARD READER (SINGLE-GANG)

8. VISUAL ANNUNCIATOR

9. MAGNETIC DOOR HOLDER (SINGLE-GANG).

10. MAGNETIC DOOR HOLDER (SINGLE-GANG). , CONCEALED IN FRAME OR IN FACE PLATE MORTISED INTO EITHER SIDE OR TOP JAMB

11. VISUAL ANNUNCIATOR