SECTION 00912 - ADDENDUM NUMBER 2

PARTICULARS

1.01 DATE: May 28, 2013

1.02 PROJECT: UNIVERSITY OF SOUTH CAROLINA - COKER 7TH FLOOR PHARMACY RENOVATIONS

1.03 PROJECT NUMBER: State Project #H27-6101, A/E #12023.01

1.04 OWNER: University of South Carolina

1.05 ARCHITECT: GMK Associates, Inc.

TO: PROSPECTIVE BIDDERS

2.01 This Addendum forms a part of the Contract Documents and modifies the Bidding Documents dated April 23, 2013, and Addendum Number 1 issued May 22, 2013, with amendments and additions noted below.

2.02 Acknowledge receipt of this Addendum in the space provided in the Bid Form. Failure to do so may disqualify the Bidder.

2.03 This Addendum consists of 4 pages and the following attachments:

A. SE-330 Bid Form

B. SECTION 12351 - METAL LABORATORY CASEWORK

C. SECTION 15073 - VIBRATION AND SEISMIC CONTROLS

D. SECTION 15080 - MECHANICAL INSULATION

E. SECTION 15145 - PLUMBING PIPING

F. SECTION 15755 - STEAM HUMIDIFIERS

G. SECTION 15840 - AIR TERMINAL UNITS

H. SECTION 15926 - DIGITAL CONTROLS

I. SECTION 16711 - STRUCTURED TELECOMMUNICATIONS CABLING AND ENCLOSURES

J. DRAWING P0.0

K. DRAWING P2.7

L. DRAWING P3.7

M. DRAWING M2.0

N. DRAWING M2.1

O. DRAWING M2.7

P. DRAWING M7.1

Q. DRAWING E0.0

R. DRAWING E2.7

CLARIFICATIONS

3.01 Additional site visits to inpect the existing spaces will be made available. Advanced scheduling of the visits shall be coordinated with David Harmon, SC College of Pharmacy, harmon@sccp.sc.edu, 803-777-4737 -OR- Dwight Cathcart, USC Facilities Design & Construction, DCATHCAR@fmc.sc.edu, (803) 777-9824.

3.02 Existing Laboratory 717 shall remain operational during construction of the project.

3.03 There are no time constraints for the Work other than the substantial completion and final completion dates.

3.04 Contractor parking and lay-down will be coordinated with the Contractor who is awarded the Work.

3.05 The internal building haul route for demolition debris and new material ingress is from the loading dock on Devine Street, into the basement corridor, and using one elevator to the 7th floor. Construction activities shall be limited to this route. A dumpster will be allowed at the loading dock. The Contractor shall always use soft wheeled carts with wall bumpers and enclosed bottom, sides and top for debris removal.

CHANGES TO THE PROJECT MANUAL

4.01 SE-330 Bid Form

A. Replace the existing SE-330 bid form with the attached revised SE-330 bid form in it's entirety.

B. Alternate #1 was added to the bid form.

4.02 SECTION 09680 - CARPET

A. 2.01, A: Modify to read: "Bentley, Style Name - City Center, Style Number - 8CN32. Color as selected from standard colors."

4.03 SECTION 12351 - METAL LABORATORY CASEWORK

A. Add this section in it's entirety.

B. This is for alternate #1.

4.04 SECTION 15066 - VARIABLE FREQUENCY CONTROLLERS

A. Add the following manufactuers to paragraph 2.01
   1. Toshiba
   2. Danfoss

4.05 SECTION 15073 - VIBRATION AND SEISMIC CONTROLS

A. Replace the existing section with the attached revised section in it's entirety.

4.06 SECTION 15080 - MECHANICAL INSULATION

A. Replace the existing section with the attached revised section in it's entirety.

4.07 SECTION 15128 - GAGES AND METERS

A. Add Paragraph 3.02.A.3 to the project manual - "3. At all locations shown on drawings and details."

B. Add Paragraph 3.02.B.2 to the project manual - "2. At all locations shown on drawings and details."

4.08 SECTION 15145 - PLUMBING PIPING

A. Replace the existing section with the attached revised section in it's entirety.

4.09 SECTION 15183 - HYDRONIC SPECIALTIES

A. Add the following manufacturer's to paragraph 2.03
   1. Nexus

4.10 SECTION 15185 - STEAM AND CONDENSATE SPECIALTIES

A. Delete paragraph 2.03 in its entirety.

4.11 SECTION 15720 - ROOFTOP UNITS

A. Add the following manufactuer's to paragraph 2.01
   1. USA Coil & Air
   2. Daikin McQuay

4.12 SECTION 15755 - STEAM HUMIDIFIERS

A. Replace the existing section with the attached revised section in it's entirety.

4.13 SECTION 15820 - DUCT ACCESSORIES

A. Add the following manufacturer's to paragraph 2.03.A
   1. Pottorff

4.14 SECTION 15835 - POWER VENTILATORS

A. Add the following manufacturer's to paragraph 2.01
   1. Twin City

4.15 SECTION 15840 - AIR TERMINAL UNITS

A. Replace the existing section with the attached revised section in it's entirety.

4.16 SECTION 15850 - AIR OUTLETS AND INLETS

A. Add the following manufacturer's to paragraph 2.01
   1. Metal Aire
   2. Nailor

4.17 SECTION 15926 - DIGITAL CONTROLS

A. Replace the existing section with the attached revised section in it's entirety.

4.18 SECTION 16711 - STRUCTURED TELECOMMUNICATIONS CABLING AND ENCLOSURES

A. Add this section in it's entirety.

CHANGES TO THE DRAWINGS

5.01 DRAWING P0.0

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.02 DRAWING P2.7

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.03 DRAWING P3.7

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.04 DRAWING M2.0

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.05 DRAWING M2.1

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.06 DRAWING M2.7

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.07 DRAWING M7.1

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.08 DRAWING E0.0

A. Replace the existing drawing with the attached revised drawing in it's entirety.

5.09 DRAWING E2.7

A. Replace the existing drawing with the attached revised drawing in it's entirety.

APPROVAL OF ADDITIONAL PRODUCTS/SYSTEMS

6.01 Drawing E0.0: Light Fixture Schedule

A. H.E Williams is an approved manufacturer of fixtures A, A2, A3, B, P, P1 and EX.

B. Columbia Lighting is an approved manufacturer of fixtures A, A2, A3 and B.

C. Lamar Lighting is an approved manufacturer of fixtures P and P1.

D. Compass is an approved manufacturer of fixture EX.

END OF SECTION

BID FORM
SE-330

2011 Edition

Bidders shall submit bids on only Bid Form SE-330.

BID SUBMITTED BY: _____
(Bidder's Name)

BID SUBMITTED TO: University of South Carolina
(Owner's Name)

FOR PROJECT: H27-6101 COKER- 7TH FLOOR PHARMACY RENOVATIONS
(Number) *(Name)*

OFFER

§ 1. In response to the Invitation for Construction Bids and in compliance with the Instructions to Bidders for the above-named Project, the undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into a Contract with the Owner on the terms included in the Bidding Documents, and to perform all Work as specified or indicated in the Bidding Documents, for the prices and within the time frames indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

§ 2. Pursuant to Section 11-32-3030(1) of the SC Code of Laws, as amended, Bidder has submitted Bid Security as follows in the amount and form required by the Bidding Documents:

☐ Bid Bond with Power of Attorney ☐ Electronic Bid Bond ☐ Cashier's Check
(Bidder check one)

§ 3. Bidder acknowledges the receipt of the following Addenda to the Bidding Documents and has incorporated the effects of said Addenda into this Bid:

ADDENDUM No: _____

§ 4. Bidder accepts all terms and conditions of the Invitation for Bids, including, without limitation, those dealing with the disposition of Bid Security. Bidder agrees that this Bid, including all Bid Alternates, if any, may not be revoked or withdrawn after the opening of bids, and shall remain open for acceptance for a period of 60 Days following the Bid Date, or for such longer period of time that Bidder may agree to in writing upon request of the Owner.

§ 5. Bidder herewith offers to provide all labor, materials, equipment, tools of trades and labor, accessories, appliances, warranties and guarantees, and to pay all royalties, fees, permits, licenses and applicable taxes necessary to complete the following items of construction work:

§ 6.1 BASE BID WORK ***(as indicated in the Bidding Documents and generally described as follows)*:**
The project consists of renovations to the 7th floor of Coker College at University of South Carolina. The Work includes, but is not limited to, an approximately 7,000 square foot demolition and renovation of finishes, HVAC, plumbing, electrical and roofing for the lab space.

_____, which sum is hereafter called the Base Bid.

§ 6.2 BID ALTERNATES – as indicated in the Bidding documents and generally described as follows:

ALTERNATE #1 (*Brief Description*): Metal Laboratory Casework in lieu of Wood Laboratory Casework.

☐ **ADD TO** or ☐ **DEDUCT FROM BASE BID:** _____

(Bidder to Mark appropriate box to clearly indicate the price adjustment offered for each alternate)

ALTERNATE #2 (*Brief Description*): na

☐ **ADD TO** or ☐ **DEDUCT FROM BASE BID:** _____

(Bidder to Mark appropriate box to clearly indicate the price adjustment offered for each alternate)

ALTERNATE #3 (*Brief Description*): na

☐ **ADD TO** or ☐ **DEDUCT FROM BASE BID:** _____

(Bidder to Mark appropriate box to clearly indicate the price adjustment offered for each alternate)

§ 7. LISTING OF PROPOSED SUBCONTRACTORS PURSUANT TO SECTION 3020(b)(i), CHAPTER 35, TITLE 11 OF THE SOUTH CAROLINA CODE OF LAWS, AS AMENDED – ***(See Instructions on the following page BF-3A)***

Bidder shall use the below-listed Subcontractors in the performance of the Subcontractor Specialty work listed:

SUBCONTRACTOR SPECIALTY **By License Classification and/or Subclassification** (Completed by Owner)	**SUBCONTRACTOR(S) OR PRIME CONTRACTOR'S NAME** ((Must be completed by Bidder)	**SUBCONTRACTOR'S SC LICENSE NUMBER**
	BASE BID	
no listing required		
	ALTERNATE # 1	
na		
	ALTERNATE # 2	
na		
	ALTERNATE # 3	
na		

If a Bid Alternate is accepted, Subcontractors listed for the Bid Alternate shall be used for the work of both the Alternate and the Base Bid work.

INSTRUCTIONS FOR SUBCONTRACTOR LISTING

1. Section 7 of the Bid Form sets forth a list of subcontractor specialties for which bidder is required to identify by name the subcontractor(s)Bidder will use to perform the work of each listed specialty. Bidder must identify only the subcontractor(s) who will perform the work and no others.

2. For purposes of subcontractor listing, a Subcontractor is an entity who will perform work or render service to the prime contractor to or about the construction site. Material suppliers, manufacturers, and fabricators that will not perform physical work at the site of the project but will only supply materials or equipment to the bidder or proposed subcontractor(s) are not subcontractors and Bidder should not insert their names in the spaces provided on the bid form. Likewise, Bidder should not insert the names of sub-subcontractors in the spaces provided on the bid form but only the names of those entities with which bidder will contract directly.

3. Bidder must only insert the names of subcontractors who are qualified to perform the work of the listed specialties as specified in the Bidding Documents and South Carolina Licensing Laws.

4. If under the terms of the Bidding Documents, Bidder is qualified to perform the work of a specialty listed and Bidder does not intend to subcontract such work but to use Bidder's own employees to perform such work, the Bidder must insert its own name in the space provided for that specialty.

5. If Bidder intends to use multiple subcontractors to perform the work of a single specialty listing, Bidder must insert the name of each subcontractor Bidder will use, preferably separating the name of each by the word **"and"**. If Bidder intends to use both his own employees to perform a part of the work of a single specialty listing and to use one or more subcontractors to perform the remaining work for that specialty listing, bidder must insert his own name and the name of each subcontractor, preferably separating the name of each with the word **"and"**.

6. Bidder may not list subcontractors in the alternative nor in a form that may be reasonably construed at the time of bid opening as a listing in the alternative. A listing that requires subsequent explanation to determine whether or not it is a listing in the alternative is non-responsive. If bidder intends to use multiple entities to perform the work for a single specialty listing, bidder must clearly set forth on the bid form such intent. Bidder may accomplish this by simply inserting the word "**and**" between the name of each entity listed for that specialty. Owner will reject as non-responsive a listing that contains the names of multiple subcontractors separated by a blank space, the word "or", a virgule (that is a /), or any separator that the Owner may reasonably interpret as a listing in the alternative.

7. If Bidder is awarded the contract, bidder must, except with the approval of the owner for good cause shown, use the listed entities to perform the work for which they are listed.

8. If bidder is awarded the contract, bidder will not be allowed to substitute another entity as subcontractor in place of a subcontractor listed in Section 7 of the Bid except for one or more of the reasons allowed by the SC Code of Laws.

9. Bidder's failure to insert a name for each listed specialty subcontractor will render the Bid non-responsive.

§ 8. LIST OF MANUFACTURERS, MATERIAL SUPPLIERS, AND SUBCONTRACTORS OTHER THAN SUBCONTRACTORS LISTED IN SECTION 7 ABOVE ***(FOR INFORMATION ONLY):*** Pursuant to instructions in the Invitation for Bids, if any, Bidder will provide to Owner upon the Owner's request and within 24 hours of such request, a listing of manufacturers, material suppliers, and subcontractors, other than those listed in Section 7 above, that Bidder intends to use on the project. Bidder acknowledges and agrees that this list is provided for purposes of determining responsibility and not pursuant to the subcontractor listing requirements of SC Code Ann § 11-35-3020(b)(i).

§ 9. TIME OF CONTRACT PERFORMANCE AND LIQUIDATED DAMAGES

a. CONTRACT TIME: Bidder agrees that the Date of Commencement of the Work shall be established in a Notice to Proceed to be issued by the Owner and Bidder shall substantially complete the Work within 120 calendar days from the Date of Commencement, subject to adjustments as provided in the Contract Documents.

b. LIQUIDATED DAMAGES: Bidder further agrees that from the compensation to be paid, the Owner shall retain as Liquidated Damages the sum of $ 500.00 for each calendar day the actual construction time required to achieve Substantial Completion exceeds the specified or adjusted time for Substantial Completion as provided in the Contract Documents. This sum is intended by the parties as the predetermined measure of compensation for actual damages, not as a penalty for nonperformance.

§ 10. AGREEMENTS

a. Bidder agrees that this bid is subject to the requirements of the law of the State of South Carolina.

b. Bidder agrees that at any time prior to the issuance of the Notice to Proceed for this Project, this Project may be canceled for the convenience of, and without cost to, the State.

c. Bidder agrees that neither the State of South Carolina nor any of its agencies, employees or agents shall be responsible for any bid preparation costs, or any costs or charges of any type, should all bids be rejected or the Project canceled for any reason prior to the issuance of the Notice to Proceed.

§ 11. ELECTRONIC BID BOND

By signing below, the Principal is affirming that the identified electronic bid bond has been executed and that the Principal and Surety are firmly bound unto the State of South Carolina under the terms and conditions of the AIA Document A310, Bid Bond, included in the Bidding Documents.

(Electronic Bid Bond Number)	***(Signature and Title)***

BIDDER'S TAXPAYER IDENTIFICATION

FEDERAL EMPLOYER'S IDENTIFICATION NUMBER:_____

OR

SOCIAL SECURITY NUMBER:_____

CONTRACTOR'S CLASSIFICATIONS AND SUBCLASSIFICATIONS WITH LIMITATIONS

Classification(s) & Limits:_____

Subclassification(s) & Limits:_____

SC Contractor's License Number(s):_____

BY SIGNING THIS BID, THE PERSON SIGNING REAFFIRMS ALL REPRESENTATIONS AND CERTIFICATIONS MADE BY BOTH THE PERSON SIGNING AND THE BIDDER, INCLUDING WITHOUT LIMITATION, THOSE APPEARING IN ARTICLE 2 OF THE INSTRUCTIONS TO BIDDER. THE INVITATION FOR BIDS, AS DEFINED IN THE INSTRUCTIONS TO BIDDERS, IS EXPRESSLY INCORPORATE BY REFERENCE.

SIGNATURE

_____

(Legal Name of Person, Firm or Corporation Submitting Bid)

_____

(Mailing Address for the above)

BY:_____ **DATE:**_____

(Signature)

TITLE:_____ **TELEPHONE:**_____

SECTION 12351 - METAL LABORATORY CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal cabinets and cabinet hardware.

B. Countertops.

1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.

B. SEFA 2.3 - Installation of Scientific Laboratory Furniture and Equipment; 2010.

C. SEFA 3 - Work Surfaces; 2010.

D. SEFA 7 - Laboratory and Hospital Fixtures; 2010.

E. SEFA 8 - Laboratory Casework; 2010.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Details of materials, component dimensions and configurations, construction details, joint details, attachments; manufacturer's catalog literature on hardware, accessories, and service fittings, if any.

C. Shop Drawings: Casework locations, large scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, clearances required, and utility locations, if any.

D. Samples For Color Selection: Color charts for each different finish material.

E. Test Reports: Independent laboratory reports showing compliance with chemical resistance requirements for cabinet finish.

F. Manufacturer's Installation Instructions.

G. Maintenance Data: Manufacturer's recommendations for care and cleaning.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Laboratory Casework:
   1. Thermo Fisher Scientific: www.thermoscientific.com.
   2. Jamestown Metal Products: www.jamestown.com.
   3. Kewaunee Scientific Corp: www.kewaunee.com.

2.02 METAL LABORATORY CASEWORK

A. Casework: Die-formed metal sheet; each unit self-contained and not dependent on adjacent

units or building structure for rigidity; factory-fabricated, -assembled, and -finished.

1. Style: Flush overlay.
2. Sheet Metal: Steel.
   a. Gables, Front and Back Panels, Gusset Plates and Rails: 18 gage thick.
   b. Door Fronts, Drawers, Cabinet Floors, Shelves, Filler Panels and Drawer Dividers: 20 gage thick.
   c. Backing Sheet to Door and Door Fronts: 22 gage thick.
3. Structural Performance: In addition to the requirements of SEFA 3, 7 and 8, provide components that safely support the following minimum loads, without deformation or damage:
   a. Base Units: 500 pounds per linear foot (744 kg per m) across the cabinet ends.
   b. Tables: 300 pounds (136 kg) on four legs.
   c. Drawers: 125 pounds (57 kg).
   d. Hanging Wall Cases: 300 pounds (136 kg).
   e. Shelves: 100 pounds (45 kg).
4. Corners and Joints: Without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.
5. Edges and Seams: Smooth. Form shelves and drain boards from continuous sheets.
6. Shelf Edges: Turn down 1 inch on each side and return 5/8 inch front and back.
7. Ends: Close open ends with matching construction.
8. Welding: Electric spot weld; grind joints smooth and flush.
9. Drawers and Doors: Fabricate drawer and door fronts of sandwiched sheets of sheet steel welded together and reinforced for hardware. Fill with sound deadening core.
10. Fixture Locations: Cut and drill counter tops, backs, and other components for service outlets and fixtures.
11. Access Panels: Provide access panels for maintenance of utility service fixtures and fittings and mechanical and electrical components.
12. Filler Panels: Where cabinets do not fit tight to adjacent construction, provide filler panels of matching construction and finish.
13. Finish on Steel (Except Stainless Steel): Provide a finish on all surfaces having chemical resistance equal to Level 0 (no change) or Level 1 (slight change of gloss or slight discoloration) according to SEFA 8.1.
    a. Coating Type: Baked on epoxy; minimum two coats.
    b. Color: As selected from manufacturer's standard selection.
    c. Preparation: Degrease and phosphate etch, and prime.
14. Stainless Steel Finish: No. 4, brushed finish.
15. Separation: Use bituminous paint or non-conductive tape to coat metal surfaces in contact with cementitious materials and to separate dissimilar metals.

B. Countertops: As specified in Section 06415.

2.03 MATERIALS

A. Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, CS or FS Type B, with G90/Z275 coating; stretcher leveled.

B. Cabinet Hardware: Manufacturer's standard styles, exposed components stainless steel.
   1. Finish of Exposed Components: No. 4 finish.
   2. Locks: Lock with 4 pin cylinder and 2 keys per lock.
   3. Shelves:
      a. Shelf Standards and Rests: Vertical chrome steel standards with rubber button fitted

steel rests.
b. Shelf Brackets: Vertical chrome steel standards with chrome steel arms.
4. Swinging Doors:
a. Hinges: Offset pin.
b. Catches: Magnetic.
c. Pulls: Chrome wire pulls, 4 inches wide.
5. Drawers:
a. Pulls: Chrome wire pulls, 4 inches wide.
b. Slides: Steel, full extension arms, ball bearings; capacity as recommended by manufacturer for drawer height and width.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify capacity of support framing and anchors.

B. Verify that service connections are correctly located and of proper characteristics.

3.02 INSTALLATION

A. Perform installation in accordance with manufacturer's instructions and with SEFA 2.3.

B. Use anchoring devices to suit conditions and substrate materials encountered.

C. Set casework items plumb and square, securely anchored to building structure.

D. Align cabinets to adjoining components, install filler panels where necessary to close gaps; seal joints between cabinets and countertops and adjacent construction.

E. Separate dissimilar metals to prevent galvanic action.

F. Replace units that are damaged, including those that have damaged finishes.

3.03 ADJUSTING

A. Adjust operating parts, including doors, drawers, hardware, and fixtures, to function smoothly.

3.04 CLEANING

A. Clean all components.

3.05 PROTECTION

A. Do not permit finished casework to be exposed to continued construction activity.

B. Repair damage that occurs prior to Substantial Completion, including finishes, using methods prescribed by manufacturer; replace units that cannot be repaired to like-new condition.

END OF SECTION

SECTION 15073 - VIBRATION AND SEISMIC CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Equipment support bases.

B. Vibration isolators.

C. Vibration isolators.

D. Seismic restraints.

1.02 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. See Section 15010 - General Mechanical, for additional submittal procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Isolation Technology, Inc: www.isolationtech.com.

B. Kinetics Noise Control, Inc: www.kineticsnoise.com.

C. Mason Industries: www.mason-ind.com.

2.02 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

A. General:
   1. Housekeeping Pads
      a. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
      b. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.
   2. Supplementary Support Steel
      a. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.
   3. Attachments:
      a. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor’s calculations.

B. Specification Type “E”
   1. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include

spring diameters, deflection, compressed spring height and solid spring height.
2. Mason Industries, Inc. type SLF

C. Specification Type “F”
1. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Restraining Bolts shall have a neoprene bushing between the bolt and the housing. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad.Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval “OPA” Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.
2. Mason Industries, Inc. type SLR or SLRS.

D. Specification Type “J”
1. Hangers shall consist of rigid steel frames containing minimum 1 1/4" (32mm) thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30 capability.
2. Mason Industries, Inc. type 30N.

E. Specification Type “JA”
1. Hangers shall be as described in J, but they shall be supplied with a combination rubberand steel rebound washer as the seismic upstop for suspended piping, ductwork, equipment and electrical cabletrays. Rubber thickness shall be a minimum of 1/4” (6mm). Submittals shall include a drawing of the hanger showing the installation of the rebound washer.
2. Mason Industries, Inc. type RW30N.

F. Specification Type “K”
1. Hangers shall be as described in J, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30 capability.
2. Mason Industries, Inc. type PC30N.

G. Specification Type “L”
1. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be prestretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to

final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California verifying the maximum certified load ratings.

2. Mason Industries, Inc. type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam.
3. Specifications L applies to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze.
4. Specification L applies to hanging equipment as well.

H. Specification Type "M"
1. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "OPA" number from OSHPD in the state of California verifying the maximum certified load ratings.
2. Mason Industries, Inc. type SSB, SSBS or SSRF.
3. Specifications M applies to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze.
4. Specification M applies to hanging equipment as well.

I. Specification Type "N"
1. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California.
2. Mason Industries, Inc. type SRC or UC.
3. Specifications N applies to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze.
4. Specification N applies to hanging equipment as well.

J. Specification Type "O"
1. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California.
2. Mason Industries, Inc. type CCB.

K. Specification Type "P"
1. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm2). A minimum air gap of 1/8" (3mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
2. Mason Industries, Inc. type Z-1225.

L. Specification Type “R”
   1. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is “rolled up” to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.
   2. Mason Industries, Inc. type SAS.

M. Specification Type “S”
   1. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O. Evaluation Service, Inc. verifying to its allowable loads.
   2. Mason Industries, Inc. type SAB.

N. Specification Type “W”
   1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar® tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" (50mm) and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16"(400mm) to 24" (600mm) may be single sphere. Sizes ¾” (19mm) to 1½” (38mm) may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi (1.72MPa) up to 170F (77C) with a uniform drop in allowable pressure to 215 psi (1.48MPa) at 250F (121C) in sizes through 14" (350mm). 16" (400mm) through 24" (600mm) single sphere minimum ratings are 180 psi (1.24MPa) at 170F (77C) and 150 psi (1.03MPa) at 250F (121C). Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
      a. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods. If control rods are used, they must have ½” (12mm) thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi (.7 kg/mm2) maximum on the washer area.
      b. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves.
   2. Mason Industries, Inc. type SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR.

O. Specification Type “X”
   1. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings.

Sizes 3" (75mm) and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

a. Flanged
   1) 3" x 14" (75 x 350mm)
   2) 6" x 20" (150 x 500mm)
   3) 12" x 28" (300 x 700mm)
   4) 4" x 15" (100 x 375mm)
   5) 8" x 22" (200 x 550mm)
   6) 14" x 30" (350 x 750mm)
   7) 5" x 19" (125 x 475mm)
   8) 10" x 26" (250 x 650mm)
   9) 16" x 32" (400 x 800mm)

b. Male Nipples
   1) 1/2" x 9" (12 x 225mm)
   2) 1 1/4" x 12" (32 x 300mm)
   3) 2" x 14" (50 x 350mm)
   4) 3/4" x 10" (19 x 250mm)
   5) 1 1/2" x 13" (38 x 325mm)
   6) 2 1/2" x 18" (64 x 450mm)
   7) 1" x 11" (25 x 275mm)

c. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.

2. Mason Industries, Inc. type BSS.

P. Specification Type "Y"
1. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm2) and the design shall be balanced for equal resistance in any direction.
2. Mason Industries, Inc. type ADA.

Q. Specification Type "Z"
1. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (12mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of ±1 5/8" (41mm) motion, or to meet location requirements.
2. Mason Industries, Inc. type VSG.

R. Specification Type "AA"
1. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" (19mm) thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" (25mm) past either face of the wall. Where temperatures exceed 240F(115C), 10# (4.5kg) density fiberglass may be used in lieu of the sponge.

2. Mason Industries, Inc. type SWS.

2.03 VIBRATION ISOLATION OF PIPING

A. Horizontal pipe isolation:
   1. The first four pipe hangers in the main lines near the mechanical equipment shall be as described in specification K. Brace hanger rods with SRC clamps specification N.
   2. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification J & JA.
   3. Floor supported piping shall rest on isolators as described in specification F.
   4. Piping connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have:
      a. 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm).
      b. 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm).
      c. 2 1/2" (64mm) deflection thereafter.
      d. Hangers shall be located as close to the overhead structure as practical. Hanger locations that also have seismic restraints attached must have type RW Rebound Washers to limit uplift.
   5. Where piping connects to mechanical equipment install specification W expansion joints or specification X stainless hoses if W is not suitable for the service.

B. Riser isolation:
   1. Risers shall be suspended from specification JA hangers or supported by specification E mountings, anchored with specification Y anchors, and guided with specification Z sliding guides.
   2. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to ± 25% of the initial load.
   3. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

2.04 SEISMIC DESIGN

A. General
   1. Specifications and plans shall indicate minimum requirements and general intent. The actual requirements shall be determined by the seismic system designer but those requirements shall not be less than indicated on the plans and in these specifications.
   2. Calculations shall be submitted and signed by a licensed professional engineer in the state where the project is located.
   3. This project is subject to the seismic bracing requirements of the International Building Code, 2009 edition. The following criteria are applicable to this project.
      a. Seismic Use Group (Table 1604.5): III
      b. Site Class Category (Table 1615.1.1): D
      c. Forces shall be calculated for the above requirements and Equation 16-67, 68, & 69 in section 1621.1.4, unless exempted by 1621.1.1.

B. Seismic restraint of piping:
   1. Seismically restrain all piping listed below. Use specification M cables if isolated.

Specification M or N restraints may be used on unisolated piping.
   a. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
   b. All other piping 2 1/2" (64mm) diameter and larger.
2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600m) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.
8. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in areas with Ss of 0.35 or greater shall be braced as in sections 3.02.C.2 and 3. For areas with Ss less than 0.35, 2 band clamps may be used with a reduced spacing of 1/2 of those listed in sections 3.02.C.2 and 3.
9. Connection to the structure must be made with a non-friction connection (i.e. no “C” clamps)
10. Hanger locations that also have seismic restraints attached must have Specification JA.
11. Pipe Exclusions
   a. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
   b. All other piping less than 2 1/2" (64mm) inside diameter.
   c. All piping suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12" or less.
   d. All trapezed piping where the distance from the suspension point to the trapeze member is 12" or less.
   e. If any suspension location in the run exceeds the above, the entire run must be braced.

C. Seismic restraint of ductwork:
   1. Seismic restraint of ductwork
      a. Seismically restrain all ductwork with specification L or M restraints as listed below:
         1) Restrain rectangular ducts with cross sectional area of 6 sq.ft. (.5 m2) or larger.
         2) Restrain round ducts with diameters of 28" (700mm) or larger.
         3) Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
      b. Transverse restraints shall occur at 30' (9mm) intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
      c. Longitudinal restraints shall occur at 60' (18m) intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a

longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' (1.2m) of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.

d. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
e. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
f. Walls, including gypsum board non bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
g. Connection to the structure must be made with a non-friction connection (i.e. no “C” clamps)
h. Hanger locations that also have seismic restraints attached must have Specification JA.
i. Ductwork Exclusions:
    1) Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
    2) Round duct less than 28" (.5m2) in diameter.
    3) All trapezed ductwork where the distance from the suspension point to the trapeze member is 12" or less.
    4) Ductwork hung with straps where the top of the duct is 12" or less from the suspension point and the strap has 2 #10 sheet metal screws within 2" of the top of the duct.
    5) If any suspension location in the run exceeds the above, the entire run must be braced.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

3.02 GENERAL

A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. “Building” includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades which will result in rigid contact with equipment or piping

due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.

G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.

H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractors expense.

I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
   1. Flanges of structural beams.
   2. Upper truss cords in bar joist construction.
   3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Specification L cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

K. Specification L cable assemblies are installed taut on non-isolated systems. Specification M seismic solid braces may be used in place of cables on rigidly attached systems only.

L. At locations where specification L or M restraints are located, the support rods must be braced when necessary to accept compressive loads with specification N braces.

M. At locations where specification L cable restraints are installed on support rods with spring isolators, the spring isolation hangers must be specification type JA.

N. At all locations where specification L or M restraints are attached to pipe clevis, the clevis cross bolt must be reinforced with specification type O braces.

O. Drill-in concrete anchors for ceiling and wall installation shall be specification type R, and specification type S female wedge type for floor mounted equipment.

P. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification AA wall seals.

Q. All fire protection piping shall be braced in accordance with NFPA 13 and 14.

R. All mechanical equipment shall be vibration isolated and seismically restrained as specified.

S. All fire protection equipment is considered life safety equipment and shall be seismically restrained.

T. Terminal boxes and fan powered equipment weighing less than 50 lbs. (23kg) and rigidly connected to the supply side of the duct system and supported with a minimum of 4 hanger rods.

3.03 SEISMIC CERTIFICATION AND ANALYSIS:

A. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer licensed in the state of the job location.

B. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 to the weakest mode.

C. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure.

3.04 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.05 SCHEDULE

A. Pipe Isolation Schedule.
   1. 1 Inch Pipe Size: Isolate 120 diameters from equipment.
   2. 2 Inch Pipe Size: Isolate 90 diameters from equipment.
   3. 3 Inch Pipe Size: Isolate 80 diameters from equipment.
   4. 4 Inch Pipe Size: Isolate 75 diameters from equipment.

B. Equipment Isolation Schedule.
   1. HVAC Pumps.
      a. Type: W
   2. Rooftop Unit
      a. Type: F,P
      b. Deflection: 1.5"
   3. Lab Exhaust Fans (LEF).
      a. Type: F,P
      b. Deflection: 1.5"

END OF SECTION

SECTION 15080 - MECHANICAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Piping insulation.

1.02 SCOPE OF WORK:

A. Provide insulation as specified for make-up water and chilled water piping systems, including valves, fittings, flanges, strainers, and mechanical couplings.

1.03 RELATED SECTIONS

A. Section 15075 - Mechanical Identification.

1.04 REFERENCES

A. ASTM C 518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 1991.

B. ASTM C 553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 1992.

C. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 1993.

D. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials; 1995.

1.05 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

C. Operation and Maintenance Manuals: Include in manuals the information listed below. For information on how to prepare and submit manuals see section 1780 (Closeout Submittals).
   1. Shop drawings and product data

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.07 REGULATORY REQUIREMENTS

A. Materials: Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and

mechanical damage, by storing in original wrapping.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 DUCT INSULATION

A. GLASS FIBER, FLEXIBLE
1. Manufacturers.
a. Provide products complying with the specifications by one of the following manufactures.
1) Certain Teed Corporation.
2) Johns Manville
3) Knauf Fiberglass GmbH.
4) Owens-Corning Fiberglass Corporation.
2. Insulation: ASTM C 553; flexible, noncombustible blanket.
a. 'K' value : ASTM C 518, 0.31 at 75 degrees F.
b. Maximum service temperature: 250 degrees F.
c. Maximum moisture absorption: 0.20 percent by volume.
3. Vapor Barrier Jacket:
a. Kraft paper with glass fiber yarn and bonded to aluminized film.
b. Moisture vapor transmission: ASTM E 96; 0.02 perm.
c. Secure with pressure sensitive tape.
4. Vapor Barrier Tape:
a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. GLASS FIBER, RIGID
1. Manufacturers.
a. Provide products complying with the specifications by one of the following manufactures.
1) Certain Teed Corporation.
2) Johns Manville
3) Knauf Fiberglass GmbH.
4) Owens-Corning Fiberglass Corporation.
2. Insulation: ASTM C 612; rigid, noncombustible blanket.
a. 'K' value : ASTM C 518, 0.24 at 75 degrees F.
b. Maximum service temperature: 250 degrees F.
c. Maximum moisture absorption: 0.20 percent by volume.
d. Density: 3.0 lb/cu ft.
3. Vapor Barrier Jacket:
a. Kraft paper with glass fiber yarn and bonded to aluminized film.
b. Moisture vapor transmission: ASTM E 96; 0.04 perm.
c. Secure with pressure sensitive tape.
4. Vapor Barrier Tape:
a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with

pressure sensitive rubber based adhesive.

2.02 PIPE INSULATION

A. Insulation shall have composite (insulation jacket or facing, and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure ASTM E84, NFPA 255 or UL 723 not exceeding:
   1. Flame Spread: 25.
   2. Smoke Developed: 50.

B. Insulation shall be glass fiber with a maximum K factor of .24 at 75 degrees F mean temperature with factory applied fire resistant vapor barrier jacket, for cold piping and fire retardant jacket for hot water. Insulation for outdoor piping shall be rigid foam urethane, Armalok II or equal.
   1. For fittings and valve bodies 3" and smaller, insulation shall be one-pound density glass fiber blanket wrapped firmly under compression with No. 20 gauge galvanized annealed steel wire and given a smoothing coat of finishing cement.

C. Accessories such as adhesives, mastics, cements, tapes and cloth for fittings shall have the same component rating as listed above. All products or their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed requirements. Treatment of jackets or facings to impart flame and smoke-safety shall be permanent. The use of water-soluble treatments are prohibited.
   1. Where Benjamin-Foster adhesives are specified equal products manufactured by 3M Company, or the manufacturer of the insulation are acceptable upon approval by the Engineer. Armstrong 520 adhesive shall be used for Armstrong insulation.
   2. In lieu of longitudinal lap seam specified, self-sealing lapped jacket shall be acceptable with requirement for aluminum bands on concealed piping.

D. GLASS FIBER
   1. Manufacturers.
      a. Provide products complying with the specifications by one of the following manufactures.
         1) Certain Teed Corporation.
         2) Johns Manville
         3) Knauf Fiberglass GmbH.
         4) Owens-Corning Fiberglass Corporation.
   2. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible.
      a. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
      b. Maximum service temperature: 850 degrees F.
      c. Maximum moisture absorption: 0.2 percent by volume.
   3. Insulation: ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
      a. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
      b. Maximum service temperature: 650 degrees F.
      c. Maximum moisture absorption: 0.2 percent by volume.
   4. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96 of 0.02 perm-inches.
   5. Vapor Barrier Lap Adhesive:
      a. Compatible with insulation.
   6. Insulating Cement/Mastic:

a. ASTM C 195; hydraulic setting on mineral wool.

7. Fibrous Glass Fabric:
   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Blanket: 1.0 lb/cu ft density.
   c. Weave: 5x5.

E. HYDROUS CALCIUM SILICATE
1. Insulation: ASTM C 533 and ASTM C 795; rigid molded, asbestos free, gold color.
   a. 'K' value: ASTM C 177 and C518; 0.40 at 300 degrees F.
   b. Maximum service temperature: 1200 degrees F.
   c. Density: 15 lb/cu ft.
2. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
3. Insulating Cement:
   a. ASTM C 449/C 449M.

F. FLEXIBLE ELASTOMERIC CELLULAR INSULATION
1. Manufacturer:
   a. Armacell International: www.armacell.com.
   b. Substitutions: See Section 01600 - Product Requirements.
2. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534; use molded tubular material wherever possible.
   a. Minimum Service Temperature: -40 degrees F.
   b. Maximum Service Temperature: 220 degrees F.
   c. Connection: Waterproof vapor barrier adhesive.
3. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

G. CELLULAR GLASS INSULATION
1. Manufacturers
   a. Pittsburgh Corning
2. Absorption of moisture - 0.2%.
3. Water-Vapor permeability - 0.00 perm-in
4. Composition - Soda-lime silicate glass, inorganic with no fibers or binders.
5. Compressive strength - 90 psi
6. Density - 7.5 lb/ft^3
7. Linear coefficient of expansion - 5.0 x 10e-6/deg F.
8. Thermal conductivity - 0.28 Btu-in/hr ft F at 50 deg F."

H. JACKETS
1. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   a. Lagging Adhesive:
      1) Compatible with insulation.
2. Aluminum Jacket: ASTM B 209 (ASTM B 209M) formed aluminum sheet.
   a. Thickness: 0.016 inch sheet.
   b. Finish: Embossed.
   c. Joining: Longitudinal slip joints and 2 inch laps.
   d. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   e. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that piping has been tested before applying insulation materials.

C. Verify that equipment has been tested before applying insulation materials.

D. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. DUCT INSULATION
1. Insulated ducts conveying air below ambient temperature:
   a. Provide insulation with vapor barrier jackets.
   b. Finish with tape and vapor barrier jacket.
   c. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   d. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
2. Insulated ducts conveying air above ambient temperature:
   a. Provide with or without standard vapor barrier jacket.
   b. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. PIPE INSULATION
1. Longitudinal lap and 4" wide vapor barrier joint seal strips shall be adhered neatly in place with BF 85-20 adhesive or approved equal and banded.
2. The ends of pipe insulation shall be sealed off with BF 30-35 coatings at all flanges, valves and fittings and at intervals of not more than 21 feet on continuous runs or pipes.
3. Fittings shall be vapor sealed by applying a layer of white open weave glass fabric (20 x 20 between two 1/16" thick coats of BF 30-35.
4. Insulation shall be fastened in place with 16 gauge annealed wire on 18" centers maximum for piping runs and as required for a secure installation at fittings, valves, and appurtenances. Provide 8 ounce canvas jacket pasted in place and sized for all exposed piping.
5. Exposed piping in mechanical rooms shall receive 8 ounce canvas jacket.
6. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
7. Glass fiber insulated pipes conveying fluids below ambient temperature:
   a. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   b. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
8. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
9. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at

equipment.

10. Glass fiber insulated pipes conveying fluids above ambient temperature:
    a. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
    b. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
11. Inserts and Shields:
    a. Application: Piping 1-1/2 inches diameter or larger.
    b. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
    c. Insert location: Between support shield and piping and under the finish jacket.
    d. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
    e. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
12. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07840.
13. Outdoor piping shall receive 0.16 Embossed aluminum jacket, applice with sheet metal screws. Jacket shall be waterproof.

3.03 SCHEDULES

A. DUCTWORK INSULATION
    1. Outside Air Intake Ducts:
        a. Rigid Glass Fiber Duct Insulation: 2 inch thick.
    2. Supply Ducts.
        a. Flexible Glass Fiber Duct Insulation: 2 inch thick.

B. PIPING INSULATION
    1. Domestic cold water piping (above ground):
        a. Pipe sizes 1/2 - 3 inches: 1-inch Glass fiber insulation.
        b. Cold water pipe sizes 4 inches and larger: 1-inch Glass fiber insulation.
        c. Hot water pipe sizes 4 inches and larger: 1 1/2-inch Glass fiber insulation.
    2. Chilled water supply and return piping:
        a. All pipe sizes: 1-1/2 inch Glass fiber insulation.
    3. Chilled water supply and return piping outdoors:
        a. All pipe sizes: 1-1/2 inch Cellular Glass insulation.
    4. Heating water supply and return piping:
        a. Piping 1 1/2" and smaller: 1-1/2 inch Glass fiber insulation.
        b. Piping greater than 1 1/2": 2" Glass fiber insulation.
    5. Condensate piping:
        a. All pipe sizes: 1-1/2 inch Glass fiber insulation or 3/4" flexible elastomeric cellular insulation.
    6. Steam Piping and Steam Condensate Piping Outdoors
        a. Piping 1 1/2" and smaller: 1 1/2" Cellular Glass insulation
        b. Piping greater than 1 1/2": 3" Cellular Glass insulation
    7. Steam and Steam Condensate Piping:
        a. Piping 1 1/2" and smaller: 1 1/2" Glass fiber insulation.
        b. Piping greater than 1 1/2": 3-inch Glass fiber insulation.

8. Condensate Drains from Cooling Coils:
   a. All pipe sizes: 1-1/2 inch Glass fiber insulation.
   b. All pipe sizes: 3/4" inch Flexible Elastomeric Cellular Insulation.

END OF SECTION

SECTION 15145 - PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for piping systems.
   1. Sanitary sewer.
   2. Domestic water.
   3. Gas.
   4. Deionized water

1.02 RELATED REQUIREMENTS

A. Section 15082 - Piping Insulation.

1.03 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 1996 (Reaffirmed 2003).

B. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings; The American Society of Mechanical Engineers; 2010.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2010).

E. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV; The American← Society of Mechanical Engineers; 2011.

F. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2007.

G. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers; 1968.

H. Pipe.ASTM B 32 - Standard Specification for Solder Metal; 2008.

I. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.

J. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes; 2007.

K. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications; 2000 (Reapproved 2010).

L. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.

M. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40; 2009.

N. ASTM F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2009.

O. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80; 2009.

P. ASTM F442/F442M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR); 2009.

Q. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2010.

R. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2010.

S. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.

T. PPI TR4 - PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis, Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe; Plastics Pipe Institute; 2011

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Project Record Documents: Record actual locations of valves.

D. Shop drawings and product data

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with State of South Carolina, standards.
   1. Maintain one copy on project site.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME (BPV IX).

E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 REGULATORY REQUIREMENTS

A. Perform Work in accordance with State of South Carolina plumbing code.

1.07 PIPE MARKERS

A. Color: Conform to ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

1.08 DELIVERY, STORAGE, AND HANDLING

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

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 CHEMICAL RESISTANT SEWER PIPING

A. CPVC TYPE IV GRADE I ASTM F2618, SCHD 40.

B. CPVC Pipe:
1. Schd. 40
2. Fittings: CPVC.
3. FJoints: Solvent welded, with ASTM F493 solvent cement.
4. CPVC to Glass Joints: Charlotte Pipe transition coupling AW 95C
5. CPVC to Duriron Joints: Charlotte Pipe transition coupling AW 96C
6. Flame spread of less than 25 and smoke developed rating of less than 50 based on the ULC S102.2 test protocol

2.02 WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B 88, Type L (B), Drawn (H).
1. Fittings: ASME B16.22, wrought copper and bronze, or ASME B16.18 bronze sand castings. Fittings manufactured to copper tubing sizes, with grooved ends designed to accept grooved end couplings of the same manufacturer. (Flaring of tube and fitting ends to IPS dimensions is not allowed.
2. Joints: ASTM B 32, alloy Sn95 solder. Maximum lead content 0.10%

2.03 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints: NFPA 54, threaded or welded to ASME B31.1.

2.04 Fittings: ASME B16.22, wrought copper and bronze, or ASME B16.18 bronze sand castings. Fittings manufactured to copper tubing sizes, with grooved ends designed to accept grooved end couplings of the same manufacturer. (Flaring of tube and fitting ends to IPS dimensions is not allowed.

2.05 Joints: ASTM B 32, alloy Sn95 solder. Maximum lead content 0.10%

2.06 Deionized Water Piping

A. POLYPROPYLENE HIGH PURITY PIPING.

2.07 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Copper tube and pipe: Class 150 bronze unions with soldered joints.

2.08 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate

type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.

B. Plumbing Piping - Drain, Waste, and Vent:
1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
5. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.09 BALL VALVES

A. Manufacturers:
1. Allied Healthcare Products: www.alliedhpi.com/index html
2. Apollo
3. Conbraco Industries: www.conbraco.com.
4. Substitutions: See Section 01600 - Product Requirements.

B. Construction 2 Inches and Smaller: Meets the intent of MSS SP-110, 300 psi CWP, forged brass body, two piece, chrome plated brass ball and stem, standard port, Teflon seats, blow-out proof stem, lever handle, Vic Press 304™ ends.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges, grooved joint couplings or unions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 15122.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15082.

H. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08310.

I. Install valves with stems upright or horizontal, not inverted.

J. Install water piping to ASME B31.9.

K. Sleeve pipes passing through partitions, walls and floors.

L. Inserts:
   1. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   2. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

M. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.
   8. Prime coat exposed steel hangers and supports. Refer to Section 09900. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.03 APPLICATION

A. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

B. Provide plug valves in natural gas systems for shut-off service.

3.04 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.05 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Section 02515.

B. Prior to starting work, verify system is complete, flushed and clean.

C. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.06 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe size: 1/2 inches to 1-1/4 inches:
         1) Maximum hanger spacing: 6.5 ft.
         2) Hanger rod diameter: 3/8 inches.
      b. Pipe size: 1-1/2 inches to 2 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 3/8 inch.
   2. Plastic Piping:
      a. All Sizes:
         1) Maximum hanger spacing: 6 ft.
         2) Hanger rod diameter: 3/8 inch.

END OF SECTION

SECTION 15755 - STEAM HUMIDIFIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Dry Steam Humidifiers.

1.02 RELATED REQUIREMENTS

A. Section 15184 - Steam and Steam Condensate Piping.

B. Section 15185 - Steam and Steam Condensate Specialties.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog data indicating rated capacity, dimensions, duct and service connections, electric nameplate data and wiring diagrams.

C. Shop Drawings: Indicate layout of system and components.

D. Manufacturer's Instructions: Indicate installation instructions and recommendations.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

G. Operation and Maintenance Manuals: Include in manuals the information listed below. For information on how to prepare and submit manuals see section 1780 (Closeout Submittals).

H. Recommended spare parts

I. Spare parts lists

J. Operating instructions

K. Maintenance instructions, including preventative and corrective maintenance.

L. Copies of warranties

M. Wiring diagrams

N. Shop drawings and product data

1.04 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide two year manufacturer warranty for humidifier unit except the cylinder.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Armstrong International, Inc: www.armstronginternational.com.

B. Dri-Steem Humidifier Company: www.dristeem.com.

C. Neptronic

D. Herrmidifier

2.02 STEAM HUMIDIFIERS

A. Steam, dispersion panels shall be factory-assembled and include the following components:
   1. Steam supply header/separator
   2. Condensate collection header
   3. Closely-spaced steam dispersion tubes spanning the distance between the two headers

B. Each dispersion tube shall be fitted with two rows of steam discharge tubelets inserted into the tube wall, centered on the diametric line, and spaced 1.5" (38 mm) apart. Each tubelet shall be made of a thermal-resin material designed for high steam temperatures. The two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions, perpendicular to airflow.

C. Each tubelet shall extend through the wall of and into the center of the dispersion tube and contain a steam orifice sized for its required steam capacity.

D. Each packaged humidifier panel assembly of tubes and headers shall be contained within a galvanized metal casing to allow convenient duct mounting, or to facilitate the stacking of and/or the end-to-end mounting of multiple humidifier panels in ducts or air handler casings. When so designated, the humidifier panel shall be shipped unassembled.

E. All tubes and headers shall be 304 stainless steel, and welded joints shall be Heli-arc welded.

F. Tubes shall be joined to headers with slip-fit couplings to facilitate easy removal.

G. Humidifier shall have float and thermostatic (F&T) traps as required by the manufacturer.

H. Valve:
   1. Modulating electronic humidification steam control valve: Valve shall be a normally closed with an electronic actuator. Valve trim shall be stainless steel, and sized to meet humidification requirements. Actuator shall respond to a variable electronic signal. Available signal inputs: 4 to 20 mA, 2 to 10 VDC.

I. High-efficiency dispersion tube:
   1. Dispersion tubes shall be insulated with a plenum-approved insulating material for in-duct installation and have an R-value not less than 0.5 at a thickness not more than 0.125" (3.2 mm), for minimal increase in dispersion tube diameter.
   2. Airstream heat gain shall not exceed the values as scheduled; the values shall be supported by the manufacturer's published data.
   3. Insulating material shall meet the following criteria at 0.125" (3.2 mm) thickness:
      a. Fire/smoke index shall be 0/0 per any of the following test procedures:
      b. - UL 723 fire/smoke index (Test for Surface Burning Characteristics of Building Materials)
      c. - NFPA 255 (Standard Method of Test of Surface Burning Characteristics of Building Materials)
      d. - ASTM E84 (Surface Burning Characteristics for Materials Used in Plenums)
      e. Stable up to 300 °F (148 °C) continuous - to prevent material degradation, hardening, or crumbling at high temperatures
      f. Closed-cell construction does not absorb water or support microbial growth - to negate the need for vapor barriers and jackets

g. Non-toxic and pure as documented in manufacturer's data - to prevent off-gassing and to facilitate use in clean rooms, pharmaceutical applications, and food industries
h. Will not degrade when exposed to UVC light - to negate the need for UV wraps
i. Continuous, seam-welded, and held in place without bands or clamps - to minimize surfaces for the accumulation of particulate matter

J. Humidifier Control Options
1. Control input accessory:
a.
b. Humidistat, electronic, duct: The duct humidistat shall provide a modulating output in response to humidity changes. Preset at 35% RH set point. Provided by controls contractor.
c. Humidistat, electronic high limit, duct: The duct high limit humidistat shall provide a modulating output in response to humidity changes. Preset at 85% RH set point. Provided by controls contractor.
d. Airflow proving switch. Provided by controls contractor.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Connect dry steam humidifiers to steam supply and to condensate piping. Provide gate valve, inlet strainer, and inverted bucket steam trap. Refer to Section 15184 and Section 15185.

END OF SECTION

SECTION 15840 - AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Terminal units.

B. Electronic Airflow Control Valves

1.02 RELATED REQUIREMENTS

A. Section 15065 - Motors for Mechanical Equipment.

B. Section 15182 - Hydronic Piping: Connections to heating coils.

C. Section 15183 - Hydronic Specialties: Connections to heating coils.

D. Section 15810 - Ducts.

E. Section 15820 - Duct Accessories.

F. Section 15850 - Air Outlets and Inlets.

G. Section 15928 - Instruments and Control Elements: Thermostats and Actuators.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
   1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.

D. Project Record Documents: Record actual locations of units.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

G. Operation and Maintenance Manuals: Include in manuals the information listed below. For information on how to prepare and submit manuals see section 1780 (Closeout Submittals).
   1. Spare parts lists
   2. Operating instructions
   3. Maintenance instructions, including preventative and corrective maintenance.
   4. Copies of warranties
   5. Wiring diagrams
   6. Shop drawings and product data

1.04 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier

B. Phoenix Controls

C. Enviro-Tec

D. Trane

E. JCI

F. EH Price

G. Titus

H. LCS Airflow Control Solutions

I. Metal Aire

J. Nailor

2.02 AIR TERMINAL UNITS

A. Refer to schedules for model and type terminal unit specified.

B. Hot Water Heating Coil:
   1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.

C. Automatic Damper Operator:
   1. Electric Actuator: 24 volt with high limit.

2.03 ELECTRONIC AIRFLOW CONTROL VALVE

A. General
   1. The airflow control device shall be a venturi valve.
   2. The valve assembly manufacturer's Quality Management System shall be registered to ISO 9001:2008.
   3. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system.
   4. The airflow control device shall maintain accuracy within ±5% of signal over an airflow turndown range of no less than:
      a. 12.5 to 1 (medium pressure all valve sizes)
      b. 16 to 1 (medium pressure w/o 14” valve)
      c. 7 to 1 (low pressure all valve sizes)
      d. 11 to 1 (low pressure w/o 14” valve)
      e. 8 to 1 (medium pressure shut-off all valve sizes)
      f. 14 to 1 (medium pressure shut-off w/o 14” valve)

g. 5 to 1 (low pressure shut-off all valve sizes)
h. 9 to 1 (low pressure shut-off w/o 14" valve)

5. The airflow control device shall maintain pressure independence regardless of loss of power.
6. The airflow control device shall be constructed of one of the following four types:
   a. Class A-The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device's shaft and internal "S" link shall be made of 316 stainless steel. The shaft support brackets shall be made of galvaneal (non shutoff valves) or 316 stainless steel (shutoff valves). The pivot arm shall be made of aluminum (for non shutoff valves) and 303/304 stainless (for shut off valves). The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a PP (polypropylene) or PPS (polyphenylene sulfide) composite. Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.
   b. Class B-The airflow control device for corrosive airstreams, such as fume hoods and biosafety cabinets, shall have a baked-on, corrosion-resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal "S" link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of PP (polypropylene) or PPS (polyphenylene sulfide) composite.
7. Actuation
   a. For electrically actuated VAV operation, a CE certified electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to position itself in an appropriate failsafe state. Options for these failsafe states include: normally open-maximum position, normally closed-minimum position and last position. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications).
8. The controller for the airflow control devices shall be microprocessor based and operate using peer-to-peer control architecture. The room-level airflow control devices shall function as a standalone network.
9. Each laboratory control system shall have the capability of performing fume hood control, pressurization control, temperature control, humidity control, and implement occupancy and emergency mode control schemes.
10. The control valves shall integrate with the BMS.
11. Certification
   a. Each airflow control device shall be factory characterized to the job specific airflows as detailed on the plans and specifications using NIST accredited air stations and instrumentation having a combined accuracy of no more than ±1% of signal (5,000 to 250cfm), ±2% of signal (249 to 100cfm) and ±3% of signal (199 to 35cfm). Electronic airflow control devices shall be further characterized and their accuracy verified to ±5% of signal at a minimum of 48 different airflows across the full operating range of the device.
   b. Each airflow control device shall be marked with device-specific factory characterization data. At a minimum, it should include the room number, tag

number, serial number, model number, eight-point characterization information (for electronic devices), date of manufacture and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation. Characterization data shall be stored indefinitely by the manufacturer and backed up off site for catastrophic event recovery.

12. Airflow control devices that are not venturi valves and are airflow measuring devices (e.g., pitot tube, flow cross, air bar, orifice ring, vortex shedder, etc.) shall only be acceptable, provided these meet all the performance and construction characteristics as stated throughout this specification and:
    a. The airflow control device employs transducers manufactured by Rosemount, Bailey, Bristol, or Foxboro. Accuracy shall be no less than ±0.15% of span (to equal ±5% of signal with a 15 to 1 turndown) over the appropriate full-scale range, including the combined effects of nonlinearity, hysteresis, repeatability, drift over a one-year period, and temperature effect. 316L stainless steel materials shall be provided for all exhaust applications. The use of 304 stainless steel or aluminum materials shall be provided for all supply air applications.
    b. Airflow sensors shall be of a multi-point averaging type, 304 stainless steel for all supply and general exhaust applications, 316L stainless steel for all fume hood, canopy, snorkel, and biosafety cabinet applications. Single point sensors are not acceptable.
    c. Suppliers of airflow control devices or airflow measuring devices requiring minimum duct diameters shall provide revised duct layouts showing the required straight duct runs upstream and downstream of these devices. Coordination drawings reflecting these changes shall be submitted by the supplier of the LACS. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase fan sizes and horsepower and all associated electrical changes shall be borne by the control system supplier.

B. EXHAUST AND SUPPLY AIRFLOW DEVICE CONTROLLER
1. The airflow control device shall be a microprocessor-based design and shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.
2. The airflow control device shall store its control algorithms in non-volatile, re-writeable memory. The device shall be able to stand-alone or to be networked with other room-level digital airflow control devices using an industry standard protocol.
3. Room-level control functions shall be embedded in and carried out by the airflow device controller using distributed control architecture. Critical control functions shall be implemented locally; no room-level controller shall be required.
4. The airflow control device shall use industry standard 24 VAC power.
5. The airflow control device shall have provisions to connect a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.
6. The airflow control device shall have built-in integral input/output connections that address fume hood control, temperature control, humidity control occupancy control, emergency control, and non-network sensors switches and control devices. At a minimum, the airflow controller shall have:
    a. Three universal inputs capable of accepting 0 to 10 VAC, 4 to 20 mA, 0 to 65 K ohms, or Type 2 or Type 3 10 K ohm @ 25 degree C thermistor temperature sensors.

b. One digital input capable of accepting a dry contact or logic level signal input.
c. Two analog outputs capable of developing either a 0 to 10 VAC or 4 to 20 mA linear control signal.
d. One Form C (SPDT) relay output capable of driving up to 1 A @ 24 VAC/VAC.

7. The airflow control device shall meet FCC Part 15 Subpart J Class A, CE, and CSA Listed per file #228219.

C. TWO-POSITION EXHAUST AIRFLOW CONTROL DEVICE

1. The airflow control device shall maintain a factory characterized fixed maximum and minimum flow set point based on a remote contact/sash switch for electronic valves or a switched 0 to 20 psi pneumatic signal for pneumatic valves. Two-position devices requiring feedback shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow. All two-position devices shall be either networked or hard-wired into the room-level network so as to be considered under pressurization control.

D. LOCAL DISPLAY UNIT

1. The control system shall have an optional local display option that allows control and system variables to be displayed on a user interface terminal device. The Local Display Unit shall connect to the room-level network and provide access to all room-level control data.
2. The display unit shall be powered by 24 VAC or 24 VAC.
3. The Local Display Unit shall have the provisions of being flush mounted or surface mounted either directly to a standard electrical enclosure or DIN rail. Electrical conductors shall terminate inside the display module housing to a pluggable terminal block.
4. The display unit shall utilize an LCD display with variable contrast adjustment and backlighting to adapt the display to various lighting conditions.
5. The display unit shall provide a means of entering and displaying a unique location descriptor that may be used to identify the location and/or function of the display unit. The descriptor shall allow up to two lines of at least 13 alphanumeric characters to be entered in the description field.
6. The display unit shall allow access to pertinent flow, temperature, humidity, pressure data, as well as occupancy and emergency mode control status, and current device or system alarm status. Data shall be viewable in units of measure appropriate for users of the system.
7. The display unit shall have the ability to display up to 250 parameters, organized into display screens of up to five parameters per screen. Each screen shall have the ability to have a descriptive name of up to 16 alphanumeric characters for ease of navigation. Each parameter being displayed shall have the ability to include such information as:
   a. Descriptive tag (up to 13 alphanumeric characters).
   b. Present value, which may be read directly off the network, or conditioned with a fixed multiplier and/or offset to scale the value for the desired units of measure.
   c. Units of measure, which are configurable based on local user conventions.
8. Set points and editable control parameters shall be viewable on the Local Display Unit. The user shall have the ability to enable a pass code to prevent unauthorized changes to set points and editable control parameters.

E. FUME HOOD MONITOR

1. A fume hood monitor shall be provided to receive the sash sensor output, and presence

and/or motion signal. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity. Audible and separate visual alarms shall be provided for flow alarm and emergency exhaust conditions. The fume hood monitor shall incorporate the following capabilities:

a. LED display with the ability to display Cubic feet per minute (CFM).
b. Alarm Muting option, which silences the audible alarm for an adjustable time period when the mute button is pushed. If another alarm is generated during the mute period, the new alarm will override the mute delay and the alarm will sound again.
c. Auto Alarm Muting option, which sets the alarm to mute automatically after 20 seconds.
d. Emergency Exhaust button with LED, which activates an emergency exhaust mode. In this mode, the exhaust air is at its maximum flow. When activated, the alarm will sound and the LED will flash. To activate emergency exhaust mode, push the button. Push the button again to cancel emergency exhaust mode.
e. Flow Alarm LED, which illuminates to indicate an unsafe airflow condition. The audible alarm will also activate and may be muted.
f. Broken retracting cable alarm, an audible alarm with a flashing LED that indicates whether a vertical sash sensor cable is detached, thereby ensuring the fume hood users' safety.

2.04

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Support units individually from structure. Do not support from adjacent ductwork.

C. Connect to ductwork in accordance with Section 15810.

3.02 ELECTRONIC AIRFLOW CONTROL VALVES

A. Installation
1. The automatic temperature controls (ATC) contractor shall install the sash sensors, interface boxes, and fume hood monitor on the fume hood under initial supervision of the laboratory airflow control system supplier. Reel-type sash sensors and their stainless steel cables shall be hidden from view. Bar-type sash sensors shall be affixed to the individual sash panels. Sash interface boxes with interface cards shall be mounted in an accessible location.
2. The ATC contractor shall install the laboratory control unit in an accessible location in the designated laboratory room.
3. The ATC contractor shall terminate and connect all cables as required (refer to the chart below). In addition, integrated laboratory control unit connectors shall be furnished by the ATC.
4. The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.
5. The mechanical contractor shall provide and install all reheat coils and transitions.
6. The mechanical contractor shall provide and install insulation as required.

7. The electrical contractor shall wire a dedicated, single-phase 120 Vac power circuit to the laboratory control unit or power supply, and to required field mounted power transformers for electric actuated valves for each lab.

B. System Start-up and Training
   1. System start-up shall be provided by a factory-authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust, or return).
   2. The balancing contractor shall be responsible for final verification and reporting of all airflows.
   3. The laboratory airflow control system supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.
   4. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.
   5. Valve Types
      a. Supply Valve
         1) Supply Valve shall refer to a normally-closed valve that will go to the minimum flow position upon loss of power.
      b. Exhaust Valve
         1) Exhaust Valve shall refer to a normally-open valve that will go to the maximum flow position upon loss of power.
   6. Vertical Sash Sensor
      a. Reel sash sensor shall have a maximum reach of 42 inches and retract a maximum of 41 inches. Cable shall be stainless steel, nylon jacketed. Cable shall be capable of retracting from 41 inches down to 0 inches in order to measure sash position.
      b. Each reel sensor shall be furnished with a pre-terminated 22 AWG, two-wire, PVC-jacketed cable for connection to fume hood monitor.
      c. Mount reel sash sensor in accordance with manufacturer's recommendations.
      d. Sash Sensor shall be provided for all fume hoods and shall communicate sash position to the controller in order to determine min or max exhaust flow.

C. Fume Hood Monitors
   1. Contractor shall provide all power requirements for fume hood monitor. Contractor shall coordinate with Division 16.
      a. Fume hood monitor shall be surface mounted in accordance with manufacturer's recommendations. Contractor shall supply all equipment needed for mounting.

D.

END OF SECTION

SECTION 15926 - DIGITAL CONTROLS

PART 1 GENERAL

RELATED DOCUMENTS

2.01 All work of this Division shall be coordinated and provided by the single Central Control and Monitoring System (CCMS) Contractor.

A. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 15 Sections for details.

B. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

2.02 Scope

A. This section includes the controls, instrumentation and associated piping and wiring required to make the mechanical systems provided under Division 15 perform as described in these specifications and as shown. Provide a complete system of automatic temperature control of the direct digital type. The system shall be complete in all respects including all labor, materials, equipment, and service necessary, and shall be installed by personnel in the direct employ of the manufacturer. Provide a distributed process network control system complete with all necessary hardware and software including all programming. The DDC systems shall be an Andover Continuum Bacnet system installed by Emcor Inc.

B. Provide a complete and operational Central Control and Monitoring System (CCMS) including all devices and software necessary to perform the functions herein described or indicated on the drawings.

C. The CMMS shall be a Web based system communicating over the building owners Local Area Network (LAN). Contractor shall be responsible for coordination with the owner's IT staff to ensure that the CMMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN. TCP/IP connections and addresses shall be provided by the owner for connection of supervisory panels to the USCA network..

D. The primary focus of the Central Control and Monitoring System (CCMS) will be to monitor and control the new HVAC system components, air handling units, fans, heat exchangers, coils, valves, pumps, variable speed drives, trending, graphic functions, etc. The system shall be expandable to serve future equipment, systems, and auxiliary field devices.

E. CCMS contactor shall provide all DDC panels, power supplies, wiring, conduit, solenoid valves, relays, differential pressure transmitters, differential pressure switches, RTDS, pressure sensors, etc. necessary for a complete and operable automatic control system and DDC field panels and connecting LAN.

F. The systems engineering phase shall include the selection and integration of components into a complete system which will meet the performance and prescriptive requirements of the Contract, together with drawings, specifications, descriptions of operation, diagrams including system architecture and other materials listed under "Submittals" paragraph of this Section. The successful contractor shall be responsible for all systems engineering.

2.03 Quality Assurance

A. Quality assurance for automatic control systems includes a multi-step program consisting of a pre-qualification procedure for manufacturer and installation specialist; a system engineering, products and shop drawing phase; installation; testing and adjusting; reporting; commissioning testing and verifications; operating instruction and training; and the submission of maintenance and operating manuals.

B. CMMS Contractor
   1. The Central Control and Monitoring System (CMMS) herein specified shall be fully integrated and installed as a complete package by the Central Control and Monitoring System contractor. The System shall include all wiring, piping, installation supervision, calibration, adjustments, and checkout necessary for a complete and fully operational system.
   2. The CMMS Contractor shall be a factory owned branch office that is regularly engaged in the engineering, programming, installation and service of CMMSs of similar size and complexity. Bids by wholesalers, mechanical contractors, franchised dealers, applied partners or any other firm whose principal business is not that of manufacturing and installing automatic temperature control systems shall not be acceptable.
   3. The CMMS Contractor shall have a minimum of ten years experience with the complete, turnkey installation of CMMSs of similar size and technical complexity.
   4. The CMMS shall be complete in all respects and shall be provided, installed and commissioned by the CMMS equipment manufacturer. Equipment manufacturer shall be responsible for and warrant the proper installation and operation of the CMMS and control system equipment.
   5. The following CMMS contractors are approved to provide and install the CMMS for this project subject to their ability to meet all requirements of this specification:
   6. Johnson Controls
   7. Bid approval does not imply nor suggest compliance of specification requirements.

C. CMMS Products Manufacturer:
   1. The CMMS architecture shall consist of the products of a manufacturer regularly engaged in the production of CMMSs, and shall be the manufacturer's latest standard of design. Controllers and DDC (Direct Digital Control) system components shall be current production products.
   2. All other equipment shall be the products of the CMMS manufacturers or of an approved manufacturer regularly engaged in production of specialized CMMS materials or equipment.
   3. Following is a list of acceptable CMMS products manufacturers:
   4. Johnson Controls
   5. Bid approval does not imply nor suggest compliance of specification requirements.

2.04 Work Included and Interface Requirements

A. Installation of Central Control and Monitoring System (CMMS)
   1. The CMMS contractor shall provide all necessary hardware and software to integrate the new control system with the existing USC SOM campus CMMS. Integration means the ability to monitor, override, change setpoints, and provide real-time bi-directional dynamic data exchange between the new control system and the existing CMMS hardware and software.
   2. The CMMS contractor shall upgrade existing Metasys software to latest version.
   3. The existing USC SOM campus CMMS is a Johnson Controls Metasys system. The CMMS is comprised of multiple supervisory controllers, monitoring and

communicating with various building control systems over the USC SOM campus Ethernet LAN system. The new building control system will be connected to, and communicate with, the existing campus CMMS over the USC SOM campus Ethernet LAN

4. All new control points, monitoring points and software points shall be added to the existing USC SOM CMMS database and shall be available for monitoring and adjustment at any computer, with current copy of Microsoft Internet Explorer software (Release 6.0 or later), that is connected to the USC SOM LAN.
5. All new building software and databases shall be archived on the hard drive at the USC SOM CMMS server. In the event that any building controller should lose its program that controller's archived software program shall be downloaded across the CMMS network from the CMMS server to the respective building controller.
6. Integrity of the existing CMMS shall be maintained during installation.
7. The new building control system shall be compatible in every respect with existing Metasys CMMS hardware and software. All new controllers shall be compatible with Metasys database and Metasys software development tools.

2.05 Submittals

A. Shop Drawings, Product Data, and Samples
   1. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
   2. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
   3. The CCMS Contractor shall correct any errors or omissions noted in the first review.
   4. At a minimum, submit the following:
      a. CCMS network architecture diagrams including all nodes and interconnections.
      b. Systems schematics, sequences and flow diagrams.
      c. Points schedule for each point in the CCMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
      d. Samples of Graphic Display screen types and associated menus.
      e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
      f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
      g. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
      h. Details of all CCMS interfaces and connections to the work of other trades.

B. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

2.06 Record Documentation

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the CCMS provided:
   a. Table of contents.
   b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
   c. Manufacturers product data sheets or catalog pages for all products including software.
   d. System Operator's manuals.
   e. Archive copy of all site-specific databases and sequences.
   f. CCMS network diagrams.
   g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

2.07 Warranty

A. Standard Material and Labor Warranty:
   1. Provide a one-year labor and material warranty on the CCMS.
   2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the CCMS Contractor at the cost of the CCMS Contractor.
   3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during CCMS Contractor's normal business hours.

PART 2 PRODUCTS

3.01 Large General Description

A. The Building Management System (CCMS) shall use an open architecture. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

B. The Building Management System shall consist of the following:
   1. Standalone Network Automation Engine(s)
   2. Field Equipment Controller(s)
   3. Input/Output Module(s)
   4. Local Display Device(s)
   5. Distributed User Interface(s)
   6. Network processing, data storage and communications equipment
   7. Other components required for a complete and working CCMS

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

3.02 CCMS Architecture

A. Automation Network
   1. The CCMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
   2. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
   3. Network Automation Engines (NAE) shall reside on the automation network.
   4. The automation network will be compatible with other campus-wide networks. Where indicated, the automation network shall be connected to the campus network and share resources with it by way of standard networking devices and practices.

B. Control Network
   1. Network Automation Engines shall provide supervisory control over the control network.
   2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
   3. DDC Controllers shall reside on the control network.

C. Distributed Web Based User Interface
   1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
   2. Alarms
      a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
         1) Log date and time of alarm occurrence.
         2) Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
         3) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
         4) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
         5) Provide the capability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
         6) Any attribute of any object in the system may be designated to report an alarm.
         7) The FMS shall annunciate diagnostic alarms indicating system failures and

non-normal operating conditions

3. Reports and Summaries
   a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
      1) All points in the CCMS
      2) All points in each CCMS application
      3) All points in a specific controller
      4) All points in a user-defined group of points
      5) All points currently in alarm
      6) All points locked out
      7) All CCMS schedules
      8) All user defined and adjustable variables, schedules, interlocks and the like.
      9) Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
      10) Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
      11) The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
4. Schedules
   a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
      1) Weekly schedules
      2) Exception Schedules
      3) Monthly calendars.
      4) Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
      5) It shall be possible to define one or more exception schedules for each schedule including references to calendars
5. Password
   a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
   b. A minimum of five levels of access shall be supported individually or in any combination as follows:
      1) Level 1 = View Data
      2) Level 2 = Command
      3) Level 3 = Operator Overrides
      4) Level 4 = Database Modification
      5) Level 5 = Database Configuration
      6) Level 6 = All privileges, including Password Add/Modify
      7) Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
6. Dynamic Color Graphics
   a. The graphics application program shall be supplied as an integral part of the User

Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.
   1) The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.

7. Historical trending and data collection
   a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
      1) Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
         (a) Defined time interval
         (b) Upon a change of value
            (1) Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
      2) The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
8. Trend data viewing and analysis
   a. Provide a trend viewing utility that shall have access to all database points.
   b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
   c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
   d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
   e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
   f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
   g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

3.03 Network Automation Engines (NAE)

A. Network Automation Engine (NAE)
   1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
   2. Automation network - The NAE shall reside on the automation network and shall support a subnet of system controllers.
   3. Processor - The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall

be sufficient to fully meet the requirements of this Specification.

4. Memory - Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
5. Diagnostics - The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
6. Power Failure - In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
    a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
    b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

3.04 DDC System Controllers

A. Field Equipment Controller (FEC)
    1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
    2. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
    3. The FEC shall be assembled in a plenum-rated housing with flammability rated to UL94-5VB.
    4. The FEC shall include a removable base to allow pre-wiring without the controller.
    5. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
    6. The FEC shall support the following types of inputs and outputs:
        a. Universal Inputs - shall be configured to monitor any of the following:
            1) Analog Input, Voltage Mode
            2) Analog Input, Current Mode
            3) Analog Input, Resistive Mode
            4) Binary Input, Dry Contact Maintained Mode
            5) Binary Input, Pulse Counter Mode
            6) Binary Inputs - shall be configured to monitor either of the following:
                (a) Dry Contact Maintained Mode
                (b) Pulse Counter Mode
            7) Analog Outputs - shall be configured to output either of the following
                (a) Analog Output, Voltage Mode
                (b) Analog Output, current Mode
            8) Binary Outputs - shall output the following:
                (a) 24 VAC Triac
            9) Configurable Outputs - shall be capable of the following:
                (a) Analog Output, Voltage Mode
                (b) Binary Output Mode

7. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
   a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   b. The FC Bus shall support communications between the FECs and the NAE.
   c. The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
   d. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
   e.
8. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
   a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   b. The SA Bus shall support a minimum of 10 devices per trunk.
   c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
9. The FEC shall support, but not be limited to, the following:
   a. Hot water, chilled water/central plant applications
   b. Built-up air handling units for special applications
   c. Terminal units
   d. Special programs as required for systems control

3.05 Field Devices

A. Input/Output Module (IOM)
   1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
   2. The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.

B. VAV Modular Assembly (VMA)
   1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
   2. The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
   3. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
   4. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
   5. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
   6. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
   7. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
   8. Each controller shall have the ability to automatically calibrate the flow sensor to

eliminate pressure transducer offset error due to ambient temperature / humidity effects.

9. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
10. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
11. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
12. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
13. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
14. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
15. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain (“K” factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
16. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
    a. Absolute temperature loop error.
    b. Signed temperature loop error.
    c. Absolute airflow loop error.
    d. Signed airflow loop error.
    e. Average damper actuator duty cycle.
17. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
    a. Unreliable space temperature sensor.
    b. Unreliable differential pressure sensor.
    c. Starved box.
    d. Actuator stall
    e. Insufficient cooling.
    f. Insufficient heating.
        1) The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
18. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.
19. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires

reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.

20. Inputs:
    a. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
        1) 0-10 VDC Sensors
        2) 1000ohm RTDs
        3) NTC Thermistors
        4) Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
        5) For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
        6) Provide side loop application for humidity control.
21. Outputs
    a. Analog outputs shall provide the following control outputs:
        1) 0-10 VDC
        2) Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
        3) For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
22. Application Configuration
    a. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.
23. Sensor Support
    a. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
    b. The VMA shall support an LCD display room sensor.
    c. The VMA shall also support standard room sensors as defined by analog input requirements.
    d. The VMA shall support humidity sensors defined by the AI side loop.

C. Network Sensors (NS)
1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
    a. Zone Temperature
    b. Zone humidity
    c. Zone setpoint
2. The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
3. The Network Sensors shall include the following items:
    a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint.
    b. An LED to indicate the status of the Override feature.
    c. A button to toggle the temperature display between Fahrenheit and Celsius.
    d. A button to initiate a timed override command
4. The NS shall be available with either screw terminals or phone jack.
5. The NS shall be available in either surface mount or wall mount styles.

3.06 Input Devices

A. General Requirements
   1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors
   1. General Requirements:
      a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
      b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
      c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:
   2. Room Temperature Sensors
      a. Room sensors shall be constructed for either surface or wall box mounting.
      b. Room sensors shall have the following options when specified:
         1) Setpoint reset slide switch providing a +3 degree (adjustable) range.
         2) Individual heating/cooling setpoint slide switches.
         3) A momentary override request push button for activation of after-hours operation.
   3. Thermo wells
      a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
      b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
      c. Thermo wells and sensors shall be mounted in a threadolet or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.
      d. Thermo wells shall be constructed of 316 stainless steel.
   4. Outside Air Sensors
      a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
      b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
      c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
   5. Duct Mount Sensors
      a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
      b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
      c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
   6. Averaging Sensors
      a. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
      b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing

points per 12-foot long segment.
c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

7. Acceptable Manufacturers: Johnson Controls, Setra.

C. Humidity Sensors
1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
7. Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.

D. Differential Pressure Transmitters
1. General Air Transmitter Requirements:
a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
2. Low Differential Air Pressure Applications (0” to 5” w.c.)
a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
1) (0.00 - 1.00” to 5.00”) w.c. input differential pressure ranges. (Select range appropriate for system application.)
2) 4-20 mA output.
3) Maintain accuracy up to 20 to 1 ratio turndown.
4) Reference Accuracy: +0.2% of full span.
5) Acceptable Manufacturers: Johnson Controls and Setra.
3. Medium Differential Air Pressure Applications (5” to 21” w.c.)

a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
   1) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
   2) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
   3) Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
   4) Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
   5) Acceptable manufacturers: Johnson Controls and Setra.

E. Flow Monitoring
1. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet sensors shall not be substituted for duct or plenum sensor probes indicated on the plans.
   a. Duct and plenum mounted sensors shall be fabricated of anodized aluminum alloy tube with 303/304 stainless steel mounting brackets.
   b. Fan inlet probes shall be field adjustable to fit the fan inlet and have 303/304 stainless steel mounting feet.
2. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. Each transmitter shall have an LCD display capable of displaying airflow and temperature. Airflow shall be field configurable to be displayed as a velocity or volumetric rate. Each transmitter shall operate on 24 VAC.
3. Each sensing point shall independently determine the airflow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output. Devices, which average multiple non-linear sensing point signals, are not acceptable. Pitot tube arrays are not acceptable.
4. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location. Probes and transmitters shall not require field matching for proper operation.
5. The operating airflow range shall be 50-5,000 FPM unless otherwise indicated on the plans.
6. The operating temperature range for the measuring probes shall be -20° F to 140° F. The operating humidity range for the measuring probe shall be 0-99% RH (non-condensing).The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
7. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range and be wind tunnel calibrated or verified against standards that are traceable to NIST.
   a. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
8. Each independent temperature sensor shall have a laboratory accuracy of +/-0.15° F

over the entire operating temperature range and be calibrated or verified against standards that are traceable to NIST.

9. The airflow/temperature measuring device shall be capable of displaying the airflow and temperature readings of each sensor on the transmitter's LCD display.
10. The transmitter shall be capable of communicating with the host controls using the following interface options:
    a. Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire)
    b. RS-485: Field selectable ModBus-RTU and Johnson Controls N2 Bus
    c. 10 Base-T Ethernet: Field selectable ModBus TCP and TCP/IP
11. Airflow/Temperature measuring devices shall be UL listed as an entire assembly.
12. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.
13. Product:
    a. Ebtron "Gold Series"
    b. Substitutions: See Section 01600 - Product Requirements

F. Power Monitoring Devices
1. Current Measurement (Amps)
    a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
    b. Current Transformer - A split core current transformer shall be provided to monitor motor amps.
        1) Operating frequency - 50 - 400 Hz.
        2) Insulation - 0.6 Kv class 10Kv BIL.
        3) UL recognized.
        4) Five amp secondary.
        5) Select current ration as appropriate for application.
        6) Acceptable manufacturers: Veris Industries
        7) Current Transducer - A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
            (a) 6X input over amp rating for AC inrushes of up to 120 amps.
            (b) Manufactured to UL 1244.
            (c) Accuracy: +.5%, Ripple +1%.
            (d) Minimum load resistance 30kOhm.
            (e) Input 0-20 Amps.
            (f) Output 4-20 mA.
            (g) Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
            (h) Acceptable manufacturers: Veris Industries

G. Smoke Detectors
1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 16 for installation under Division 15. All wiring for air duct detectors shall be provided under Division 16, Fire Alarm System.

H. Status and Safety Switches
1. General Requirements
a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the CCMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
2. Current Sensing Switches
a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
d. Acceptable manufacturers: Veris Industries
3. Air Filter Status Switches
a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
c. Provide appropriate scale range and differential adjustment for intended service.
d. Acceptable manufacturers: Johnson Controls, Cleveland Controls
4. Air Flow Switches
a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
5. Air Pressure Safety Switches
a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
c. Acceptable manufacturers: Johnson Controls, Cleveland Controls
6. Low Temperature Limit Switches
a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
d. The low temperature limit switch shall be equal to Johnson Controls A70.

3.07 Output Devices

A. Actuators

1. General Requirements
   a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
2. Electronic Damper Actuators
   a. Electronic damper actuators shall be direct shaft mount.
   b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
   c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
   d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
   e. Acceptable manufacturers: Johnson Controls, Mamac.
3. Electronic Valve Actuators
   a. Electronic valve actuators shall be manufactured by the valve manufacturer.
   b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
   c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
   d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
f. Acceptable manufacturers: Johnson Controls

B. Control Relays
1. Control Pilot Relays
a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
b. Mounting Bases shall be snap-mount.
c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
d. Contacts shall be rated for 10 amps at 120VAC.
e. Relays shall have an integral indicator light and check button.
f. Acceptable manufacturers: Johnson Controls, Lectro

C. Electronic Signal Isolation Transducers
1. A signal isolation transducer shall be provided whenever an analog output signal from the CCMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.
4. Acceptable manufacturers: Advanced Control Technologies

D. External Manual Override Stations
1. External manual override stations shall provide the following:
a. An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.
b. A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
c. A Status LED shall illuminate whenever the output is ON.
d. An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.
e. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

E. Control Valves (Chilled Water)
1. All modulating control valves shall be of the“pressure independent” type configured with one integrated valve body that incorporates one chamber with an adjustable Cv and a separate pressure regulating chamber used to maintain a constant differential pressure across the control surface.
2. Each control valve shall be individually flow tested at the factory and verified to deviate no more than ±5% through the selected operating pressure range. A calibrated performance tag shall be provided with each valve that verifies the flow rate in 10° rotation increments up to full rated flow (option with 1/2”). All testing shall be performed with instruments calibrated to the requirements of ANSI/ISA-S75.11-1985, with traceability to NIST and/or ISO standards.
3. Control valve rangeability shall be 100:1 minimum.
4. Each control valve shall be subjected to 70 psid and tested to exceed ANSI/FCI 70-2-1998 leakage ratings. Class IV leakage or better is required for control valves 2" nominal size and less. Class III leakage or better is required for control valves larger than 2".

5. In all control valves 8” and smaller, it shall be possible to modify the valve flow characteristics without removing the valve from the piping system.
6. Balancing valves and associated balancing shall not be required where pressure independent modulating control valves are installed.
7. The control valve actuator shall modulate all valves up to 8" in nominal size from 0 to 100% design flow while rotating the valve stem a maximum of 90°.
8. There shall be three ports installed at the factory integral to each valve and capable of being used to measure pressure or temperature. The first port shall be installed at the inlet to the valve. The second shall be installed between the Cv chamber and the pressure regulating chamber. The third shall be installed at the outlet of the valve. Should the ports not be provided as part of the valve body than they shall be installed in a spool piece and attached to the body.
9. The differential pressure between the first and the third port shall be used in commissioning to verify that the minimum differential pressure (typically 5 psid) required for pressure independent operation is available.
10. The differential pressure between the first and second ports shall be used to verify proper valve operation and flow regulation. It shall be possible to verify the flow rate through the control valve using the valve stem position and the differential pressure measurement between the first and second port in the valve. If these valve features are not available, a flow meter shall be installed to verify actual flow rate in operation through the valve.
11. All valves shall be warranted by the manufacturer for no less than 5 years from the date of purchase.

F. Electronic/Pneumatic Transducers
1. Electronic to Pneumatic transducers shall provide:
   a. Output: 3-15 PSIG.
   b. Input: 4-20 mA or 0-10 VDC.
   c. Manual output adjustment.
   d. Pressure gauge.
   e. External replaceable supply air filter.
   f. Acceptable manufacturers: Johnson Controls, Mamac

3.08 Miscellaneous Devices

A. Local Control Panels
1. All control panels shall be factory constructed, incorporating the CCMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices-such as relays, transducers, and so forth-that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies
1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

3.09 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to Building Management System specified in Section _____ .

B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 15928.

E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

3.10 OPERATOR INTERFACE

A. PC Based Work Station:

B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.

C. Hardware:

3.11 CONTROLLERS

A. BUILDING CONTROLLERS
1. General:
a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.

b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
c. Share data between networked controllers.
d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
e. Utilize real-time clock for scheduling.
f. Continuously check processor status and memory circuits for abnormal operation.
g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
h. Communication with other network devices to be based on assigned protocol.

2. Communication:
   a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
   b. Perform routing when connected to a network of custom application and application specific controllers.
   c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
4. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. INPUT/OUTPUT INTERFACE
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
   a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
   b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
   a. Allow monitoring of On/Off signals from remote devices.
   b. Provide wetting current of 12 mA minimum, compatible with commonly available

control devices and protected against the effects of contact bounce and noise.
c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
   b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
   b. Outputs provided with three position (On/Off/Auto) override switches.
   c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
   c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
   a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
   b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
   c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
   a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
   b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

3.12 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.

9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
a. Dielectric strength of 1000 volts minimum.
b. Response time of 10 nanoseconds or less.
c. Transverse mode noise attenuation of 65 dB or greater.
d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

3.13 SYSTEM SOFTWARE

A. Operating System:
1. Concurrent, multi-tasking capability.
a. Common Software Applications Supported: Microsoft Excel.
b. Acceptable Operating Systems: _____.
2. System Graphics:
a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
b. Animation displayed by shifting image files based on object status.
c. Provide method for operator with password to perform the following:
1) Move between, change size, and change location of graphic displays.
2) Modify on-line.
3) Add, delete, or change dynamic objects consisting of:
(a) Analog and binary values.
(b) Dynamic text.
(c) Static text.
(d) Animation files.
3. Custom Graphics Generation Package:
a. Create, modify, and save graphic files and visio format graphics in PCX formats.
b. HTML graphics to support web browser compatible formats.
c. Capture or convert graphics from AutoCAD.
4. Standard HVAC Graphics Library:
a. HVAC Equipment:
b. Ancillary Equipment:

B. Workstation System Applications:
1. Automatic System Database Save and Restore Functions:
a. Current database copy of each Building Controller is automatically stored on hard disk.
b. Automatic update occurs upon change in any system panel.
c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
a. Save database from any system panel.
b. Clear a panel database.
c. Initiate a download of a specified database to any system panel.
3. Software provided allows system configuration and future changes or additions by

operators under proper password protection.

4. On-line Help:
   a. Context-sensitive system assists operator in operation and editing.
   b. Available for all applications.
   c. Relevant screen data provided for particular screen display.
   d. Additional help available via hypertext.
5. Security:
   a. Operator log-on requires user name and password to view, edit, add, or delete data.
   b. System security selectable for each operator.
   c. System supervisor sets passwords and security levels for all other operators.
   d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
   e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
   f. All system security data stored in encrypted format.
6. System Diagnostics:
   a. Operations Automatically Monitored:
      1) Workstations.
      2) Printers.
      3) Modems.
      4) Network connections.
      5) Building management panels.
      6) Controllers.
   b. Device failure is annunciated to the operator.
7. Alarm Processing:
   a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
   b. Configurable Objects:
      1) Alarm limits.
      2) Alarm limit differentials.
      3) States.
      4) Reactions for each object.
8. Alarm Messages:
   a. Descriptor: English language.
   b. Recognizable Features:
      1) Source.
      2) Location.
      3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
   a. Logging.
   b. Printing.
   c. Starting programs.
   d. Displaying messages.
   e. Dialing out to remote locations.
   f. Paging.
   g. Providing audible annunciation.
   h. Displaying specific system graphics.
10. Custom Trend Logs:
    a. Definable for any data object in the system including interval, start time, and stop time.

b. Trend Data:
    1) Sampled and stored on the building controller panel.
    2) Archivable on hard disk.
    3) Retrievable for use in reports, spreadsheets and standard database programs.
    4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
    5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

11. Alarm and Event Log:
    a. View all system alarms and change of states from any system location.
    b. Events listed chronologically.
    c. Operator with proper security acknowledges and clears alarms.
    d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
    a. Provide a method to view, edit if applicable, the status of any object and property in the system.
    b. Status Available by the Following Methods:
        1) Menu.
        2) Graphics.
        3) Custom Programs.
13. Reports and Logs:
    a. Reporting Package:
        1) Allows operator to select, modify, or create reports.
        2) Definable as to data content, format, interval, and date.
        3) Archivable to hard disk.
    b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
    c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
    d. Set to be printed on operator command or specific time(s).
14. Reports:
    a. Standard:
        1) Objects with current values.
        2) Current alarms not locked out.
        3) Disabled and overridden objects, points and SNVTs.
        4) Objects in manual or automatic alarm lockout.
        5) Objects in alarm lockout currently in alarm.
        6) Logs:
            (a) Alarm History.
            (b) System messages.
            (c) System events.
            (d) Trends.
    b. Custom:
        1) Daily.
        2) Weekly.
        3) Monthly.
        4) Annual.
        5) Time and date stamped.
        6) Title.
        7) Facility name.

c. Tenant Override:
1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
2) Annual report showing override usage on a monthly basis.
d. Electrical, Fuel, and Weather:
1) Electrical Meter(s):
(a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
(b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
2) Fuel Meter(s):
(a) Monthly showing daily natural gas consumption for each meter.
(b) Annual summary showing monthly consumption for each meter.
3) Weather:
(a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

C. Workstation Applications Editors:
1. Provide editing software for all system applications at the PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
a. Configuration.
b. Name.
c. Control parameters.
d. Set-points.
4. Scheduling:
a. Monthly calendar indicates schedules, holidays, and exceptions.
b. Allows several related objects to be scheduled and copied to other objects or dates.
c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
b. Programming Features:
1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
7) Support for floating-point arithmetic utilizing plus, minus, divide, times,

square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.

8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values cab be used in IF/THEN comparisons, calculations, programming statement logic, etc.
9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

3.14 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. System Security:
   1. User access secured via user passwords and user names.
   2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
   3. User Log On/Log Off attempts are recorded.
   4. Automatic Log Off occurs following the last keystroke after a user defined delay time.

C. Object or Object Group Scheduling:
   1. Weekly Schedules Based on Separate, Daily Schedules:
      a. Include start, stop, optimal stop, and night economizer.
      b. 10 events maximum per schedule.
      c. Start/stop times adjustable for each group object.

D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

E. Alarms:
   1. Binary object is set to alarm based on the operator specified state.
   2. Analog object to have high/low alarm limits.
   3. All alarming is capable of being automatically and manually disabled.
   4. Alarm Reporting:
      a. Operator determines action to be taken for alarm event.
      b. Alarms to be routed to appropriate workstation.
      c. Reporting Options:

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation in Section 15940.

H. PID Control Characteristics:
   1. Direct or reverse action.
   2. Anti-windup.
   3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
   4. User selectable controlled variable, set-point, and PED gains.

I. Staggered Start Application:

1. Prevents all controlled equipment from simultaneously restarting after power outage.
2. Order of equipment startup is user selectable.

J. Energy Calculations:
1. Accumulated instantaneous power or flow rates are converted to energy use data.
2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

K. Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
2. Allows minimum on-time and off-time to be selected.

L. On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
2. Provides operator with capability to assign high run-time alarm.

PART 3 EXECUTION

4.01 CCMS Specific Requirements

A. Graphic Displays
1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .

B. Actuation / Control Type
1. Primary Equipment
a. Controls shall be provided by equipment manufacturer as specified herein.
b. All damper and valve actuation shall be electric.
2. Air Handling Equipment
a. All air handers shall be controlled with a HVAC-DDC Controller
b. All damper and valve actuation shall be electric.
3. Terminal Equipment:
a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.

4.02 Installation Practices

A. CCMS Wiring
1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the CCMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this

section.

2. All CCMS wiring materials and installation methods shall comply with CCMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the CCMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the CCMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
   a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
   b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. CCMS Raceway
1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2”.
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

C. Penetrations
1. Provide fire stopping for all penetrations used by dedicated CCMS conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

D. CCMS Identification Standards
1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
   a. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

E. CCMS Panel Installation
1. The CCMS panels and cabinets shall be located as indicated at an elevation of not less

than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

2. The CCMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

F. Input Devices
1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the CCMS in accessible local control panels wherever possible.

G. HVAC Input Devices - Genera1
1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the CCMS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
   a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
   b. Sensors shall be installed with a rain proof, perforated cover.
6. Duct Temperature Sensors:
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
   b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
   c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
   d. The sensor shall be mounted to suitable supports using factory approved element holders.
7. Space Sensors:
   a. Shall be mounted per ADA requirements.
   b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
8. Low Temperature Limit Switches:
   a. Install on the discharge side of the first water or steam coil in the air stream.
   b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
   c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
9. Air Differential Pressure Status Switches:
   a. Install with static pressure tips, tubing, fittings, and air filter.

H. HVAC Output Devices
1. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the

entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

4.03 Training

A. The CCMS contractor shall provide the following training services:
   1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the CCMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

4.04 SEQUENCE OF OPERATION

A. GENERAL
   1. Power - Fail Restart:
      a. In the event of a power failure the FMS computer will analyze the status of all controlled equipment and compare it with normal occupancy scheduling. The equipment will then be started or stopped as necessary to prevent all equipment from coming on at the same time.
   2. FMS Monitoring:
      a. Refer to the attached Input/Output schedule for a listing of all monitoring and override points and for additional software features.
   3. Optimal Start:
      a. All scheduled HVAC equipment will be started based on an optimal start feature that will calculate the approximate time the unit will have to be started prior to scheduled start time in order for the space temperature to be at setpoint at schedules occupancy.
      b. Once space temperatures reach occupied setpoint O.A. dampers will be modulated open. Whenever the unit goes in the unoccupied mode the O.A. damper will be closed.
   4. Night High Limit and Night Low Limit:
      a. During unoccupied periods scheduled HVAC equipment will be energized whenever space temperature drops below a night low limit setpoint of 65 degrees(adjustable) or a night high limit of 85 degrees(adj).
   5. Controllers:
      a. Each AHU, CH and RTU shall be provided with an individual standalone DDC controller for controlling temperature, humidity and pressure as indicated in sequence of operation.
   6. Smoke dampers and smoke detectors:

a. Units 15,000 CFM or greater will be provided with both supply and return air smoke detectors (provided and wired by div 16 - installed by div 15) as well as both supply and return air smoke dampers. When the unit is to be started the supply and return air smoke dampers will be driven open. The supply fan will be started once the AHU supply and return air dampers reach 100% open as indicated by damper end switches. When the unit is stopped the smoke dampers will not be allowed to close until the supply fan has been allowed to coast down to a complete stop.

B. EQUIPMENT
1. RTU-1
a. Start/Stop:
1) The unit will be capable of being started and stopped based on a time of day schedule from the FMS.
2) When the unit goes into the occupied mode and is to be started, the outdoor air damper will be driven to its minimum CFM position, as sensed by outdoor air CFM measuring device. The outdoor air damper will remain closed during night low limit and morning warmup. Outdoor air damper will not be allowed to be closed past minimum CFM position when the unit is in the occupied mode.
b. Safeties:
1) Duct smoke detector will shut the supply fan off whenever products of combustion are sensed. The smoke detector will be provided and wired back to fire alarm system by division 16 and interlocked with the fan starter under division 15.
2) A temperature low limit switch will shutdown the fan whenever mixed air temperatures drop below 38 degrees .
3) A static pressure high limit switch will shut down the air handler whenever static pressure in the discharge of the air handler exceeds 5" W.G.
c. Temperature Control:
1) Discharge air temperature shall be controlled at 53 degrees F. (adjustable) by modulating the CHW valve as necessary to maintain setpoint.
d. Pressure Control:
1) The supply variable speed drive shall be modulated to maintain supply duct static pressure setpoint.
2) When the supply fan starts the VSD shall be in the "unloaded" position. VSD will load fan over an adjustable time period.
2. DUCT MOUNTED HUMIDIFIER
a. Modulate humidifier control valve as required to duct humidity setpoint and duct hi-limit setpoint.
b. See Section 15755 for humidity setpoints.
3. VAV/CAV Boxes
a. Each VAV box shall be controlled by a unit mounted DDC controller. On a call for cooling the air valve will be modulated as required to maintain room temperature setpoint. As space temperature drops below setpoint the air valve will be modulated to minimum position. On a continued drop in space temperature, the hot water control valve shall open.
4. ELECTRONIC AIRFLOW CONTROL VALVES
a. The laboratory control system shall control supply and auxiliary exhaust airflow

devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces.

b. The pressurization control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. The offset shall be adjustable.
c. As space temperature fall below setpoint the hot water valve shall open.

5. LEF-1 & 2
   a. The unit will be capable of being started and stopped based on a time of day schedule from the FMS.
   b. Modulate make-up air damper on LEF to maintain constant discharge velocity on fan.
   c. The variable speed drive shall be modulated to maintain supply duct static pressure setpoint.
6. EF-1:
   a. Exhaust fans shall operate continously.

END OF SECTION

SECTION 16711

STRUCTURED TELECOMMUNICATIONS CABLING AND ENCLOSURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cabling and pathways inside building(s).

B. Distribution frames, cross-connection equipment, enclosures, and outlets.

C. Grounding and bonding the telecommunications distribution system.

1.02 SCOPE

A. The contractor shall provide all equipment specified in this section. The installation and testing of all devices and cable sections shall be performed by the contractor. The work includes all materials, all labor, and all information required to provide the system specified. It shall include but not necessarily be limited to all cables, jacks, punch blocks, patch panels, supports and equipment as shown on the drawings and as herein specified to provide complete communications system cabling.

1.03 RELATED REQUIREMENTS

A. Section 07840 - Firestopping.

B. Section 16450 - Grounding and Bonding: Electrical system grounding and bonding.

C. Section 16111 - Conduit.

1.04 REFERENCE STANDARDS

A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.

B. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.

C. ICEA S-90-661 - Category 6 Individually Unshielded Twisted Pair Indoor Cable for Use in General Purpose and LAN Communications Wiring Systems; Insulated Cable Engineers Association; 2002.

D. NFPA 70 - National Electrical Code; 2008.

E. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (R 2002).

F. TIA-526-7 - OFSTP-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; 2002.

G. TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev B, 2001; Addenda 1-7.

H. TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Rev B, 2001; Addenda 1-11.

I. TIA/EIA-568-B.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables; Rev B, 2000; Addendum 1.

J. TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces; Rev B, 2004.

K. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev A, 2002.

L. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.

M. UL 444 - Communications Cables; 2002.

N. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; 2001.

O. UL 514C - Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; 1996.

P. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords; 2001.

Q. UL 1863 - Standard for Communications-Circuit Accessories; 2004.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Storage and handling requirements and recommendations.
2. Installation methods.

C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).

D. Provide a floor plan layout identifying each outlet with respect to the label requirements specified in Paragraph 3.03 herein.

E. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.

F. Field Test Reports: Provide USC University Technology Services, Infrastructure Planner with a copy of all test results.

G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. Record actual locations of outlet boxes and distribution frames.
2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
3. Identify distribution frames and equipment rooms by room number on contract drawings.

H. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.

B. The complete system (excluding raceway, fittings, boxes, grounding and power service to this system) shall be installed by a Contractor who specializes in the installation of such systems and meets the minimum requirements as stated in Section C below.

C. Installer Qualifications: A company having at least 3 years experience in the installation and

testing of the type of system specified, and:

1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
2. Supervisors and installers factory certified by manufacturers of products to be installed.
3. Can show evidence that they maintain a fully equipped service organization that has been in operation for at least 2 years and can provide testing, service, maintenance and spare parts for the system.
4. Employing BICSI Registered Cabling Installation Technicians (RCIT) for all work.
5. Provide information to demonstrate sound financial condition of the company and that the company is adequately bonded and insured.
6. Employing experienced technicians for all work; show at least 3 years experience in the installation of the type of system specified, with evidence from at least 3 projects of similar size and scope that have been in use for at least 18 months; submit project name, address, and written certification by user.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Keep stored products clean and dry.

1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cabling and Equipment:
   1. Equipment material and devices:
      a. Hubbell: www.hubbell-premise.com
   2. Cable only:
      a. Commscope: www.commscope.com
      b. Belden: www.belden.com

2.02 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA/EIA-568 and TIA/EIA-569, latest editions.
   2. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
   3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F (0 to 60 degrees C) at relative humidity of 0 to 95 percent, noncondensing.
   4. In this project, the term plenum is defined as return air spaces and all other spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

B. Capacity:
   1. Horizontal Cabling: Copper.
      a. Offices and Work Areas: See Plans
      b. General: Unless otherwise noted on the plans provide a minmum of one Category 6 cables (Blue) for each outlet. regardless or type, shown on the plans.
      c. Offices and Work Areas: See plans.

d. Labs and Classrooms: See Plans.
e. Wireless access points:
   1) Unless otherwise noted on the plans install one Category 6 cable (Green) to each wireless access point (AP) in the building.
   2) Install wireless access point devices where shown on the plans with antennas.
f. Television (TV) outlets: Unless othewise noted on the plans Install one RG6 Quad Shield coaxial cable and two Category 6 cables.

2. Provide additional outlets and cables where indicated on drawings.

2.03 PATHWAYS

A. Conduit: As specified in Section 16111; provide pull cords in all conduit.

B. Cable Ties: Use velcro style cable ties. Cable runs are to be bundled loosely to minimize cross-talk. All cables must be supported of the ceiling grid.

C. 1. Bat wing/bridle ring supports can be attaced to ceiling grid wires that are spaced 4 to 5 feet apart and not filled beyond capacity.

D. 2. Do not attach cable to pipes.

E. Lab system raceways.
1. Install individual cables in lab system raceways to each individual work station or seated position in classroom and install a jack or jacks at each location.

2.04 COPPER CABLE AND TERMINATIONS

A. Copper Horizontal Cable: TIA/EIA-568 Category 6 solid conductor unshielded twisted pair (UTP), 23 AWG, 100 ohm; 4 individually twisted pairs; pairs separated within jacket with an isolator;covered with green jacket (Except where otherwise noted) and complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444.
1. In locations other than in plenums, provide NFPA 70 type CMG general purpose, CMR riser-rated, or type CMP plenum-rated cable.
2. In plenums, provide NFPA 70 type CMP plenum-rated cable.

B. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

C. Jacks and Connectors: RJ-45, non-keyed, terminated with 110-style insulation displacement connectors; high impact thermoplastic housing; complying with same standard as specified horizontal cable and UL 1863.
1. Performance: 500 mating cycles.
2. Voice and Data Jacks: Hubbell, Green, HXJ6GN, Xceleraor, Category 6 jack terminate using T568-B pin-out configuration.
3. The data jacks shall be terminated in the the labs, lab raceways, and office areas. Voice and data connections in the office areas shall be terminated in Hubbell IFP1xOW, Office white faceplate. The "x" indicateds the number of ports 1 through 4 and 6.

2.05 CROSS-CONNECTION EQUIPMENT

A. Patch Panels for Copper Cabling: Sized to fit EIA standard 19 inch (482.6 mm) wide equipment racks; 0.09 inch (2.2 mm) thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface. Hubbell Category 6 type.
1. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
2. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.

3. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
4. Provide incoming cable strain relief and routing guides on back of panel.

B. Patch Cords:
1. Provide one patch cord for each pair of patch panel ports. Furnish Category 6 plenum rated cable (Black) in appropriate lengths.

2.06 ENCLOSURES

A. Outlet Boxes: For flush mounting in walls; depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
1. Size, Unless Otherwise Indicated: 4 inches (100 mm) square by 2-1/8 inches (54 mm) deep.
2. Single-gang plaster ring cover
3. Minimum 1-inch diameter conduit from outlet box, stubbed out above ceiling grid
4. Wall-Mounted Telephones: 4 inches (100 mm) high by 2 inches (50 mm) wide by 2-1/8 inches (54 mm) deep.
5. Faceplates: High impact thermoplastic, complying with system design standards and UL 514C.
6. Labels: Comply with TIA/EIA-606 using encoded identifiers; label each jack on the face plate as to its function with a unique numerical identifier.

B. Firestop: Sleeve and Firestop all wall and floor or ceiling penetrations. Fire stop shall be EZ Path Fire Rated Pathway at fire walls where cables will pass through. Reference link www.stifirestop.com /ezpath.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA/EIA-568, TIA/EIA-569, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

3.02 PATHWAYS

A. Install with the following minimum clearances:
1. 48 inches (1220 mm) from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
2. 12 inches (300 mm) from power conduits and cables and panelboards.
3. 5 inches (125 mm) from fluorescent and high frequency lighting fixtures.
4. 6 inches (150 mm) from flues, hot water pipes, and steam pipes.

B. Conduit: Install a grommet at the end of the conduit to protect the cable from damage.

C. No more than two 90-degree bends between pull points in conduit.
1. Leave pull cords in place where cables are not initially installed.
2. Minimum of 6 times the conduit diameter for conduit up to 2 inch trade size.
3. Minimum of 10 times the conduit diameter for larger diameters
4. Do not use 90-degree condulets because the over bend the cable.
5. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.

c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
d. Under floor slabs, locate conduit at 12 inches (300 mm), minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.

D. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.

E. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 07840.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:
1. Install transmission media without damaging conductors, shield, or jacket.
2. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
3. Do not over-cinch or crush cables.
4. Do not exceed manufacturer's recommended cable pull tension.
5. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
6. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway. Install cable simultaneously where more than one cable is to be installed in a raceway.

B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches (3000 mm).
a. Do not make a circular coil with cables.
2. At Outlets - Copper: 10 inches (254 mm).
3. a. Install slack above ceiling not in outlet box.
4. b. Do not tie wrap the slack above the ceiling.

C. Copper Cabling:
1. Category 6: Maintain cable geometry; do not untwist more than 1/2 inch (12 mm) from point of termination.
2. For 4-pair cables in conduit, do not exceed 25 pounds (110 N) pull tension.
3. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.
4. Install exposed cable, parallel, and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
5. No splices are allowed in the cables unless explicitly shown on the drawings.
6. Use splices and tap connectors that are compatible with media material.
7. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published instructions or torque tightening values.
8. All CAT6 cable shall be within the 300 ft installation standard.

D. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
1. Cables: Install color coded labels on both ends. Identify each cable with respect to each jack, punch panel, terminal block, and other connection point. The cable connections shall be identified on one end by labeling it with respect to the room number, the specific outlet, and the specific jack to which it is connected. It shall be labeled on the other end with respect to the punch panel, terminal block, or other connection to which it is terminated. Using the color code of each individual wire or fiber within a multi-conductor or multifiber cable, the specific terminal number to which each is connected shall be identified.
2. Outlets: Label each jack on its face plate as to its type and function, with a unique

numerical identifier. Hand written labels are not acceptable.

3.04 FIELD QUALITY CONTROL

A. Comply with inspection and testing requirements of specified installation standards.

B. Visual Inspection:
   1. Inspect cable jackets for certification markings.
   2. Inspect cable terminations for color coded labels of proper type.
   3. Inspect outlet plates and patch panels for complete labels.

C. Testing - The complete cabling system shall be tested to Category 6 (see EIA/TIA TSB 67) standards and as follows:
   1. Test operation of shorting bars in connection blocks.
   2. Category 6 Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay for all copper cables. Record results for each cable and turn over document to owner.

3.05 WARRANTY

A. Provide a written twenty-five year warranty for all equipment provided under this section. Warranty period shall begin on the date of official final acceptance of the system by the USC Planner. The USC Planner shall complete the "Date of Final Acceptance" on the warranty form and forward a copy to the contractor.

B. Submit "true" as-built drawings for the complete system. The USC Planner will check the system to ensure accuracy of these drawings.

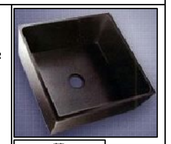
C. Provide completed test forms and a letter to the USC Planner certifying that every cable has been tested and was found to function properly.

D. The system will not be accepted until Paragraphs A, B and C above have been completed and received by the USC Planner.

END OF SECTION

PLUMBING FIXTURE SCHEDULE

SK-1; LABORATORY SINK UNDERMOUNT CHEMICAL RESISTANT FAUCET (ADA)
1. TYPE
   A. UNDERMOUNT EPOXY RESIN 24"x16"x12"
2. FAUCETS
   A. CHICAGO FAUCET 786-GN8BVE7CP TWO HANDLE MIXING LAB FAUCET, VACUUM BREAKER, AERATOR
   B. CHICAGO FAUCET 969-217LHCTF SINGLE HANDLE, VACUUM BREAKER SERRATED TIP. (DW)
3. CONNECTION
   A. 1/2" CW & HW, 1/2" DW 1-1/2" ACID WASTE
4. MOUNTING
   A. COUNTER UNDERMOUNT AS SHOWN ON ARCH DRAWINGS.
5. SUPPLIES
   A. MCGUIRE 165LK WITH LOOSE KEY STOPS. AERATOR TIP
   B. WRIST BLADE HANDLES
6. DRAIN
   A. CHARLOTTE PIPE AW-1A ACID WASTE.
7. TRAP
   A. ACID WASTE.



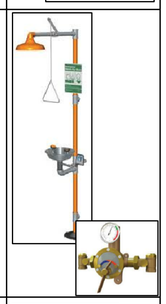
SK-2; UTILITY SINK / ADA (TWO COMPARTMENT UNDERMOUNT COUNTER)
1. TYPE
   A. ELKAY CR3322 20 GA. STAINLESS STEEL. (3 HOLES)
2. SIZE
   A. 30-3/4"x18-1/2"x 5-1/2" OVERALL. 13-1/2"x16"x5-1/2" INSIDE BOWL
3. CONNECTION
   A. 1-1/2" WASTE, 1/2" CW, 1/2" HW.
4. MOUNTING
   A. COUNTER AS SHOWN ON ARCH DRAWINGS. MIN CABINET SIZE 39"
5. FITTING
   A. DELTA 4380-SS-DST GOOSENECK SPOUT WITH SINGLE HANDLE FAUCET WITH HOSE SPRAY.
6. SUPPLIES
   A. MCGUIRE 165LK WITH LOOSE KEY STOPS.
7. DRAIN
   A. TWO (2) MCGUIRE 152 3-1/2" BASKET STRAINER AND TWO 1-1/2" OFFSET TAILPIECE.
8. TRAP
   A. TWO (2) MCGUIRE 8912 1-1/2" P-TRAP WITH C.O. PLUG.


P-1; LABORATORY DECK MOUNT DOUBLE GAS VALVE
1. TYPE
   A. WATERSAVER L4200-13GSMSA. 180° DOUBLE
   D. FORGED BRASS VALVE BODY
   E. CHROME PLATED BRASS BALL WITH MOLDED TEFLON SEALS
   F. CHROME FINISH
2. CONNECTION
   A. 3/8" IPS
3. MOUNTING
   A. DECK MOUNTED, SEE ARCH DWGS. FOR CONTINUATION

1 **P-2;** LABORATORY PANEL MOUNT DOUBLE GAS VALVE.
1. TYPE
   A. WATERSAVER L4200-141WS.
   D. FORGED BRASS VALVE BODY
   E. CHROME PLATED BRASS BALL WITH MOLDED TEFLON SEALS
   F. CHROME FINISH
2. CONNECTION
   A. 3/8" IPS
3. MOUNTING
   A. WALL MOUNTED, SEE ARCH DWGS FOR CONTINUATION

EEW-1, EMV-1; EMERGENCY EYE/FACE WASH
1. TYPE
   A. WATERSAVER EW806 DECK MOUNTED SWIVEL EYEWASH WITH DUAL SPRAY-HEADS.
2. CONNECTION
   A. 1/2" TEMPERED WATER
3. HEADS
   A. ABS PLASTIC PROTECTIVE COVERED EYEWASH HEADS.
4. VALVE
   A. CHROME PLATED BRASS STAY-OPEN BALL VALVE WITH EXTENDED HANDLE
5. SIGN
   A. ALUMINUM DESIGNED FOR WALL MOUNTING LABELED "EMERGENCY EYEWASH FOUNTAIN".
6. VACUUM BREAKER
   A. WATERSAVER IN-LINE VACUUM BREAKER BETWEEN VALVE AND SPRAY HEADS
7. MIXING VALVE; EMV-1
   A. WATERSAVER AP3602 EMERGENCY THERMOSTATIC MIXING VALVE
8. VALVE BOX
   A. SURFACE MOUNTED STAINLESS STEEL


EW-2, EMV-2; EMERGENCY SHOWER AND EYEWASH
1. TYPE
   A. WATERSAVER SS950 SAFETY STATION WITH EYE/FACE WASH
2. CONNECTION
   A. 1-1/4" TEPID WATER
3. SHOWER HEAD AND BOWL
   A. 10" DIAMETER ABS PLASTIC SHOWER HEAD
   B. 11.5" DIAMETER STAINLESS STEEL EYE/FACE BOWL
4. SHOWER VALVE
   A. CHROME PLATED BRASS 1" IPS STAY-OPEN BALL VALVE WITH STAINLESS STEEL PULL ROD AND TRIANGULAR HANDLE
5. EYEWASH HEADS
   A. CHROME PLATED BRASS YOKE WITH TWIN, AERATED, EYEWASH HEADS
6. VALVE
   A. CHROME PLATED STAY-OPEN BALL VALVE WITH PUSH FLAG HANDLE
7. SIGN
   A. UNIVERSAL IDENTIFICATION AND INSPECTION TAG.
8. MIXING VALVE EMV-2
   A. WATERSAVER AP3802 THERMOSTATIC MIXING VALVE
   B. LOCATE ABOVE CEILING



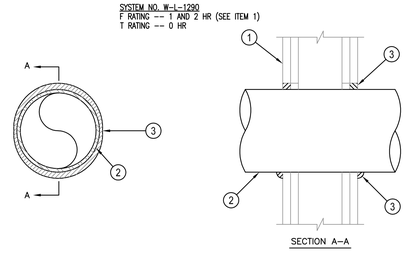
WB-1; REFRIGERATOR WATER BOX WITH CW FITTINGS.
SEE ARCHITECTURAL ELEVATIONS FOR MOUNTING HEIGHT BELOW COUNTER TOP.
1. TYPE
   A. SIMILAR TO GUY GRAY MODEL AB9201
2. CONNECTION
   A. 1/2" CW CONNECTION FTGS. BY PC.
   (PC SHALL CONNECT CW LINES TO REFRIGERATOR AS PER MANUFACTURER'S RECOMMENDATIONS.)
3. CW SUPPLY FITTING
   A. 1/4" OD COMPRESSION ANGLE VALVE FOR OUTLET FURNISHED AND INSTALLED IN BOX BY PC (PC TO PROVIDE A TEE FITTING TO CONNECT REFRIGERATOR & COFFEE MAKER LINES TO ONE WB-1.)
4. INSTALLATION
   A. SEE NOTES ON PLAN.

FD-1; FLOOR DRAIN (MED TRAFFIC ROUND TOP)
1. TYPE
   A. CHARLOTTE PIPE AW-160MS
2. TOP
   A. 6" STAINLESS STEEL.
3. CONNECTION
   A. 3" ACID WASTE
4. TRAP
   A. ACID WASTE DEEP SEAL.

PLUMBING LEGEND

SYMBOL	DESCRIPTION		SYMBOL	DESCRIPTION
	COLD WATER LINE – (CW)			UNION
	HOT WATER LINE – (HW)			STRAINER
	HOT WATER RECIRCULATING LINE – (HWR)			WALL BOX
AW	ACID WASTE LINE (AW)		FCO	FLOOR CLEANOUT
AV	ACID WASTE VENT LINE (AV)		CO	INLINE CLEANOUT
G	NATURAL GAS LINE (G)		WCO	WALL CLEANOUT
CA	COMPRESSED AIR LINE (CA)		FD	FLOOR DRAIN
CO2	CARBON DIOXIDE LINE (CA)			BALL VALVE
DW	DEIONIZED WATER LINE (DW)			GAS COCK
V	VACUUM LINE OUTLET			PRV
CA	COMPRESSED AIR OUTLET			PUMP
CO2	COMPRESSED CARBON DIOXIDE OUTLET			BALANCING VALVE
NG	NATURAL GAS OUTLET			CHECK VALVE
	END CAP			DUAL CHECK VALVE
	PIPE DOWN OR DROP (DN OR DROP)			DOUBLE CHECK VALVE
	PIPE UP			CHECK VALVE
	PIPE BREAK OR CONTINUATION			POINT OF CONNECTION – NEW TO EXISTING
	P-TRAP			AREA TO BE DEMOLISHED

SYSTEM NO. W-L-1290
F RATING — 1 AND 2 HR (SEE ITEM 1)
T RATING — 0 HR



SECTION A–A

1. WALL ASSEMBLY — THE 1 OR 2 HR FIRE RATED GYPSUM BOARD/STUD WALL ASSEMBLY SHALL INCLUDE THE FOLLOWING CONSTRUCTION FEATURES.
   A. STUDS — REFER TO ARCH DETAILS FOR TYPE & CONSTRUCTION.
   B. GYPSUM BOARD*– — REFER TO ARCH DETAILS FOR TYPE & CONSTRUCTION. MAX DIAM OF OPENING IS 5 IN. (THE HOURLY F & T RATINGS OF THE FIRESTOP SYSTEM ARE EQUAL TO THE HOURLY FIRE RATING OF THE WALL ASSEMBLY IN WHICH IT IS INSTALLED.)
2. THROUGH PENETRANT — ONE METALLIC PIPE OR TUBING INSTALLED CONCENTRICALLY OR ECCENTRICALLY WITHIN THE FIRESTOP SYSTEM. PIPE, OR TUBING MAY BE INSTALLED AT AN ANGLE NOT GREATER THAN 45 DEGREES FROM PERPENDICULAR. PIPE OR TUBE TO BE RIGIDLY SUPPORTED ON BOTH SIDES OF WALL ASSEMBLY. THE ANNULAR SPACE BETWEEN THE PIPE OR TUBE & PERIPHERY OF THE OPENING SHALL BE MIN 0 IN (POINT CONTACT) TO MAX 1/2 IN. THE FOLLOWING TYPES & SIZES OF METALLIC PIPES MAY BE USED:
   A. IRON PIPE — NOM 4 IN. DIAM (OR SMALLER) CAST OR DUCTILE IRON PIPE.
   B. COPPER PIPE — SHALL FOLLOW WL-1243 SYSTEM
3. FILL, VOID OR CAVITY MATERIAL*–SEALANT — MIN 5/8 IN. THICKNESS OF FILL MATERIAL APPLIED WITHIN THE ANNULUS, FLUSH WITH BOTH SURFACES OF WALL. AT THE POINT CONTACT LOCATION BETWEEN PIPE & WALL, A MIN ½ IN DIAM BEAD OF FILL MATERIAL SHALL BE APPLIED AT THE PIPE/WALL INTERFACE.

*BEARING THE UL CLASSIFICATION MARK

1 FIRE STOPPING DETAIL
NTS

PIPE IDENTIFICATION SCHEDULE

SERVICE TYPE	DECAL IDENTIFICATION	TAPE COLOR
COLD WATER SERVICE	COLD WATER SUPPLY	GREEN
HOT WATER	DOMESTIC HOT WATER	YELLOW
VACUUM	VACUUM	WHITE
NATURAL GAS	GAS	GREEN
COMPRESSED AIR	COMP AIR	YELLOW
DE-IONIZED WATER	DI WATER	GREEN

1. PIPE SIZES 1-1/4" TO 6", USE 2-1/4" LETTERING.
2. PIPE SIZES 1" OR LESS, USE 1-1/4" LETTERING.

FIXTURE SIZE SCHEDULE

MARK	WASTE	VENT	CW	HW
WC	4"	2"	1"	---
L	2"	1 1/2"	1/2"	1/2"
U	2"	1 1/2"	3/4"	---
SK	2"	1 1/2"	1/2"	1/2"
MSB	3"	1 1/2"	3/4"	3/4"
SH	2"	1 1/2"	1/2"	1/2"
EWC	2"	1 1/2"	1/2"	---

NOTE: USE THESE SIZES FOR FIXTURE CONNECTIONS UNLESS OTHERWISE NOTED

ABBREVIATIONS *

ABV	Above	NC	Normally Closed
AD	Access Door	NIC	Not in Contract
AFF	Above Finished Floor	NO	Normally Open
BFP	Backflow Preventer	NPT	National Pipe Thread
CI	Cast Iron	NTS	Not To Scale
COL	Column Line	OFST	Over Flow Storm Drain
CONN	Connection	OX	Oxygen
CW	Cold Water	PC	Plumbing Contractor
DI	Dionized Water	P–#	Pump – No.
DN	Down	PRV	Pressure Reducing Valve
EC	Electrical Contractor	PSI	Pounds Per Square Inch
ELEV	Elevation	RD	Roof Drain
ET	Expansion Tank	SA	Shock Absorber
EWC–#	Electric Water Cooler	SH–#	Shower
FD	Floor Drain	SK–#	Sink
FL	Floor	SS	Stainless Steel
FT	Feet	ST	Storm Drain
GC	General Contractor	STD	Standard
GPH	Gallons Per Hour	TEMP	Temperature
GPM	Gallons Per Minute	TOS	Top of Steel
HW	Hot Water	TYP	Typical
HWR	Hot Water Return	U–#	Urinal
IE	Invert Elevation	VAC	Vacuum
L–#	Lavatory	VB	Vacuum Breaker
MA	Medical Air	V	Sanitary Vent
MAX	Maximum	VTR	Vent Thru Roof
MC	Mechanical Contractor	W	Sanitary Waste
MIN	Minimum	WB–#	Wall Box
MPT	Male Pipe Thread	WC–#	Water Closet
MSB–#	Mop Sink Basin	WTS	Water Tight Sleeve
N/A	Not Applicable		

* Not All Abbreviations Used

PLUMBING GENERAL NOTES

1. VERIFY EXACT LOCATION OF ALL PLUMBING FIXTURES IN OR ATTACHED TO CASEWORK WITH THE ARCHITECT AND THE MILLWORK SHOP DRAWINGS. COORDINATE PRIOR TO INSTALLATION.
2. CONFIRM OR VERIFY EXACT LOCATION AND ACTUAL INVERT OF ACID WASTE LINES PRIOR TO INSTALLATION.
3. DUE TO THE LARGE QUANTITY OF PIPING, DUCTWORK, CONDUIT, ETC. ABOVE THE CEILING COORDINATION WITH OTHER DISCIPLINES IS MANDATORY.
4. LOCATE SHUT-OFF VALVE ABOVE CEILING AND IN LOCATIONS ACCESSIBLE FOR SERVICE. LOCATION SHALL COMPLY WITH THE REQUIREMENTS OF ALL CODES REFERENCED HEREIN.
5. ALL SANITARY/ACID DRAINAGE PIPING 3" AND LARGER SHALL SLOPE 1/8" PER FOOT UNLESS NOTED OTHERWISE. ALL SANITARY/ACID DRAINAGE PIPING 2" AND SMALLER SHALL SLOPE 1/4" PER FOOT UNLESS NOTED OTHERWISE.
6. CONTRACTOR SHALL REFERENCE DIVISION 15 OF THE SPECIFICATIONS AND EQUIPMENT SCHEDULE ON DRAWING P0.0 FOR PLUMBING FIXTURES, EQUIPMENT, MATERIALS, PIPING, INSULATION, HANGERS, AND SUPPORTS.
7. REFERENCE PLUMBING FIXTURE CONNECTION SCHEDULE ON DRAWING P0.0 FOR LINE SIZES NOT SHOWN TO FIXTURES/EQUIPMENT.
8. ALL FLOOR DRAINS SHALL BE INSTALLED PLUMB AND LEVEL WITH FINISHED FLOOR ELEVATION FOR SLAB INSTALLATION.
9. CONTRACTOR SHALL PROVIDE HANGERS AND SUPPORTS FOR SEISMIC RESTRAINT PER THE I2007 INTERNATIONAL BUILDING CODE.
10. ALL DRAINAGE PIPING AND PRESSURE SYSTEM PIPING SHALL BE RUN AS HIGH AS POSSIBLE TO BOTTOM OF STRUCTURE, UNLESS NOTED OTHERWISE. COORDINATE PIPE ROUTING WITH ALL OTHER TRADES.
11. THE FOLLOWING PLUMBING SYSTEMS SHALL BE INSULATED: COLD WATER, HOT WATER, HOT WATER RECIRCULATION, P-TRAPS AND HORIZONTAL PIPING RECEIVING CONDENSATE ABOVE CEILINGS, HORIZONTAL ROOF DRAIN LEADERS (REFERENCE DIVISION 15 OF THE SPECIFICATIONS).
12. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THAT ITEMS TO BE FURNISHED FIT THE SPACE AVAILABLE.
13. ALL WALL HUNG FIXTURES SHALL BE SEALED BETWEEN WALL AND FIXTURES WITH WHITE SILICONE CAULKING.
14. ALL COUNTER MOUNTED FIXTURE RIMS SHALL BE SEALED WITH SILICONE CAULKING.
15. LOCATE FLOOR CLEANOUTS PAST LIMITS OF THE CASEWORK.
16. CONTRACTOR SHALL MAKE PROVISIONS FOR EXPANSION LOOPS WHERE NECESSARY WHETHER OR NOT SHOWN ON DRAWINGS.
17. OFFSET PLUMBING VENTS, WATER PIPING AS NECESSARY TO AVOID CONFLICTS WITH DUCTWORK. SEE HVAC PLANS.
18. IT IS THE INTENT AND MEANING OF THE DRAWINGS TO PROVIDE COMPLETE AND OPERABLE PLUMBING AND DRAINAGE SYSTEMS.
19. CONTRACTOR SHALL BE BOUND BY THE REQUIREMENTS OF THE UNDERGROUND UTILITIES DAMAGE PREVENTION ACT, STATUTE 58-35-10.
20. ALL PLUMBING LINE SIZE REDUCTIONS SHALL BE MADE WITH REDUCERS AND/OR REDUCING FITTINGS.
21. PLUMBING CONTRACTOR SHALL TEST EACH REDUCED PRESSURE BACKFLOW PREVENTER AND DOUBLE CHECK VALVE INSTALLED USING A CERTIFIED TESTER IN ACCORDANCE WITH SOUTH CAROLINA PRIMARY DRINKING WATER REGULATIONS.
22. ALL GAS PIPING IN PARTITION WALLS SHALL BE ANNEALED COPPER WITH BRAZED JOINTS. A STEEL STRIKER BARRIER NOT LESS THAN 0.0508 INCH THICK SHALL BE INSTALLED BETWEEN THE PIPING AND THE FINISHED WALL EXTENDING AT LEAST 4 INCHES BEYOND CONCEALED PENETRATIONS OF PLATES, FIRE STOPS, WALL STUDS, ETC... GAS PIPING SHALL NOT BE INSTALLED IN CMU OR SOLID WALLS.
23. PLUMBING CONTRACTOR TO MAKE FINAL CONNECTIONS ON ALL LAB FIXTURES.
24. PROVIDE WATTS #7C BACKFLOW PREVENTER AND DOWN STREAM OF DUAL OUTLET SHUT OFF VALVE FOR DISHWASHER.
25. THESE DRAWINGS ARE SCHEMATIC IN NATURE AND DO NOT SHOW EXACT LOCATIONS OF FIXTURES AND EQUIPMENT. ALL OFFSETS AND FITTINGS FOR COMPLETE INSTALLATION MAY NOT BE DEFINED ON THE DRAWINGS. CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING EXACT DIMENSIONS AT THE BUILDING AND ANY NECESSARY CHANGES MADE IN ACCORDANCE WITH STRUCTURAL CONDITIONS, EQUIPMENT TO BE INSTALLED AND COORDINATION WITH OTHER SYSTEMS. IF CONFLICTS CANNOT BE RESOLVED THEY SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ARCHITECT/ENGINEER.
26. CONTRACTOR SHALL COMPLY WITH THE FOLLOWING CODES AND STANDARDS INSOFAR AS THEY APPLY: NFPA 54, 2006 INTERNATIONAL BUILDING, GAS AND PLUMBING CODES.
27. CONTRACTOR SHALL SECURE ALL PERMITS, INSPECTIONS, LICENSES AND TESTS REQUIRED FOR THIS WORK AND PAY ALL FEES IN CONNECTION THEREWITH.
28. ALL MATERIALS SHALL BEAR THE MANUFACTURER'S NAME, TRADE NAME AND BE U.L. LABELED IF REQUIRED, UNLESS SPECIFICALLY INDICATED OTHERWISE. ALL EQUIPMENT AND MATERIALS SHALL BE INSTALLED IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE MANUFACTURER. ALL EQUIPMENT OF A SIMILAR TYPE SHALL BE OF THE SAME MANUFACTURER.H
29. CONTRACTOR SHALL LOCATE AND SIZE ALL OPENINGS REQUIRED FOR PLUMBING EQUIPMENT AND PIPING; AND PROVIDE THIS INFORMATION TO THE GENERAL CONTRACTOR IN TIME NOT TO DELAY BUILDING CONSTRUCTION.
30. CONTRACTOR SHALL PROVIDE AND LOCATE SLEEVES AND INSERTS REQUIRED BEFORE THE FLOOR AND WALLS ARE BUILT OR SHALL BE RESPONSIBLE FOR THE COST OF CUTTING AND PATCHING REQUIRED FOR PIPES WHERE SLEEVES AND INSERTS WERE NOT INSTALLED OR WHERE THEY WERE INCORRECTLY LOCATED.
31. THE ENGINEER SHALL NOT BE RESPONSIBLE FOR THE MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES OF CONSTRUCTION SELECTED BY THE CONTRACTOR OR OF THE SAFETY PRECAUTIONS AND PROGRAMS INCIDENTAL TO THE WORK OF THE CONTRACTOR. THE ENGINEER SHALL NOT BE RESPONSIBLE FOR THE FAILURE OF THE CONTRACTOR TO PERFORM THE CONSTRUCTION WORK IN ACCORDANCE WITH THE DRAWINGS.

GMK ASSOCIATES, INC.
Design/Planning/Construction
1201 Main Street, Suite 2100
Columbia, S.C. 29201
tel. 803-256-0000
fax 803-255-7243

consultants

owner

UNIVERSITY OF SOUTH CAROLINA

project name
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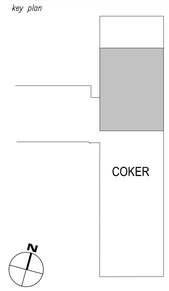
State project number
H27- 6101
project number
12023.01

seals/signature

issued for
CONSTRUCTION
date
APRIL 23, 2013

number	item	date
1	ADDENDUM #2	05-23-2013

key plan



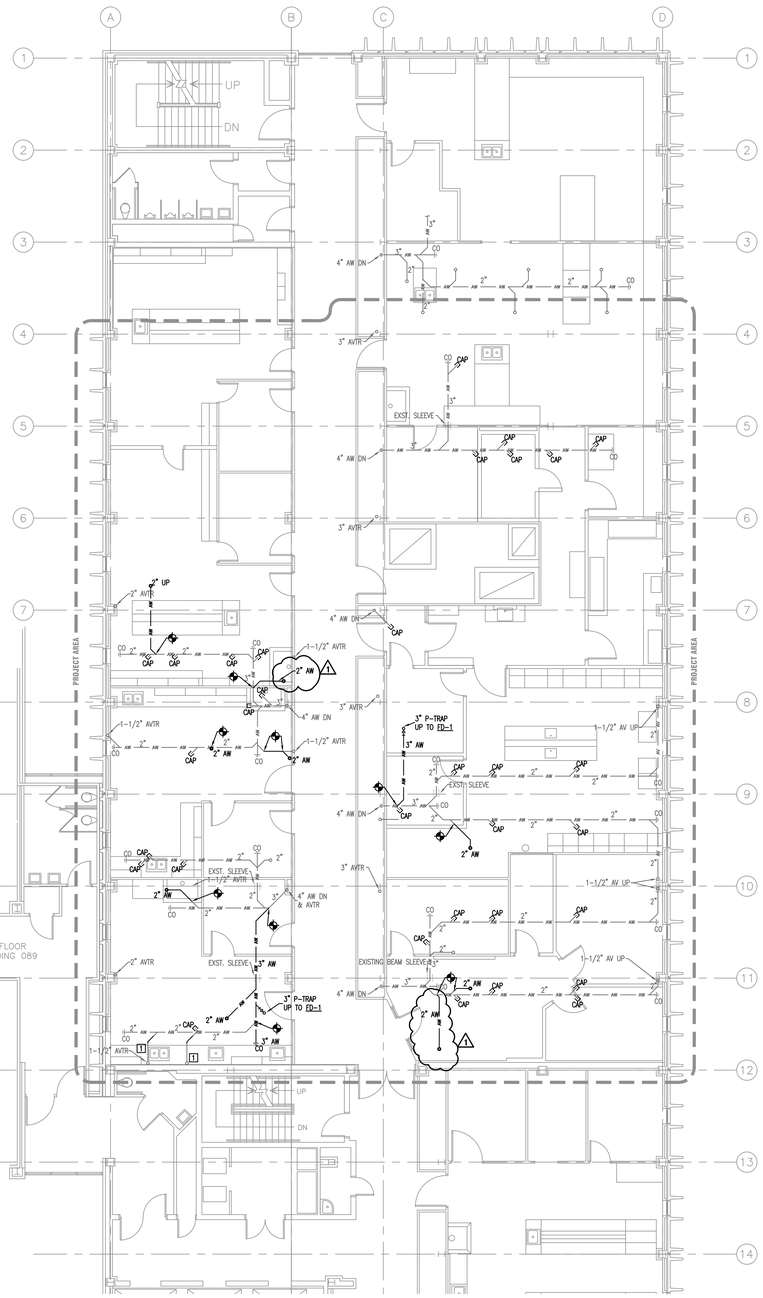
sheet title
PLUMBING NOTES, ABBREVIATIONS SCHEDULES, AND SYMBOLS

sheet number
P0.0

drawn by JJR
checked by JWB, RLW

WASTE PIPING NOTES:

1 CONNECT TO EXISTING ACID VENT PIPE



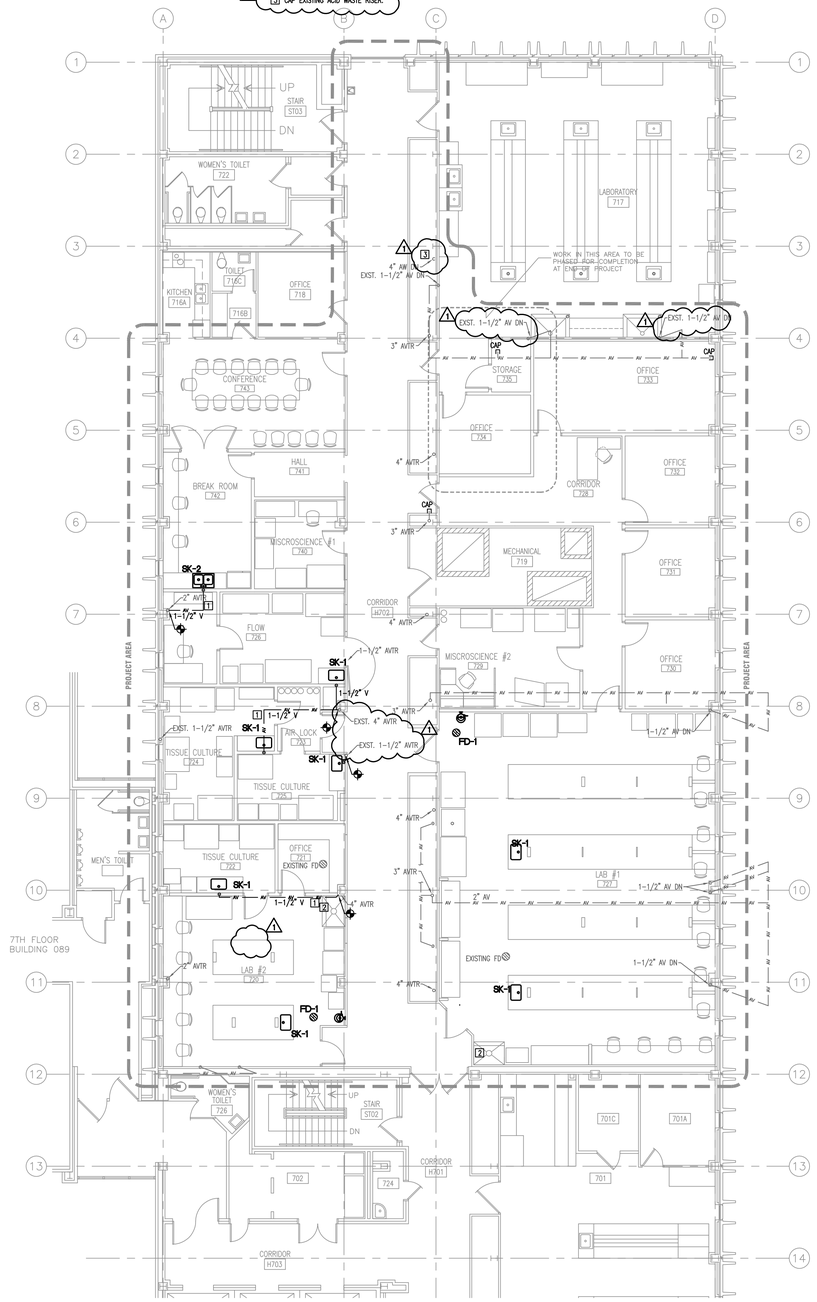
1 PARITAL SIXTH FLOOR PLAN – WASTE & VENT PIPING
1/8"=1'-0"

KEYNOTES:

1 COORDINATE VENT PIPE ROUTING WITH DUCTWORK.

2 STUB UP NEW 2" ACID WASTE LINE FOR NEW FUME HOOD. PC SHALL MAKE FINAL CONNECTION.

3 CAP EXISTING ACID WASTE RISER.



2 PARITAL SEVENTH FLOOR PLAN – WASTE & VENT PIPING
1/8"=1'-0"

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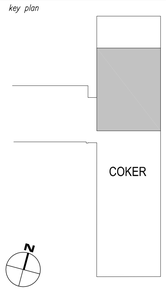


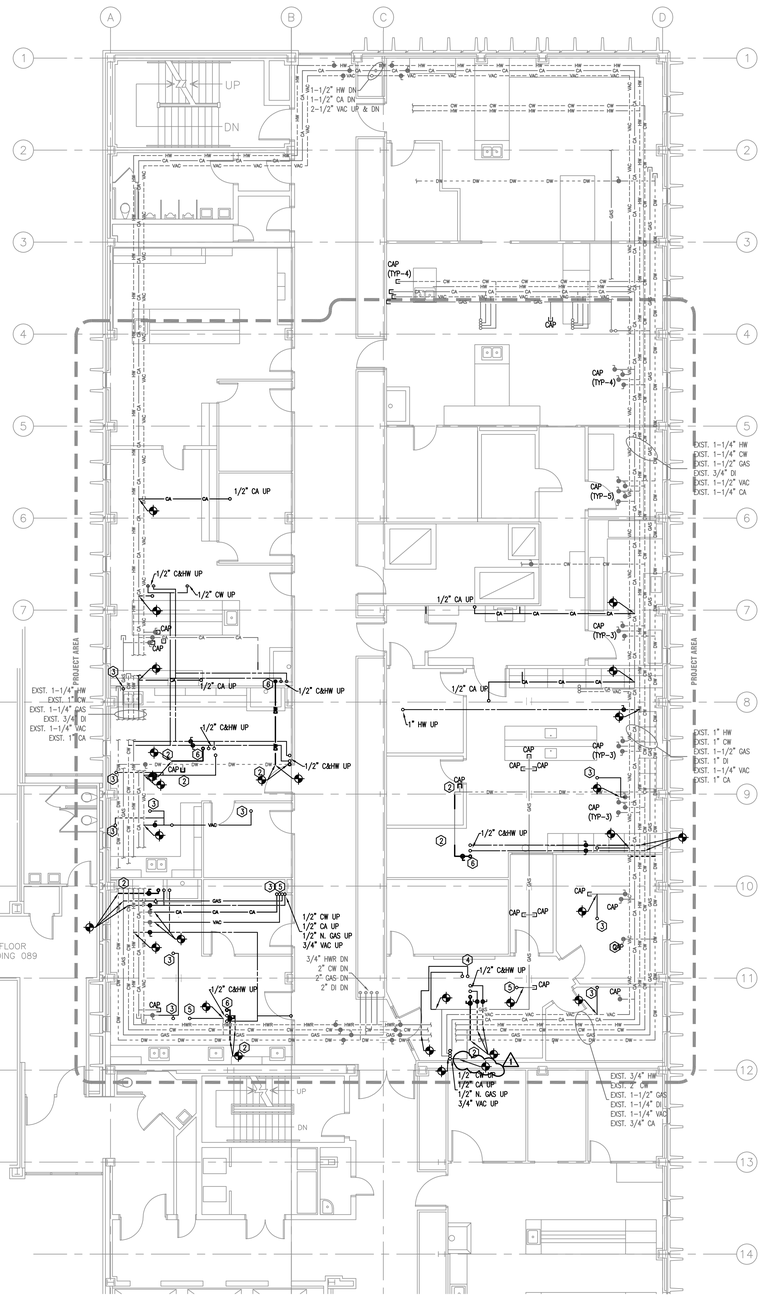
sheet title
PARTIAL SIXTH & SEVENTH FLOOR
WASTE & VENT PIPING PLAN

sheet number
P2.7

drawn by JJR
checked by JWB

WATER PIPING NOTES:

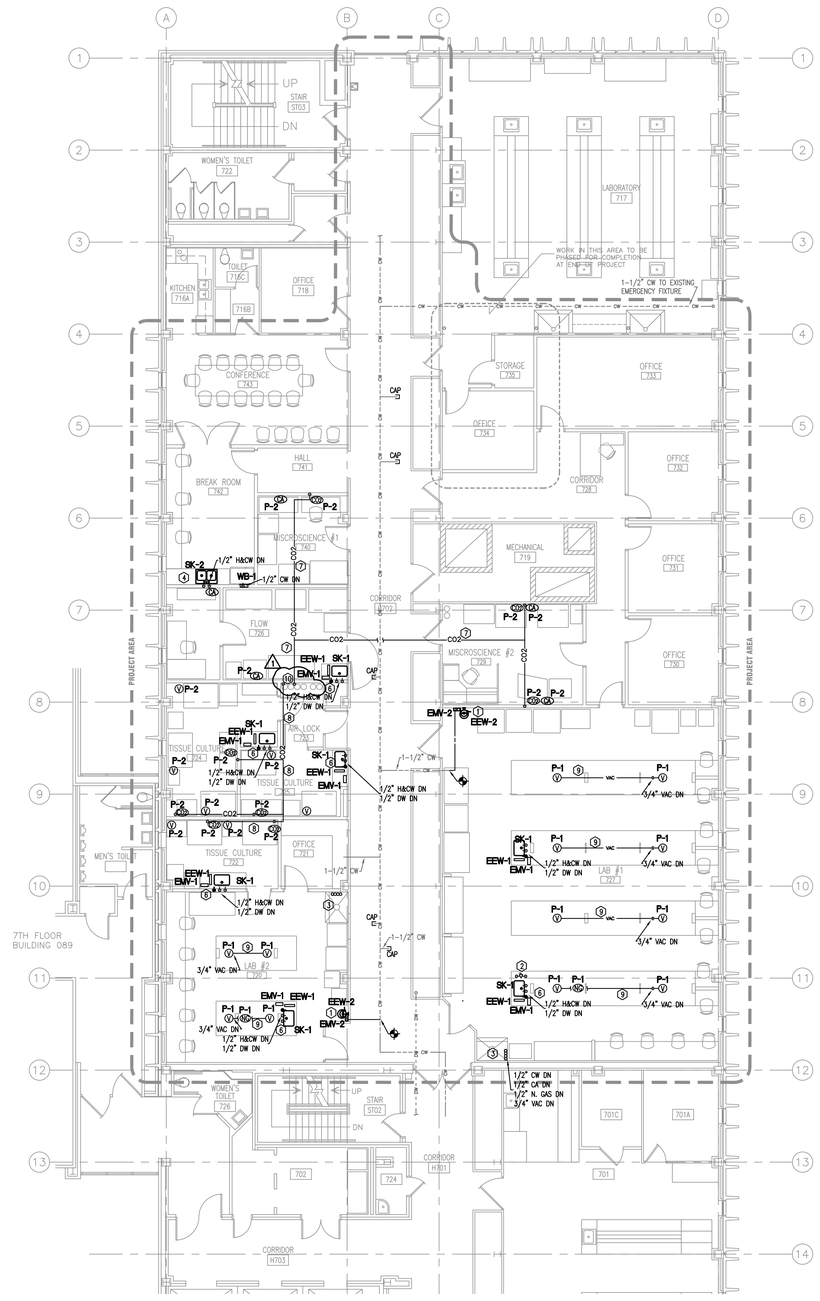
1. REMOVE TEMPORARY CAPS AND CONNECT NEW 3/4" CW & HW SUPPLY PIPING TO EXISTING PIPING BELOW FLOOR.
2. CONTRACTOR SHALL CONNECT TO EXISTING TIN-LINED COPPER DEIONIZED WATER PIPING WITH POLYPROPYLENE PIPE BY COMPRESSION TO FLANGED TRANSITION FITTINGS.
3. 3/4" VAC RISER UP
4. 1-1/4" NATURAL GAS PIPING UP TO NEW GAS CUT-OFF VALVE.
5. 1/2" NATURAL GAS PIPING UP.
6. 1/2" DE-IONIZED WATER UP.



1 PARITAL SIXTH FLOOR PLAN – WATER & GAS PIPING
1/8"=1'-0"

KEYNOTES:

1. EMV-2 LOCATED ABOVE CEILING. 1" HW FROM BELOW 7TH FLOOR.
2. NEW INSTRUCTOR'S GAS CUT OFF VALVE LOCATED IN CASE WORK. PROVIDE LEVER HANDLE BALL VALVE WITH LOCKING TABS. ROUTE PIPING AND LOCATE VALVE TO PROVIDE ACCESS. 1-1/4" GAS.
3. STUB UP NEW 1/2" CW, CA, N. GAS AND 3/4" VAC FOR NEW FUME HOOD. PC SHALL MAKE FINAL CONNECTIONS. LEVER HANDLE BALL VALVES IN VERTICAL RISE ABOVE FLOOR.
4. PC SHALL PROVIDE 1/4" COPPER FOR CW SUPPLY TO COFFEE MAKER. PC SHALL PROVIDE TEE CONNECTION AND TIE INTO CW SUPPLY FROM WB-1.
5. PC PROVIDE GAS MANIFOLD FOR CO2 AND NITROGEN "K" TANKS. COMPRESSED GASES BY OTHERS.
6. TRANSITION FROM TIN-LINED DEIONIZED WATER FAUCET TO ORION POLYPROPYLENE WHITELINE PIPE.
7. PIPING FOR GAS MIX 5% CO2/95% AIR
8. PIPING FOR GAS MIX 100% CO2
9. 3/4" VAC PIPING ROUTED IN CASEWORK.
10. TYPE "K" COMPRESSED GAS TANKS BY OWNER. COMPRESSED GAS MANIFOLD PROVIDED BY GAS SUPPLIER. PC SHALL MAKE ALL FINAL COMPRESSED GAS CONNECTIONS TO OUTLETS P-1 & P-2. OWNER SHALL MAKE FINAL EQUIPMENT CONNECTIONS.



2 PARITAL SEVENTH FLOOR PLAN – WATER & GAS PIPING
1/8"=1'-0"

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Design/Planning/Construction
1201 Main Street, Suite 2100
Columbia, S.C. 29201
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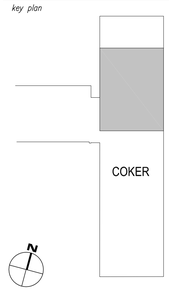
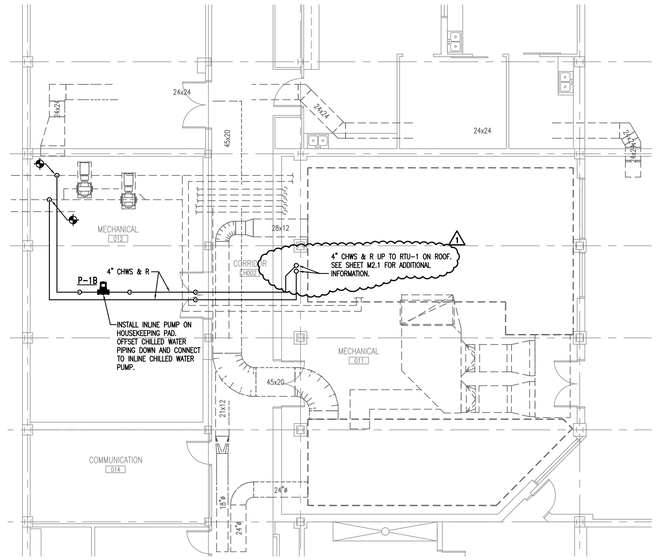


sheet title
PARTIAL SIXTH & SEVENTH FLOOR PLUMBING PIPING

sheet number
P3.7

drawn by JJR
checked by JWB, RLW



1 PARTIAL BASEMENT FLOOR PLAN – HVAC RENOVATIONS
1/8"=1'-0"

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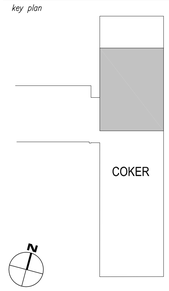
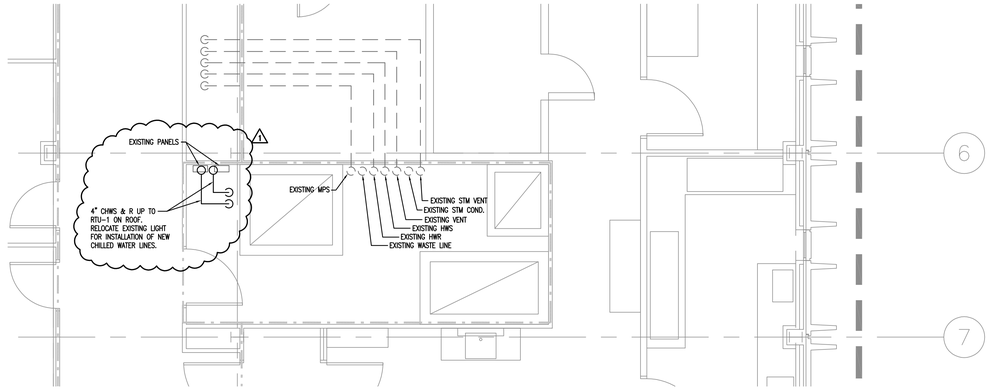


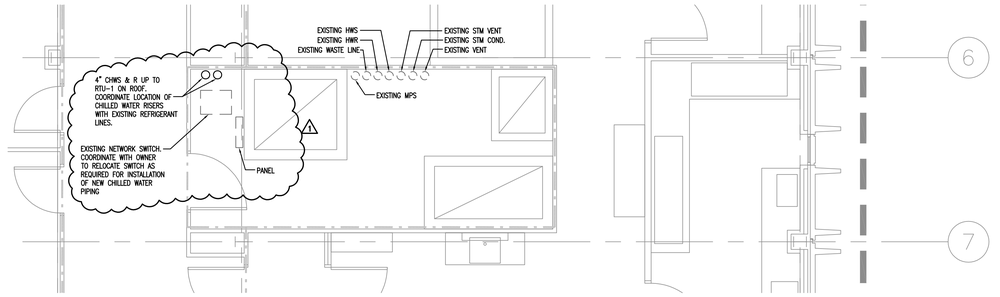
sheet title
PARTIAL BASEMENT FLOOR PLAN HVAC RENOVATIONS

sheet number
M2.0

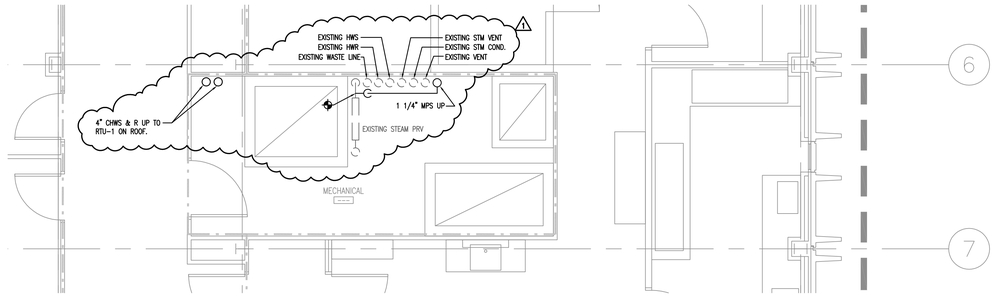
drawn by JDR
checked by JDR



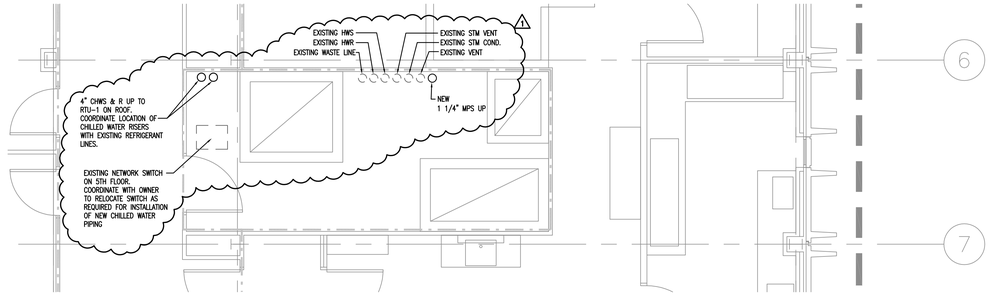
1 PARTIAL FIRST FLOOR PLAN – HVAC RENOVATIONS
1/4"=1'-0"



2 PARTIAL SECOND FLOOR PLAN – HVAC RENOVATIONS
1/4"=1'-0"



3 PARTIAL THIRD FLOOR PLAN – HVAC RENOVATIONS
1/4"=1'-0"



4 PARTIAL FOURTH THROUGH SIXTH FLOOR PLAN – HVAC RENOVATIONS
1/4"=1'-0"

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Design/Planning/Construction
1201 Main Street, Suite 2100
Columbia, S.C. 29201
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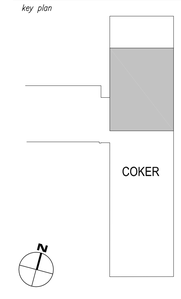
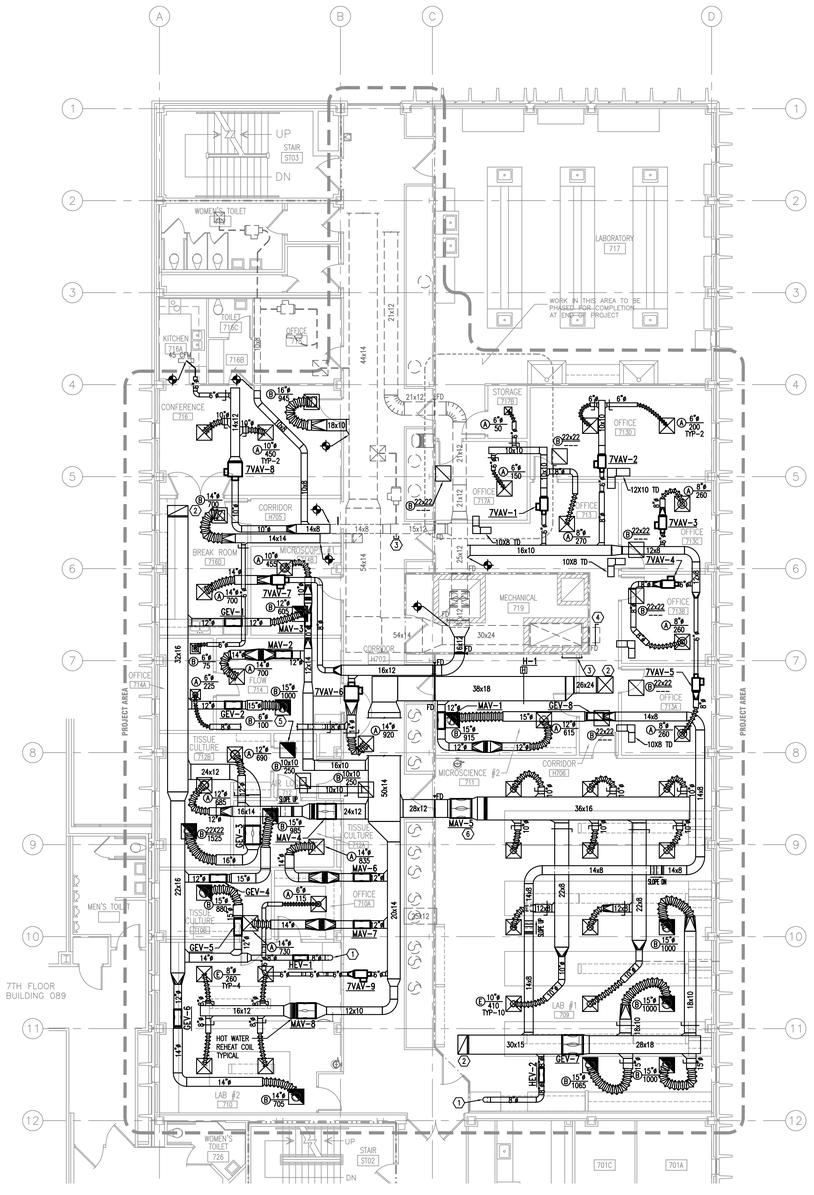


sheet title
PARTIAL FIRST, SECOND, THIRD, FOURTH, FIFTH, & SIXTH FLOOR PLAN - HVAC RENOVATIONS

sheet number
M2.1

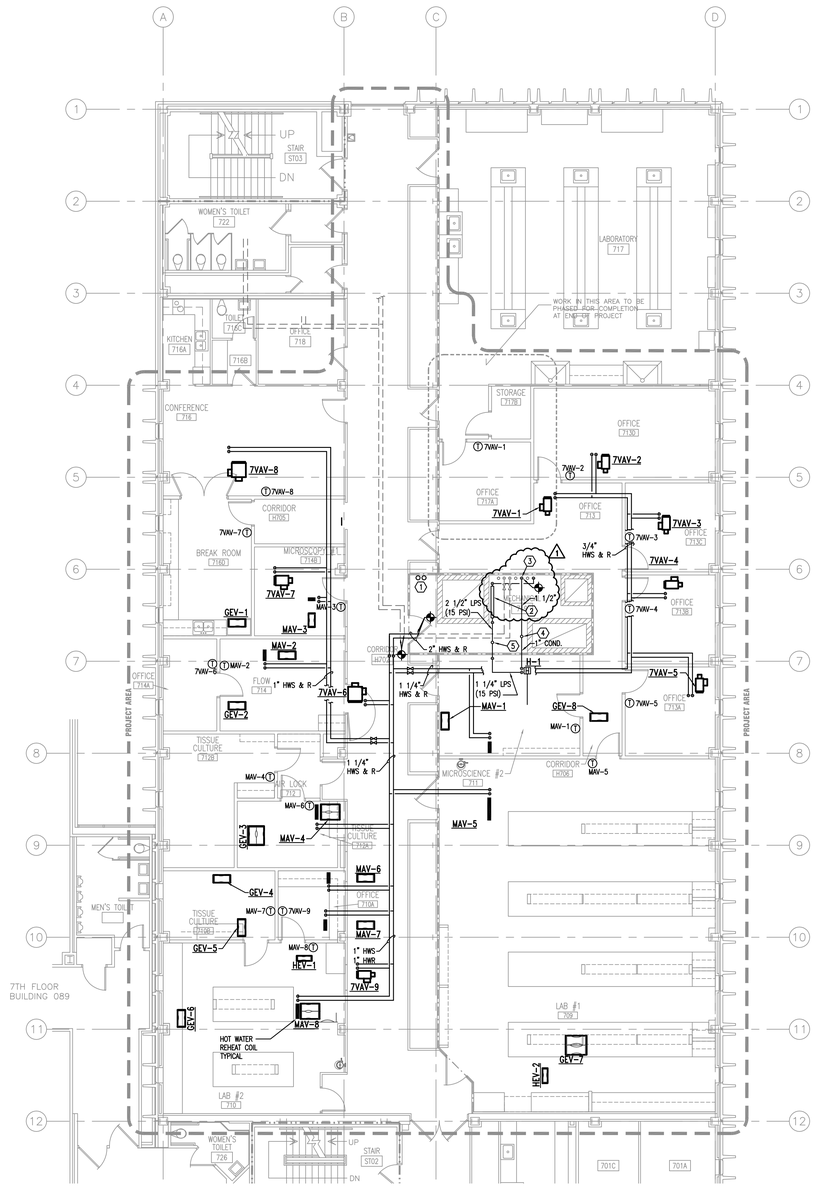
drawn by JDR
checked by JDR



NOTES:

1. ROUTE DUCT DOWN AND CONNECT TO FUME HOOD. TRANSITION DUCT AS REQUIRED TO FUME HOOD CONNECTION SIZE. COORDINATE SIZE AND LOCATION WITH FUME HOOD MANUFACTURER.
2. DUCT UP THROUGH ROOF. SEE SHEET M2.8 FOR CONTINUATION.
3. CAP AND REINSULATE EXISTING DUCT.
4. ADD NEW BALANCING DAMPER IN EXISTING RETURN DUCT AND BALANCE TO 1400 CFM.
5. 6"ø UP TO EF-1 ON ROOF AND DOWN TO (B) 6"ø 100". PROVIDE TRANSITION FROM 6"ø EXHAUST DUCT TO CONNECTION OF EF-1.
6. SEE VENTURI TYPE VALVE WITH REHEAT DETAIL FOR ADDITIONAL INFORMATION.

1 PARTIAL SEVENTH FLOOR PLAN – HVAC DUCTWORK
1/8"=1'-0"



PIPING NOTES:

1. 4" CHWS & R UP TO ROOF. SEE ROOF PLAN FOR CONTINUATION.
2. NEW STEAM PRESSURE REDUCING STATION. SEE STEAM PRESSURE REDUCING STATION DETAIL ON SHEET M0.3 FOR ADDITIONAL INFORMATION.
3. 1 1/2" CONDENSATE DOWN. SEE PARTIAL MECHANICAL ROOM PLANS FOR CONTINUATION.
4. 1 1/2" CONDENSATE UP TO ROOF. SEE SHEET M2.8 FOR CONTINUATION.
5. 2" LPS (15 PSI) UP TO ROOF. SEE SHEET M2.8 FOR CONTINUATION.

2 PARTIAL SEVENTH FLOOR PLAN – HVAC PIPING
1/8"=1'-0"

GMK ASSOCIATES, INC.
Design/Planning/Construction
1201 Main Street, Suite 2100
Columbia, S.C. 29201
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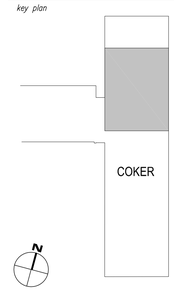


sheet title
PARTIAL SEVENTH FLOOR PLAN HVAC DUCTWORK AND PIPING

sheet number
M2.7

drawn by JDR
checked by JDR

ABBREVIATIONS

ABV	Above	MBH	Thousand BTU/Hr (thousands)
AFF	Above Finished Floor	MIN	Minimum
BHP	Brake Horsepower	MPS	Medium Pressure Steam
BR	Barometric Relief Damper	N/A	Not Applicable
CFM	Cubic Feet Per Minute	NIC	Not in Contract
CC-1	Cooling Coil No. 1	NTS	Not To Scale
CHWS	Chilled Water Supply	OA	Outside Air
CHWR	Chilled Water Return	OBD	Opposed Blade Damper
DD	Duct Smoke Detector	OD	Outside Diameter
DB	Dry Bulb Temperature	PD	Pressure Drop
EAT	Entering Air Temperature	RH-1	Re-Heat Coil No. 1
ELEC	Electric or Electrical	RA	Return Air
EWB	Entering Air Wet Bulb	RET	Return
EWT	Entering Water Temperature	RH	Relative Humidity
ERW-1	Energy Recovery Wheel No. 1	SA	Supply Air
F-#	Filter Type No.	SEER	Seasonal Energy Efficiency Ratio
FL	Floor	SHT	Sheet
H-1	Humidifier No. 1	SP	Static Pressure
HWS	Hot Water Supply	SPEC	Specifications
HWR	Hot Water Return	SPL	Supply
HP	Horsepower	T	Thermostat
LAT	Leaving Air Temperature	T-1	Tank No. 1
LWB	Leaving Air Wet Bulb	TEMP	Temperature
LWT	Leaving Water Temperature	TSTAT	Thermostat
MAX	Maximum	TYP	Typical
		VFD	Variable Frequency Drive
		WB	Wet Bulb Temperature
		WPD	Water Pressure Drop (in. w.g)

MECHANICAL GENERAL NOTES

1. DO NOT SCALE DRAWINGS; SEE ARCHITECTURAL DRAWINGS AND REFLECTED CEILING PLANS FOR EXACT LOCATIONS OF DOORS, WINDOWS, CEILING, DIFFUSERS, ETC.
2. EXTEND ALL DRAIN LINES TO EXTERIOR AND SPILL ON GRADE. ROUTE TO AVOID INTERFERENCE WITH PASSAGEWAYS. CONDENSATE DRAINS SHALL BE TRAPPED. SLOPE DRAIN LINES 1/8" PER FOOT.
3. ALL PIPING AND DUCTWORK INSULATION SHALL BE RUN CONTINUOUSLY THROUGH FLOORS, ROOFS AND PARTITIONS EXCEPT WHERE PROHIBITED BY FIRE CODES.
4. ALL PIPING SHALL BE SUPPORTED IN ACCORDANCE WITH THE SPECIFICATIONS AND FURTHER SUPPORTS OR HANGERS SHALL BE ADJACENT TO ELBOWS, TO PREVENT WEIGHT OF PIPING BEING PLACED ON THE EQUIPMENT. SUPPORT DETAILS SHALL BE SUBMITTED TO THE MECHANICAL ENGINEER.
5. ALL PIPING AND DUCTWORK LOCATIONS SHALL BE COORDINATED WITH THE WORK UNDER OTHER DIVISIONS OF THE SPECIFICATIONS TO AVOID INTERFERENCE.
6. ALL PIPING, DUCTS, VENTS, ETC. EXTENDING THRU EXTERIOR WALLS AND ROOFS SHALL BE FLASHED AND COUNTERFLASHED.
7. PROVIDE ALL TRANSITIONS REQUIRED FOR INSTALLATION OF DUCT, EXHAUST FANS, AND ALL OTHER EQUIPMENT AND APPURTENANCES.
8. ALL DUCT IS GALVANIZED SHEET METAL EXCEPT AS NOTED.
9. DUCT SIZES ARE CLEAR INSIDE DIMENSIONS.

MECHANICAL DEMOLITION NOTES

1. DRAWINGS SHOW GENERAL INTENT OF DEMOLITION. QUANTITIES, LOCATIONS, SIZES AND EQUIPMENT ARE SHOWN TO INDICATE TYPE OF SYSTEM INSTALLED AND DOES NOT NECESSARILY REPRESENT EXACT CONDITIONS. CONTRACTOR SHALL FIELD VERIFY BEFORE BIDDING.
2. DEMOLITION OF EQUIPMENT, SYSTEMS, AND COMPONENTS SHALL INCLUDE ALL SUPPORTS, PADS, HANGERS, INSULATION, CONTROLS, STARTERS, ACCESSORIES, AND APPURTENANCES NOT REQUIRED FOR THE INSTALLATION OF THE NEW SYSTEM.
3. WHEN PARTIAL DEMOLITION OF A SYSTEM IS INDICATED, THE PART OF THE SYSTEM SHOWN TO REMAINED SHALL BE REMOVED TO THE ACTIVE MAIN OR BRANCH IF NOT REQUIRED FOR THE INSTALLATION OF THE NEW SYSTEM. THE ACTIVE MAIN OR BRANCH SHALL BE REPAIRED TO MATCH NEW INSTALLATION AS MUCH AS PRACTICAL. IF SYSTEM IS INSULATED, INSULATION SHALL BE PATCHED AND FINISHED REPAIR (IE: VAPOR BARRIER, COATING, ETC.)
4. REMOVAL OF SYSTEMS SHALL INCLUDE COMPLETE SYSTEM WHENEVER PRACTICAL. IF NOT, SYSTEM (IE: PIPE, CONDUIT, ETC.) SHALL BE REMOVED TO 1 INCH BELOW SURFACE.

HVAC LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
T	TEMPERATURE SENSOR OR THERMOSTAT		CEILING SUPPLY DIFFUSER, RETURN GRILLE W/ FLEX DUCT CONN. FOR RETURN OR EXHAUST AIR; SEE "DIFFUSER & GRILLE SCHEDULE"	18x12 12x12	TRANSITION, FLAT ON BOTTOM (FOB) FLAT ON TOP (FOT, IF APPLICABLE)
S	WALL SWITCH		EXISTING DUCT WORK TO REMAIN		TURNING VANES
H	WALL HUMIDISTAT		EXISTING DUCT WORK TO BE REMOVED		DUCT SMOKE DETECTORS
	CONNECT TO EXISTING		DUCT TURNING DOWN	CR	CONCEALED REGULATOR
18x12	RECTANGULAR DUCT SIZE, FIRST FIGURE IS SIDE SHOWN		DUCT TURNING UP		MANUAL VOLUME DAMPER
18"ø	ROUND DUCT SIZE		UNION	A 6"ø 100	A – DIFFUSER TAG 6"ø – NECK SIZE 100 – CFM
R	CHANGE OF ELEVATION, RISER (R), DROP (D)		STRAINER		GATE VALVE
	ACOUSTICAL LINING INSULATION		STRAINER WITH BLOW OFF		CONTROL VALVE, TWO WAY
	FLEXIBLE DUCT		ECCENTRIC REDUCER FLAT ON TOP		END CAP
CHWS	CHILLED WATER SUPPLY		TEE OUTLET UP		ELBOW TURNED DOWN
CHWR	CHILLED WATER RETURN		TEE OUTLET DOWN		ELBOW TURNED UP
	CONCENTRIC REDUCER				ECCENTRIC REDUCER FLAT ON BOTTOM

AIR DISTRIBUTION SCHEDULE

TAG	DESCRIPTION	NECK	MODULE SIZE	MOUNT	CONSTR.	MFGR	MODEL	NOTES
A	SQUARE PLAQUE CEILING SUPPLY	AS SHOWN	24x24	LAY-IN	ALUMINUM	PRICE	SERIES ASPD	2,3
B	PERFORATED CEILING RETURN/EXHAUST	AS SHOWN	24x24	LAY-IN	ALUMINUM	PRICE	SERIES APDDR	3
C	SQUARE PLAQUE CEILING SUPPLY	AS SHOWN	16x16	SURFACE	ALUMINUM	PRICE	SERIES ASPD	2,3
D	PERFORATED CEILING RETURN/EXHAUST	AS SHOWN	16x16	SURFACE	ALUMINUM	PRICE	SERIES APDDR	3
E	LABORATORY SUPPLY DIFFUSER	AS SHOWN	24x24	LAY-IN	ALUMINUM	PRICE	SERIES AFRFD	3,4

1. FURNISH WITH OPPOSED BLADE DAMPER
2. 4-WAY DEFLECTION UNLESS NOTED OTHERWISE
3. BAKED ENAMEL, SEE WHITE FINISH
4. 2-WAY RADIAL PATTERN
5. FURNISH WITH 2 SETS OF REPLACEMENT FILTERS

FAN SCHEDULE

TAG	TYPE	CAPACITY CFM	E.S.P. (IN. WG.)	MOTOR HP	MOTOR RPM	ELECTRICAL (VOLTS/PHASE)	EMERGENCY POWER	MANUFACTURER	MODEL NO.	NOTES
LEF-1	VENT SET	6535	2.2	15	1725	460/3/60	NO	GREENHECK	VEXTOR-CD-15-1-B-MV	3,6,9,10,11,12,13
LEF-2	VENT SET	5465	2.2	15	1725	460/3/60	NO	GREENHECK	VEXTOR-CD-15-1-B-MV	3,6,9,10,11,12,13
EF-1	DOWNBLAST	100	0.375	1/6	1725	115/1/60	NO	GREENHECK	G-060-VG	2,3,4,5,8

1. MOTORIZED BACKDRAFT DAMPER
2. GRAVITY BACKDRAFT DAMPER
3. DISCONNECT SWITCH
4. BIRDSCREEN
5. SEISMIC ROOF CURB
6. BELT GUARD
7. FILTER
8. ECM MOTOR W/VFD
9. BYPASS DAMPER
10. PLENUM
11. CHEMICAL RESIST FLEX CONNECTION
12. VFD IN NEMA 3R ENCLOSURE
13. SPRING ISOLATORS

STEAM HUMIDIFIER SCHEDULE

TAG	LOCATION	TYPE	DUCT SIZE	CFM	CAPACITY (LBS/HR)	STEAM PRESS. (PSIG)	MAXIMUM ABSORPTION DISTANCE	AIR PD (IN W.C.)	MANUFACTURER	MODEL	NOTES
H-1	RM 711	DUCT MOUNTED	38X18	11000	215	15	24"	0.051	DRI-STEEM	ULTRA-SORB LV	1,2,3,4,5,6,7

1. FULL MODULATING CONTROL
2. HI-LIMIT SENSOR
3. DUCT MOUNTED HUMIDITY SENSOR
4. HUMIDIFIER ON EMERGENCY POWER
5. PRESSURE AIRFLOW PROVING SWITCH
6. DUCT PROBE
7. ELECTRONIC ACTUATOR

ROOFTOP UNIT SCHEDULE

TAG	SERVICE	CAPACITY CFM	MINIMUM O.A.	FAN TYPE	STATIC PRESS. IN. W.G. TOTAL	STATIC PRESS. IN. W.G. EXT	FAN RPM	FAN BHP	MOTOR RPM	MOTOR HP	LAT UNIT (°F)	ELECTRICAL VOLTS/PHASE	EMERGENCY POWER	AIR VOLUME CONTROL	PREHEAT COIL EQ. NO.	HEATING COIL EQ. NO.	COOLING COIL EQ. NO.	PRE-FILTER (%)	FINAL FILTER	HUMIDIFIER EQ. NO.	MANUFACTURER	MODEL	REMARKS
RTU-1	SUPPLY	11000	11000	AIRFOIL	7.58	3.5	2017	20.21	1800	25	55.0	480/3	YES	VFD	HC-1	---	CC-1	30	F-1A & F-1B	---	TRANE	PERFORMANCE CLIMATE CHANGER-25	1,2

1. FACTORY MOUNTED VFD
2. SINGLE POINT POWER CONNECTION

FILTER SCHEDULE

TAG	SYSTEM	TYPE MEDIA	CAPACITY (CFM)	FILTER DEPTH (INCHES)	MAXIMUM AIR VELOCITY (FPM)	INITIAL PRESS. DROP (IN. WC.)	FINAL PRESS. DROP (IN. WC.)	EFFICIENCY PERCENT	MERV RATING	MANUFACTURER	MODEL	NOTES
F-1A	RTU-1	PRE-FILTER	11000	4"	500	0.31	1.0	30	8	FARR	30/30	1
F-1B	RTU-1	FINAL FILTER	11000	12"	500	0.6	1.5	95	14	FARR	RGA-FLO	1

1. TEST METHOD: ASHRAE 52.1-92 STANDARD

MAKEUP AIR VALVE SCHEDULE

TAG NO.	MAXIMUM BOX CFM	MINIMUM BOX CFM	MIN. INLET S.P. (W.C.)	PIPE RUNOUT SIZE (INCHES)	REHEAT COIL GPM	REHEAT COIL MBH	REHEAT COIL EWT (°F)	REHEAT COIL LWT (°F)	REHEAT COIL MAX. AIR VEL.	REHEAT COIL MAX COIL HT.	REHEAT COIL MAX. WPD	PRIMARY NC @ 1.5" SP DISCH/RAD.	INLET SIZE (INCHES)	ELECTRICAL (VOLTS/PHASE)	MANUFACTURER	MODEL NO.	NOTE
MAV-1	615	300	1.25	3/4"	1.2	11.7	160	140	900	12"	5	---	12	120/1	PHOENIX CONTROLS	MANF12M	1,2,3,4
MAV-2	700	300	1.25	3/4"	1.2	11.7	160	140	900	12"	5	---	12	120/1	PHOENIX CONTROLS	MANF12M	1,2,3,4
MAV-3	455	150	1.25	3/4"	0.6	5.9	160	140	900	10"	5	---	10	120/1	PHOENIX CONTROLS	MANF10M	1,2,3,4
MAV-4	1375	195	1.25	3/4"	0.8	7.6	160	140	900	12"	5	---	24X12	120/1	PHOENIX CONTROLS	MAN212M	1,2,3,4
MAV-5	4100	1495	1.25	1"	5.8	58.4	160	140	900	14"	5	---	28X14	120/1	PHOENIX CONTROLS	MAN214M	1,2,3,4
MAV-6	835	150	1.25	3/4"	0.6	5.9	160	140	900	12"	5	---	12	120/1	PHOENIX CONTROLS	MANF12M	1,2,3,4
MAV-7	730	150	1.25	3/4"	0.6	5.9	160	140	900	12"	5	---	12	120/1	PHOENIX CONTROLS	MANF12M	1,2,3,4
MAV-8	1040	480	1.25	3/4"	1.9	18.7	160	140	900	12"	5	---	24X12	120/1	PHOENIX CONTROLS	MAN212M	1,2,3,4

1. HIGH SPEED ELECTRIC ACTUATOR
2. CONTROL POWER TRANSFORMER
3. REHEAT COIL MOUNTED IN DUCT
4. FLANGED CONNECTION

GENERAL EXHAUST VALVE SCHEDULE

TAG NO.	AREA SERVED	MAXIMUM BOX CFM	MINIMUM BOX CFM	MIN. INLET S.P. (W.C.)	PRIMARY NC @ 1.5" SP DISCH/RAD.	INLET SIZE (INCHES)	ELECTRICAL (VOLTS/PHASE)	MANUFACTURER	MODEL NO.	NOTE
GEV-1	---	805	300	1.25	---	12	120/1	PHOENIX CONTROLS	EXMF12M	1,3,6,7
GEV-2	---	1000	600	1.25	---	12	120/1	PHOENIX CONTROLS	EXMF12M	1,3,6,7
GEV-3	---	1215	345	1.25	---	24X12	120/1	PHOENIX CONTROLS	EXMA212M	1,3,6,7
GEV-4	---	985	300	1.25	---	12	120/1	PHOENIX CONTROLS	EXMF12M	1,3,6,7
GEV-5	---	880	300	1.25	---	12	120/1	PHOENIX CONTROLS	EXMF12M	1,3,6,7
GEV-6	---	670	110	1.25	---	12	120/1	PHOENIX CONTROLS	EXMF12M	1,3,6,7
GEV-7	---	4085	1460	1.25	---	28X14	120/1	PHOENIX CONTROLS	EXMA214M	1,3,6,7
GEV-8	---	915	600	1.25	---	12	120/1	PHOENIX CONTROLS	EXMF12M	1,3,6,7

1. HIGH SPEED ELECTRIC ACTUATOR
2. LOW SPEED ELECTRIC ACTUATOR
3. CONTROL POWER TRANSFORMER
4. CORROSION-RESISTANT COATING ON VALVE
5. CONNECT TO TWO POSITION WALL SWITCH
6. SEE LAB CONTROL DIAGRAMS FOR MORE INFORMATION
7. FLANGED CONNECTION

VARIABLE AIR VOLUME TERMINAL BOX SCHEDULE

TAG NO.	AREA SERVED	MAXIMUM BOX CFM	MINIMUM BOX CFM	MIN. INLET S.P. (W.C.)	PIPE RUNOUT SIZE (INCHES)	REHEAT COIL GPM	REHEAT COIL MBH	REHEAT COIL EWT (°F)	REHEAT COIL LWT (°F)	REHEAT COIL MAX. WPD	PRIMARY NC @ 1.5" SP DISCH/RAD.	INLET SIZE (INCHES)	ELECTRICAL (VOLTS/PHASE)	MANUFACTURER	MODEL NO.	NOTE
7VAV-1	---	470	140	1.0	3/4"	0.8	7.7	160	140	5	---	6	120/1	TRANE	VCMF-06	1,2
7VAV-2	---	400	120	1.0	3/4"	0.7	7.3	160	140	5	---	6	120/1	TRANE	VCMF-06	1,2
7VAV-3	---	260	80	1.0	3/4"	0.5	5.0	160	140	5	---	6	120/1	TRANE	VCMF-06	1,2
7VAV-4	---	260	80	1.0	3/4"	0.5	5.0	160	140	5	---	6	120/1	TRANE	VCMF-06	1,2
7VAV-5	---	260	80	1.0	3/4"	0.5	5.0	160	140	5	---	6	120/1	TRANE	VCMF-06	1,2
7VAV-6	---	1145	1145	1.0	1"	4.4	44.1	160	140	5	---	10	120/1	TRANE	VCMF-10	1,2
7VAV-7	---	700	210	1.0	3/4"	1.0	10.4	160	140	5	---	8	120/1	TRANE	VCMF-08	1,2
7VAV-8	---	900	450	1.0	3/4"	1.8	18.5	160	140	5	---	8	120/1	TRANE	VCMF-08	1,2
7VAV-9	---	115	115	1.0	3/4"	1.8	18.5	160	140	5	---	6	120/1	TRANE	VCMF-06	1,2

1. ELECTRIC ACTUATOR
2. CONTROL POWER TRANSFORMER
3. SOUND ATTENUATOR

HOOD EXHAUST VALVE SCHEDULE

TAG NO.	AREA SERVED	MAXIMUM BOX CFM	MINIMUM BOX CFM	MIN. INLET S.P. (W.C.)	PRIMARY NC @ 1.5" SP DISCH/RAD.	INLET SIZE (INCHES)	ELECTRICAL (VOLTS/PHASE)	MANUFACTURER	MODEL NO.	NOTE
HEV-1	---	485	485	1.25	---	8	120/1	PHOENIX CONTROLS	EXMF08M	1,3,4,6,7
HEV-2	---	485	485	1.25	---	8	120/1	PHOENIX CONTROLS	EXMF08M	1,3,4,6,7

1. HIGH SPEED ELECTRIC ACTUATOR
2. LOW SPEED ELECTRIC ACTUATOR
3. CONTROL POWER TRANSFORMER
4. CORROSION-RESISTANT COATING ON VALVE
5. CONNECT TO TWO POSITION WALL SWITCH
6. SEE LAB CONTROL DIAGRAMS FOR MORE INFORMATION
7. FLANGED CONNECTION

COIL SCHEDULE

TAG	LOCATION	SERVICE	CAPACITY CFM	MAX. AIR VELOCITY (FPM)	MIN. FACE AREA (SQ. FT.)	AIR PRESS DROP (IN. WG.)	CAPACITY TOTAL MBH	CAPACITY SENS. MBH	CAPACITY KW	AIR TEMPERATURE ENTERING DB °F	AIR TEMPERATURE ENTERING WB °F	AIR TEMPERATURE LEAVING DB °F	AIR TEMPERATURE LEAVING WB °F	STEAM CAPACITY (LBS/HR)	STEAM PRESS. (PSIG)	WATER ENTERING TEMP. °F	WATER LEAVING TEMP. °F	WATER GPM	MAX. PRESS. DROP (FT. WATER)	MINIMUM NO. OF ROWS	MAXIMUM NO. OF FINS/FT.	ELECTRICAL (VOLTS/PHASE)	NOTES
CC-1	RTU-1	COOLING	11000	500	23.73	1.251	1057.33	516.23	---	95.0	80.0	53.0	52.9	---	---	48.0	60.0	175.7	20	8	163	---	---
HC-1	RTU-1	HEATING	11000	500	22.67	0.069	473.7	---	---	20.0	---	59.7	---	500.7	15	---	---	---	0.1	1	42	---	---

1. MINIMUM WATER VELOCITY - 3 FEET PER SECOND
2. 2-WAY VALVE
3. 3-WAY VALVE
4. MINIMUM WATER VELOCITY - 4 FEET PER SECOND

PUMP SCHEDULE

TAG	SERVICE	TYPE	FLOW (GPM)	HEAD (FT)	EFFICIENCY (%)	MOTOR HP	MOTOR RPM	MOTOR TYPE	ELECTRICAL (VOLTS/PHASE)	EMERGENCY POWER	MANUFACTURER	MODEL	NOTES
P-1B	SECONDARY CHILLED WATER	INLINE	200	56	59.5	7.5	1750	ODP	460/3	NO	BELL AND GOSSETT	SERIES 80 2-1/2 X 9-1/2B	1,2

1. INVERTER DUTY MOTOR
2. VARIABLE FREQUENCY DRIVE

GMK ASSOCIATES, INC.

Design/Planning/Construction
1201 Main Street, Suite 2100
Columbia, S.C. 29201
tel. 803-256-0000
fax 803-255-7243

consultants

owner

UNIVERSITY OF SOUTH CAROLINA

project name
COKER - 7th FLOOR PHARMACY RENOVATION

State project number
H27- 6101

project number
12023.01

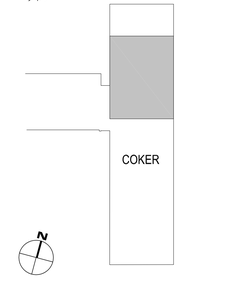
seals/signature

issued for
CONSTRUCTION

date
APRIL 23, 2013

number	item	date
1	ADDENDUM NO. 2	05/28/13

key plan



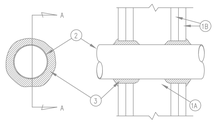
sheet title
HVAC LEGENDS, NOTES, ABBREVIATIONS & SCHEDULES

sheet number
M7.1

drawn by JDR
checked by JDR

System No. W-L-1001

F Rating – 1, 2, 3 and 4 Hr (See Items 2 and 3)
T Rating – 0, 1, 2, 3, and 4 Hr (See Item 3)
L Rating at Ambient – less than 1 CFM/sq. ft.
L Rating at 400° F – less than 1 CFM/sq. ft.



SECTION A-A

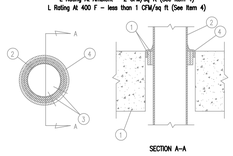
1. Wall Assembly – The 1, 2, 3, or 4 hour fire-rated gypsum wallboard/stud wall assembly shall be constructed of the materials and in the manner described in the individual U300 or U400 Series Wall or Partition Designs in the UL Fire Resistance Directory and shall include the following construction features:
   A. Studs – Wall framing may consist of either wood or steel channel studs. Wood studs (max 2 hour fire rated assemblies) or steel channel studs. Wood studs to consist of nom 2 by 4 in. lumber spaced 16 in. OC with nom 2 by 4 in. lumber end plates and cross braces. Steel studs to be min 3-5/8 in. wide by 1-3/8 in. deep channels spaced max 24 in. OC.
   B. Wallboard, Gypsum* – Nom 1/2 or 5/8 in. thick, 4 ft. wide with square or tapered edges. The gypsum wallboard type, thickness, number of layers, fastener type and sheet orientation shall be as specified in the individual U300 or U400 Series Design in the UL Fire Resistance Directory. Max diam of opening is 13-1/2 in.
2. Pipe or conduit – Nom 12 in. diam (or smaller) Schedule 10 (or heavier) steel pipe, nom 12 in. diam (or smaller) service weight (or heavier) cast iron soil pipe, nom 12 in. diam (or smaller) Class 50 (or heavier) ductile iron pressure pipe, nom 6 in. (or smaller) steel conduit, nom 4 in. diam (or smaller) steel electrical metallic tubing, nom 6 in. diam (or smaller) Type L or (or heavier) copper tubing or nom 1 in. diam (or smaller) flexible steel conduit. When copper pipe is used, max F Rating of firestop system (Item 3) is 2 hr. Steel pipes or conduits larger than nom 4 in. diam may only be used in walls constructed using steel channel studs. A max of one pipe or conduit is permitted in the firestop system. Pipe or conduit to be installed near center of stud cavity width and to be rigidly supported on both sides of wall assembly.
3. Fill, Void or Cavity Material* – Caulk – Caulk fill material installed to completely fill annular space between pipe or conduit and gypsum wallboard and with a min 1/4 in. diam bead of caulk applied to perimeter of pipe or conduit at its egress from the wall. Caulk installed symmetrically on both sides of wall assembly. The hourly F Rating of the firestop system is DEPENDENT upon the hourly fire rating of the wall assembly in which it is installed, as shown in the following table. The hourly T rating of the firestop system is dependent upon the type or size of the pipe or conduit and the hourly fire rating of the wall assembly in which it is installed, as tabulated below:

Max Pipe or conduit Diam, in.	Annular Space, In	F Rating, Hr	T Rating, Hr
1	0 to 3/16	1 or 2	0+, 1 or 2
1	1/4 to 1/2	3 or 4	3 or 4
4	0 to 1-1/2	1 or 2	0
6	1/4 to 1/2	3 or 4	0
12	3/16 to 3/8	1 or 2	0

+When copper pipe is used, T Rating is 0 hr.
Minnesota Mining & Mfg. Co. – CP 25WB+.
*Bearing the UL Classification Marking.

System No. WL1052

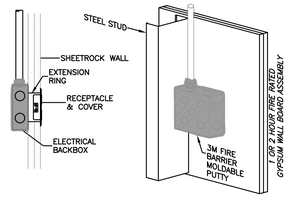
F Rating – 2, 3 AND 4 Hr
T Rating – 0 Hr
L Rating At Ambient – 2 CFM/sq ft (See Item 4)
L Rating At 400 F – less than 1 CFM/sq ft (See Item 4)



SECTION A-A

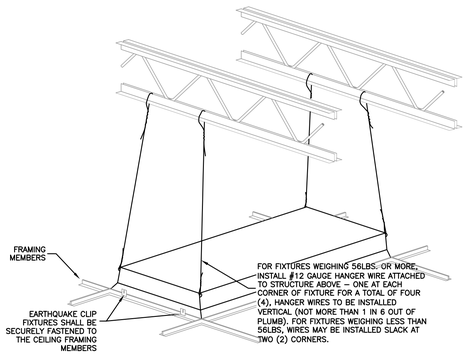
1. Floor or Wall Assembly – Lightweight or normal weight (100–150 pcf) concrete. Min. thickness of concrete floor or wall assembly is 4-1/2 in. for 2 and 3 hr F Ratings and 5-1/2 in. for 4 hr F Rating. Wall may also be constructed of any UL Classified Concrete Blocks*. Max diam of circular opening is 13-1/2 in. See Concrete Blocks (CAZT category in the Fire Resistance Directory for names of manufacturers.
2. Steel Pipe or Conduit – Nom 12 in. diam (or smaller) Schedule 10 or heavier steel pipe, nom 6 in. diam (or smaller) steel conduit or nom 4 in. diam (or smaller) steel EMT. Max one pipe or conduit per opening, centered in opening. Min clearance between pipe or conduit and sides of through opening is 1/4 in. Max clearance between pipe or conduit and sides of through opening is 1-3/4 in for 2 hr F rating and 3/4 in. for 3 and 4 hr F ratings. Pipe or conduit to be rigidly supported on both sides of floor or wall assembly.
3. Fill, Void or Cavity Material* – Wrap Strip – Nom 1/4 in. thick intumescent elastomeric material faced on one side with aluminum foil, supplied in 2 in. wide strips. For the 2 and 3 hr F Ratings, min 1 in. wide strip(s) wrapped around pipe/conduit (foil side exposed) until OD of wrap strip is equal to or max 3/16 in. less than ID of circular through opening. Wrap strip tightly bound with steel tie wire or pressure sensitive tape and slid into through opening such that the top edge of the wrap strip(s) is recessed 1/4 in. from the top surface of floor or, in wall assemblies, such that the wrap strip(s) is centered in the wall thickness. For the 4 hr F Rating, nom 2 in. wide strip(s) wrapped around pipe/conduit (foil side exposed) on each side of the floor or wall assembly until OD of wrap strip is equal to or max 3/16 in. less than ID of circular through opening. Wrap strip tightly bound with steel tie wire or pressure sensitive tape and slid into through opening on each side of floor or wall assembly such that the exposed edges are recessed 1/4 in. from the floor or wall surfaces.
   Minnesota Mining & Mfg. Co. – Types FS–195, FS–195+
4. Fill, Void or Cavity Material* – Caulk – Nom 1/4 in. thickness of caulk to be applied to the exposed edges of the wrap strip and to fill all voids between the pipe/conduit and the periphery of the through opening. For 2 or 3 hour F rating in floor assemblies, caulk to be installed flush with top surface of floor. For wall assemblies and for the 4 hour F Rating in floor assemblies, caulk to be applied on both sides of assembly.
   Minnesota Mining & Mfg. Co. – Types CP–25 S/L, CP–25 N/S, CP–25 WB, CP–25 WB+. (Note: L Ratings apply only when Type CP–25 WB+ caulk is used.)

*Bearing the UL Classification Marking.



5 WALL OPENING PROTECTION DETAIL
NTS – UL SECTION CLIV

HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC. R13240
5400 S 122ND EAST AVE, TULSA OK 74146
FS Pads, for use with max 4 by 4 in. flush device UL Listed Metallic Outlet Boxes in 1 and 2 hr. fire rated gypsum wallboard wall assemblies framed with min 3-5/8 in. wide steel studs and constructed as specified in the individual U400 Series Wall and Partition Designs in the Fire Resistance Directory. Min 1/8 in. thick moldable putty pads are to be installed to completely cover the exterior surfaces of the outlet box (except for the side of the outlet box against the stud) and completely seat against the stud within the stud cavity. When moldable putty pad outlet box protective material is used on boxes on both sides of wall as directed, the horizontal seperation between outlet boxes on opposite sides of the wall may be less than 24 in. provided that the boxes are not installed back to back.
MINNESOTA MINING & MFG CO R9700
3M CENTER, ST PAUL MN 55144
Type MPP–4S+ moldable putty pads for use with max 4–11/16 by 4–11/16 in. flush device UL listed Metallic Outlet Boxes in fire rated gypsum wallboard wall assemblies framed with min 3–1/2 in. wide wood or steel studs and constructed as specified in the individual U300 or U400 Series Wall and Partition Designs in the Fire Resistance Directory. Outlet boxes secured to wood studs by means of two nailing tabs in conjunction with nails supplied with the outlet box.



3 RECESSED LIGHTING FIXTURE DETAIL
NTS

WHERE FIXTURES ARE HUNG IN A FIRE RATED CEILING, THE CEILING CONTRACTOR SHALL PROVIDE FIRE PROTECTION AS SHOWN IN UL FIRE RESISTANCE BOOK AS DESIGN NOTE P230 OR P510.

J–BOX COVER
J–BOX CIRCUIT CONTENTS MARKED WITH INDELIBLE INK

ALL EXPOSED J–BOXES, NOT INCLUDING ELECTRICAL OR MECHANICAL ROOMS, SHALL BE MARKED ON THE INSIDE COVER. ALL OTHERS SHALL BE MARKED ON THE OUTSIDE.

ALL J–BOXES CONTAINING FIRE ALARM CIRCUITS SHALL BE PAINTED RED.

ALL J–BOXES CONTAINING SOUND CIRCUITS SHALL BE PAINTED GREEN.

4 J–BOX COVER DETAIL
NTS

ALL CONDUIT SHALL BE INSTALLED IN A NEAT AND ORDERLY MANNER, PERPENDICULAR TO ALL BUILDING WALLS AND BEAMS AND SHALL COMPLY STRICTLY WITH ALL CODES AND REQUIREMENTS OF THE NEC, NFPA, UL AND SBCCI WITH NO EXCEPTIONS.

ELECTRICAL SYMBOL SCHEDULE

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
LP1–2,4	BRANCH CIRCUIT RACEWAY. RUN CONCEALED IN CEILING OR WALLS. ARROWHEAD DENOTES HOMERUN TO PANEL. CROSSLINES DENOTE NUMBER OF PHASE AND NEUTRAL CONDUCTORS WHEN MAORE THAN TWO ARE TO BE INSTALLED. TEXT DENOTES PANEL NAME AND CIRCUIT NUMBERS FOR HOMERUN. INSTALL GROUND WIRE IN ALL RACEWAYS. #12 AWG MINIMUM AND AS PER CODE.		ELECTRICAL CIRCUIT BREAKER PANELBOARD.
LP1–2,4	BRANCH CIRCUIT RACEWAY. RUN IN AND/OR UNDER SLAB. ARROWHEAD DENOTES HOMERUN TO PANEL. CROSSLINES DENOTE NUMBER OF PHASE AND NEUTRAL CONDUCTORS WHEN MORE THAN TWO ARE TO BE INSTALLED. TEXT DENOTES PANEL NAME AND CIRCUIT NUMBERS FOR HOMERUN. INSTALL GROUND WIRE IN ALL RACEWAYS. #12 AWG MINIMUM AND AS PER CODE.	GF WP 8	DUPLEX RECEPTACLE, 120 VOLT, 20 AMP, WALL MOUNTED, GROUND FAULT CIRCUIT INTERRUPTER, 16" AFF. THE NUMBER DENOTES CIRCUIT NUMBER. "WP" DENOTES WEATHERPROOF COVER.
	FLEXIBLE CONDUIT. WEATHERPROOF TYPE WHEN CONNECTED TO MOTORS. CROSSLINES DENOTE NUMBER OF PHASE AND NEUTRAL CONDUCTORS WHEN MORE THAN TWO ARE INSTALLED. INSTALL GROUND WIRE WIRE #12 AWG MINIMUM.	GF 8	DUPLEX RECEPTACLE, 120 VOLT, 20 AMP, WALL MOUNTED. THE NUMBER DENOTES CIRCUIT NUMBER. "GF" DENOTES GFCI RECEPTACLE.
ESSENTIAL STORAGE N 1.50	SPACE NAME AND NUMBER. COORDINATE WITH ARCHITECTURAL SPACE NUMBER.	8	2 – 120 VOLT, 20 AMP DUPLEX RECEPTACLES, WALL MOUNTED, 16" AFF, UNLESS OTHERWISE NOTED. THE NUMBER DENOTES CIRCUIT NUMBER.
X	CEILING MOUNTED FLOURESCENT LIGHT FIXTURE. LETTER DENOTES TYPE OF FIXTURE IS EXISTING. SEE LIGHTING PLAN.	GF 8	2 – 120 VOLT, 20 AMP DUPLEX RECEPTACLES, WALL MOUNTED. THE NUMBER DENOTES CIRCUIT NUMBER. "GF" DENOTES GFCI RECEPTACLE.
4	EXIT SIGN. REFER TO FIXTURE SCHEDULE. DARKENED AREA DENOTES SIGN FACE. NUMBER DENOTES CIRCUIT NUMBER. STEM DESIGNATES WALL MOUNTING. NO STEM DENOTES CEILING MOUNTED.	8	DUPLEX RECEPTACLE, 20 AMP, 120 VOLT, CEILING MOUNTED. NUMBER DENOTES CIRCUIT NUMBER.
4	DOUBLE FACED EXIT SIGN. NOTATION SAME AS ABOVE. ARROWS DENOTE EXIT DIRECTION.	WP	FLUSH WALL MOUNTED JUNCTION BOX, SIZED PER NEC. "WP" DENOTES NEMA 3R WEATHERPROOF. PROVIDE AND INSTALL A FLUSH COVER PLATE.
$	LIGHT SWITCH, SPST, 20A, 48" AFF.		JUNCTION BOX, MOUNTED ABOVE CEILING, SIZED PER NEC. REFER TO THE NEC TO MAINTAIN CLEARANCES.
$3	LIGHT SWITCH, 3–WAY, 20A, 48" AFF.	1,3 20A	RECEPTACLE, 240 VOLT, WALL MOUNTED. THE ONE NUMBER DENOTES THE AMPERE RATING. THE TWO NUMBER DENOTES CIRCUIT NUMBER.
$4	LIGHT SWITCH, 4–WAY, 20A, 48" AFF.	1,3 20A	RECEPTACLE, 240 VOLT, WALL MOUNTED HIGH. THE ONE NUMBER DENOTES THE AMPERE RATING. THE TWO NUMBER DENOTES CIRCUIT NUMBER.
$M	MANUAL MOTOR STARTER FOR USE AS A DISCONNECT ON FRACTIONAL HORSEPOWER MOTORS.		TWO CHANNEL SURFACE MOUNTED RACEWAY FOR POWER AND DATA, WITH DUPLEX POWER RECEPTACLES AND TWO PORT DATA RECEPTACLES.
	CONDUIT FLOOR STUB–UP.	V	SINGLE GANG DATA OUTLET. CEILING MOUNTED.
•	DENOTES THAT ELECTRICAL DEVICE IS SURFACE MOUNTED.		

COMMUNICATIONS/SIGNAL		ABBREVIATIONS	
	SINGLE PORT VOICE OUTLET RECEPTACLE. FLUSH WALL MOUNTED, 16" AFF.	A	AMPERE.
	TWO PORT COMBINATION TELEPHONE AND DATA OUTLET RECEPTACLE, FLUSH WALL MOUNTED. SINGLE GANG, 16". DOT	AFF	ABOVE FINISHED FLOOR.
	TWO PORT COMBINATION TELEPHONE AND DATA OUTLET RECEPTACLE SAME AS ABOVE, EXCEPT MOUNTED 48" AFF OR HIGHER.	ATS	AUTOMATIC TRANSFER SWITCH
	SINGLE GANG DATA OUTLET. FLUSH WALL MOUNTED, 16" AFF.	BKR	BREAKER.
	SINGLE GANG DATA OUTLET. FLUSH WALL MOUNTED, 48" AFF OR HIIGHER.	C	CONDUIT.
	TELEPHONE OUTLET. FLUSH WALL MOUNTED, 48" AFF OR HIGHER.	CKT	CIRCUIT.
15	WALL MOUNTED FIRE ALARM HORN WITH FLASHING LIGHT. NUMBER DENOTES LIGHT LEVEL OF STROBE.	EC	ELECTRICAL CONTRACTOR, DIVISION 16.
30	FIRE ALARM VISUAL UNIT WITH STROBE LIGHT, MOUNTED 80" AFF OR 12" BELOW CEILING, WHICHEVER IS LOWER. NUMBER DENOTES LIGHT LEVEL OF STROBE.	EF	EXHAUST FAN.
TV	TV OUTLET. FLUSH MOUNTED. TWO GANG BOX, SINGLE GANG PLASTER RING. MOUNT 66" AFF BESIDE RECEPTACLE.	FCU	FAN COIL UNIT.
SD	CEILING MOUNTED SMOKE DETECTOR. IONIZATION.	GC	GENERAL CONTRACTOR, DIVISION 00 THROUGH 14.
HD	CEILING MOUNTED HEAT DETECTOR. 130°.	GF	GROUND FAULT CIRCUIT INTERRUPTER.
		JB or J–BOX	JUNCTION BOX.
		KVA	KILOVOLT AMPERES.
		KW	KILOWATT.
		MAX	MAXIMUM.
		MC	MECHANICAL CONTRACTOR, DIVISION 15.
		MDP	MAIN DISTRIBUTION PANEL.
		MIN	MINIMUM.
		V	VOLT.
		VFD	VARIABLE FREQUENCY DRIVE
		NEC	2011 NATIONAL ELECTRICAL CODE. (NFPA 70).
		SWBD	SWITCHBOARD.
		TYP	TYPICAL.
		WC	WATER COOLER.
		XFMR	TRANSFORMER.

LIGHT FIXTURE SCHEDULE

	TYPE	DESCRIPTION	CATALOG NO.	LAMPS
A	A	FLUORESCENT, 2' x 4', 3 LAMP RECESSED TROFFER NO PRE PAINT. 277 VOLT.	LITHONIA 2GTB–332–A12125–277–GEB10IS–PAF 277 VOLT	3–F32T8/SPX41
	A2	FLUORESCENT, 2' x 4', 2 LAMP RECESSED TROFFER NO PRE PAINT. 277 VOLT.	LITHONIA 2GTB–232–A12125–277–GEB10IS–PAF 277 VOLT	2–F32T8/SPX41
	A3	FLUORESCENT, 2' x 4', 2 LAMP RECESSED TROFFER NO PRE PAINT. 2–1 LAMP BALLAST. 1–1 LAMP BALLAST ON EMERGENCY CIRCUIT. 277 VOLT.	LITHONIA 2GTB–232–A12125–277–GEB10IS–2/1PAF 277 VOLT	2–F32T8/SPX41
	B	FLUORESCENT, 2' x 4', 2 LAMP RECESSED TROFFER NO PRE PAINT. 277 VOLT.	LITHONIA 2RTBS–232MVOLT–BINP–L835HTB 277 VOLT	2–F32T8/SPX41
	P	TRIM, LOW–PROFILE UNDERCABINET LIGHT FIXTURE 120 VOLT.	LITHONIA UC42E–120–LPWW–PAF 120 VOLT	2–13W T5
	P1	TRIM, LOW–PROFILE UNDERCABINET LIGHT FIXTURE 120 VOLT.	LITHONIA UC24E–120–LPWW–PAF 120 VOLT	2–8W T5
EXIT		EXIT LIGHT. SEE PLANS TO DETERMINE WHICH UNITS ARE SINGLE / DOUBLE FACED WALL OR CEILING MOUNTED. WALL MOUNTED EXIT LIGHTS SHALL BE MOUNTED AT 6" ABOVE TOP OF DOOR FRAME. LED.	MCPHILBEN #CXL–3–R–W 120 VOLT INPUT	LED
	NOTE #1:	ALL RECESSED LIGHT FIXTURES SHALL BE HUNG WITH 4 HANGER WIRES SO THAT THE WEIGHT IS INDEPENDENT OF THE CEILING GRID. ALL RECESSED FIXTURES SHALL BE INSTALLED WITH EARTHQUAKE CLIPS. ALL 2' AND 4' FLUORESCENT FIXTURES SHALL BE EQUIPPED WITH T8 LAMPS AND ELECTRONIC BALLASTS, UNLESS OTHERWISE NOTED. COORDINATE FIXTURE LOCATIONS WITH THE REFLECTED CEILING PLAN AND THE HVAC PLAN.		
	NOTE #2:	ALL HID AND FLUORESCENT LIGHT FIXTURES INSTALLED OUTDOORS OR EXPOSED TO COLD WEATHER SHALL HAVE ZERO DEGREE BALLASTS.		
	NOTE #3:	THE NUMBER AFTER THE FIXTURE CATALOG NUMBER DENOTES NUMBER OF BALLASTS (EXAMPLE: 1/4 DENOTES 1 – 4 LAMP BALLAST). TYPE "A" FIXTURES THAT ARE DOUBLE SWITCHED SHALL HAVE 2, 2 LAMP BALLASTS.		

GMK ASSOCIATES, INC.
Design/Planning/Construction
1201 Main Street, Suite 2100
Columbia, S.C. 29201
tel. 803-256-0000
fax 803-255-7243

consultants

owner

UNIVERSITY OF SOUTH CAROLINA

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COKER - 7th FLOOR PHARMACY RENOVATION

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H27- 6101

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date
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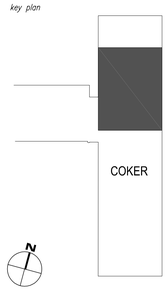
1	ADDENDUM NO. 2	05/28/2013

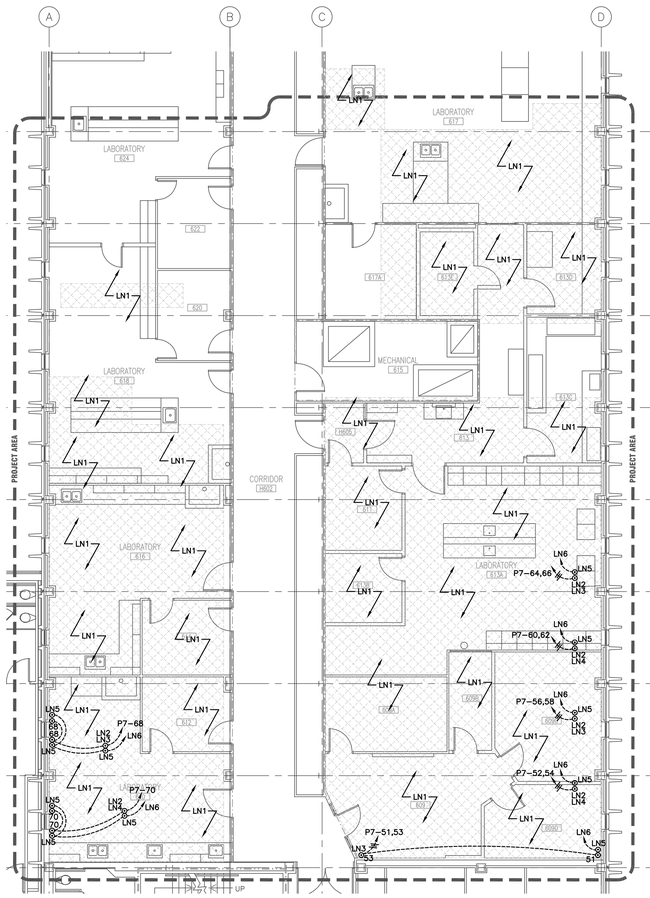
key plan



sheet title
ELECTRICAL SYMBOLS, SCHEDULES, AND DETAILS

sheet number
E0.0

drawn by TLK
checked by JBF



1 SIXTH FLOOR PLAN – RENOVATION
1/8"=1'-0"

LIGHTING NOTES (LN):

LN1. EC SHALL CLEAN LENS, RE-LAMP AS REQUIRED, AND CONNECT EXISTING LIGHT FIXTURE TO EXISTING LIGHTING CIRCUIT FROM DEMOLITION. COORDINATE BETWEEN THOSE FIXTURES THAT WERE SECURED DURING DEMOLITION AND THOSE THAT WERE DISCONNECTED AND REMOVED.

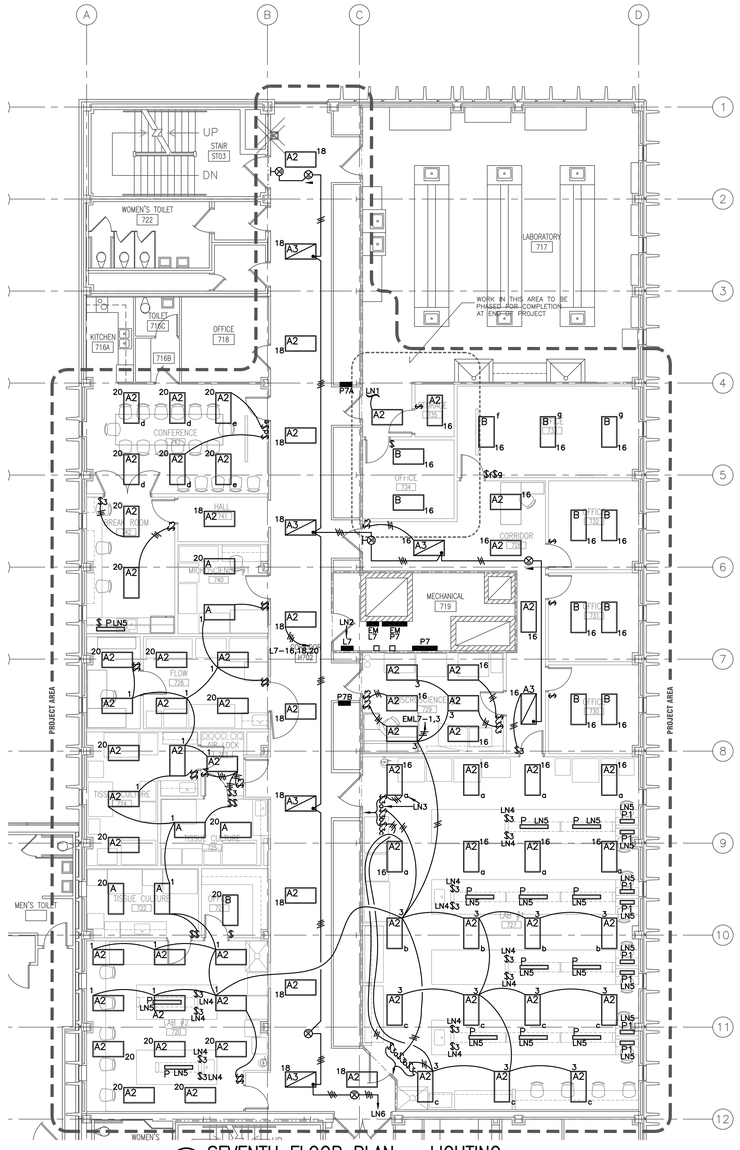
LN2. BENCH TABLE CIRCUIT PENETRATION FROM SEVENTH FLOOR ABOVE. COORDINATE SIZE, LOCATION OF PENETRATION, AND CONDUIT ROUTE TO EXISTING PANEL P7 PRIOR TO ANY ROUGH-IN.

LN3. EC SHALL FURNISH AND INSTALL A 20A/1P/120V BREAKER IN EXISTING SPACE OF EXISTING PANEL P7 LOCATED IN THE SEVENTH FLOOR ELECTRICAL ROOM.

LN4. EC SHALL FURNISH AND INSTALL A 20A/1P/120V GFI BREAKER IN EXISTING SPACE OF EXISTING PANEL P7 LOCATED IN THE SEVENTH FLOOR ELECTRICAL ROOM.

LN5. 1-1"C PENETRATION FROM SEVENTH FLOOR ABOVE FOR DATA CONDUIT. EC SHALL COORDINATE EXACT LOCATION OF PENETRATION.

LN6. EC SHALL COORDINATE DATA CONDUIT ROUTE AND STUB OUT 4" TO EXISTING CEILING PLENUM ON SEVENTH FLOOR.



2 SEVENTH FLOOR PLAN – LIGHTING
1/8"=1'-0"

LIGHTING NOTES (LN):

LN1. EC SHALL CONNECT TO EXISTING LIGHTING CIRCUIT AND SWITCH LEG IN EXISTING LABORATORY SPACE 717. COORDINATE.

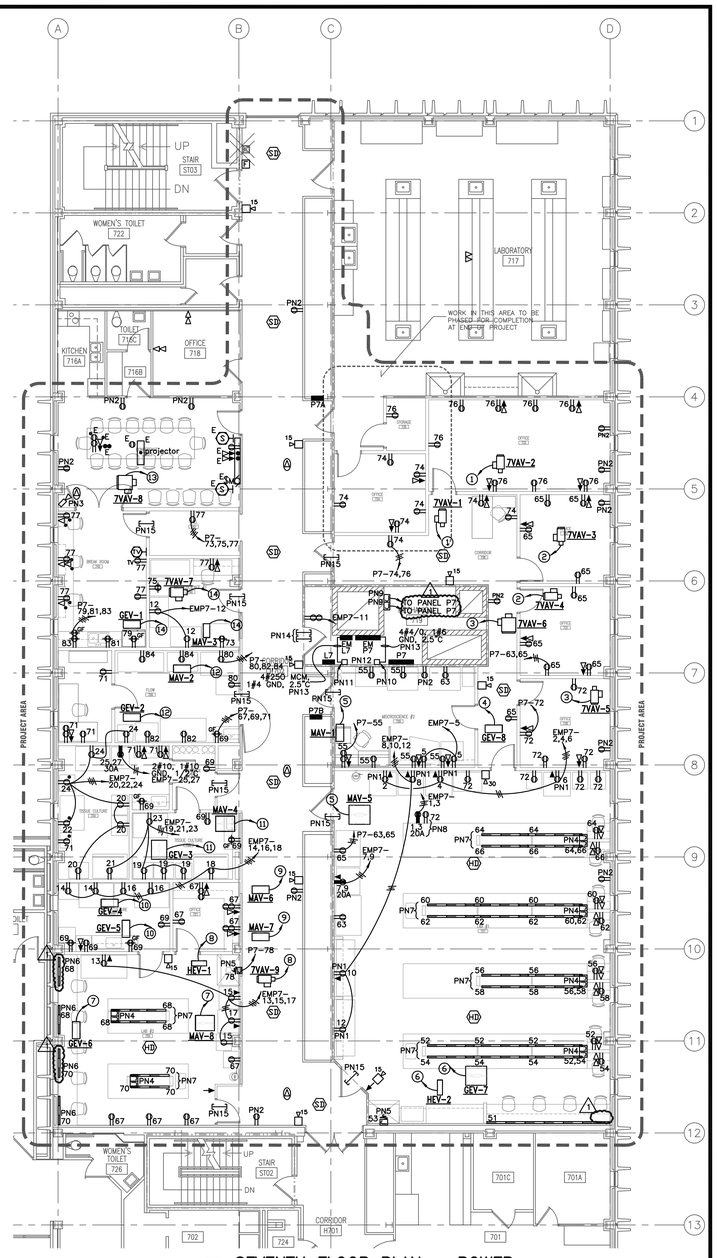
LN2. EC SHALL FURNISH AND INSTALL AN 20A/1P/277V BREAKERS IN EXISTING SPACES 16,18, AND 20 OF EXISTING PANEL L7. COORDINATE.

LN3. DENOTED SUBSCRIPT CORRESPONDS TO NEW LIGHTING SWITCH LEG. TYPICAL. COORDINATE.

LN4. 3-WAY SWITCH SHALL BE MOUNTED TO SHELVING WHERE FACE PLATE IS FLUSH. 3-WAY SWITCH SHALL CONTROL ALL UNDERCOUNTING LIGHTING FOR BENCH. COORDINATE WITH OWNER FOR EXACT MOUNTING LOCATION AND MILLWORK CONTRACTOR AND LAB BENCH SHOP DRAWINGS PRIOR TO ANY ROUGH-INS.

LN5. EC SHALL CONNECT FIXTURE TO NEAREST 120V RECEPTACLE CIRCUIT. EC SHALL COORDINATE EXACT MOUNTING LOCATION WITH MILLWORK CONTRACTOR AND LAB BENCH SHOP DRAWINGS PRIOR TO ANY ROUGH-INS.

LN6. CONNECT TO EXISTING CORRIDOR H701 EMERGENCY LIGHTING CIRCUIT. EC SHALL VERIFY THAT EXISTING EMERGENCY LIGHTING CIRCUIT HAS CAPACITY FOR NEW LOAD PRIOR TO CIRCUIT ADDITION. COORDINATE.



3 SEVENTH FLOOR PLAN – POWER
1/8"=1'-0"

POWER NOTES (PN):

PN1. EC SHALL COORDINATE RECEPTACLE TYPE WITH DEMOLITION RECEPTACLE TYPE FROM EXISTING RELOCATED EQUIPMENT AND MATCH. COORDINATE.

PN2. EXISTING RECEPTACLE FROM DEMOLITION. EC SHALL FURNISH AND INSTALL A NEW RECEPTACLE, FACEPLATE, AND CONNECT TO EXISTING CIRCUIT IN BACKBOX.

PN3. EXISTING RELOCATED CAMERA FROM DEMOLITION. EC SHALL RE-MOUNT AND MAKE OPERABLE. COORDINATE EXACT LOCATION WITH OWNER.

PN4. EC SHALL FURNISH AND INSTALL J-BOX(S) FOR POWER AND DATA CONDUIT INSIDE THE CHASE WALLS OF BENCH TABLE. EC SHALL VERIFY CONNECTION POINT WITH LAB BENCH SHOP DRAWINGS. SEE ELEVATION #6,7 ON SHEET A9.0. SEE CIRCUIT FLOOR PENETRATION AND DESCRIPTION ON 6TH FLOOR RENOVATION PLAN THIS SHEET.

PN5. EC SHALL FLEX AND CONNECT TO FUMEHOOD. MAKE OPERABLE. COORDINATE WITH FUMEHOOD MANUFACTURER DRAWINGS FOR EXACT CONNECTIONS.

PN6. EC SHALL FURNISH AND INSTALL WIREMOLD RACEWAY SERIES #AL3300. SEE WIREMOLD DETAIL #2 THIS SHEET. EC SHALL COORDINATE WIREMOLD MOUNTING HEIGHT WITH ELEVATIONS AS SHOWN ON SHEET A6.0. SEE CIRCUIT FLOOR PENETRATION AND DESCRIPTION ON 6TH FLOOR RENOVATION PLAN THIS SHEET.

PN7. EC SHALL FURNISH AND INSTALL WIREMOLD RACEWAY SERIES #AL3300. SEE WIREMOLD DETAIL #1 THIS SHEET.

PN8. COORDINATE EXACT MOUNTING HEIGHT AND LOCATION WITH LAB BENCH SHOP DRAWINGS AND OWNER PRIOR TO ANY ROUGH-INS.

PN9. JUNCTION BOX FOR HVAC CONTROLS. COORDINATE EXACT MOUNTING LOCATION WITH MC. EC SHALL FURNISH AND INSTALL AN 20A/120V/1P BREAKER IN EXISTING PANEL P7. 1

PN10. EC SHALL FURNISH AND INSTALL AN 225A/208V/3P BUS DUCT PLUG ON EXISTING 208/120V BUS DUCT RISER FOR NEW 225A SURFACE MOUNTED PANEL IN MECHANICAL ROOM 719.

PN11. EC SHALL FURNISH AND INSTALL AN 225A/480V/3P BUS DUCT PLUG ON EXISTING 480/277V BUS DUCT RISER FOR NEW 225A SURFACE MOUNTED PANEL IN MECHANICAL ROOM 719.

PN12. EXISTING 480/277V AND 208/120V BUS DUCT RISERS.

PN13. EC SHALL ROUTE FEEDER FROM BUS DUCT PLUG AROUND EXISTING HVAC DUCTWORK TO NEW SURFACE MOUNTED PANEL.

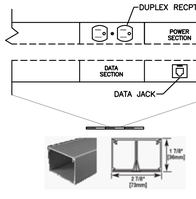
PN14. 4"C SLEEVE WITH GROMMETED ENDS ABOVE CEILING FOR DATA WIRE.

PN15. 2"C SLEEVE WITH GROMMETED ENDS ABOVE CEILING FOR DATA WIRE.

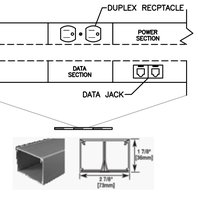
HVAC EQUIPMENT SCHEDULE

CIRCUIT I.D.	EQUIPMENT I.D.	CIRCUIT	FEEDER	BREAKER	NOTES
①	7VAV-1 7VAV-2	EMP7-26	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
②	7VAV-3 7VAV-4	EMP7-28	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
③	7VAV-5 7VAV-6	EMP7-30	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
④	GEV-8	EMP7-32	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑤	MAV-1 MAV-5	EMP7-34	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑥	GEV-7 HEV-2	EMP7-36	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑦	GEV-6 MAV-8	EMP7-29	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑧	7VAV-9 HEV-1	EMP7-31	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑨	MAV-6 MAV-7	EMP7-33	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑩	GEV-4 GEV-5	EMP7-35	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑪	MAV-4 GEV-3	EMP7-37	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑫	MAV-2 GEV-2	EMP7-39	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑬	7VAV-8	EMP7-38	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1
⑭	7VAV-7 GEV-1 MAV-3	EMP7-38	2#12, 1#12 GND, 1/2"C	20A/120V/1P	1

EQUIPMENT NOTES:
NOTE 1: DIVISION 15 CONTRACTOR TO FURNISH AND INSTALL DISCONNECT. EC TO WIRE.



TWO-PIECE DUAL-CHANNEL LAB BENCH WIRE MOLD DETAIL #1
NTS



TWO-PIECE DUAL-CHANNEL WIRE MOLD DETAIL #2
NTS

LOAD NAME	RATING	POLES	MLO A	B	C	POLES	RATING	LOAD NAME
LAB LIGHTING	20	1	1	•		2		
LAB LIGHTING			3		•	4	3	80
SPARE			5	•		6		
			7		•	8		
LEF-1	35	3	9	•		10	3	35
			11		•	12		
SPACE	20	1	13	•		14	1	20
			15		•	16		
			17	•		18		
			19		•	20		
			21	•		22		
			23		•	24		
			25	•		26		
			27		•	28		
			29	•		30		
			31		•	32		
			33	•		34		
			35		•	36		
			37	•		38		
			39		•	40		
			41	•		42		

TYPE : AQ, SURFACE
BUS AMPS : 225 AMPS
MAIN : MLO
VOLTAGE : 277-480V/3ø/4W/SN
SOURCE : 277/480V H701 EMERGENCY

PANEL NAME EML7
RMS SYM AMPS 42K AIC
SYSTEM NORMAL

PANEL EML7
• NORMAL – 277/480 VOLTS
SOURCE: 277/480V BUS DUCT

LOAD NAME	RATING	POLES	MLO A	B	C	POLES	RATING	LOAD NAME
PCR MACHINE	20	2	1	•		2	1	20
			3		•	4		
AIR TABLE/MDW STATION	20	1	5		•	6		
–80C UPRIGHT FREEZER	20	2	7	•		8		
			9		•	10		
I.T. DEDICATED RECEPT	20	1	11			12		
–80C CHEST FREEZER			13	•		14		
–20C FREEZER/FRIDGE			15		•	16		
–80C UPRIGHT FREEZER			17	•		18		
INCUBATOR/FRIDGE/FREEZ			19		•	20		
BIOSAFETY CABINET			21	•		22		
BIOSAFETY CABINET			23		•	24		
CENTRIFUGE	30	2	25	•		26		
			27		•	28		
GEV-6 , MAV-8	20	1	29	•		30		
7VAV-9 , HEV-1			31	•		32		
MAV-6 , MAV-7			33		•	34		
GEV-4 , GEV-5			35	•		36		
MAV-4 , GEV-3			37		•	38		
MAV-2 , GEV-2			39	•		40		
HEAT TRACE			41		•	42		

TYPE : AQ, SURFACE
BUS AMPS : 225 AMPS
MAIN : MLO
VOLTAGE : 120/208V/3ø/4W/SN
SOURCE : 120/208V BUS DUCT

PANEL NAME EMP7
RMS SYM AMPS 42K AIC
SYSTEM NORMAL

LOAD NAME	RATING	POLES	MLO A	B	C	POLES	RATING	LOAD NAME
–80C UPRIGHT FREEZER	20	1	1	•		2	1	20
			3		•	4		
			5	•		6		
–20C UPRIGHT FREEZER			7		•	8		
–80C CHEST FREEZER			9	•		10		
CONFOCAL SCOPE/WRK ST	20	1	11			12		
BIOSAFETY CAB/INCUBATOR			13	•		14		
BIOSAFETY CAB/INCUBATOR			15		•	16		
BIOSAFETY CABINET			17	•		18		
INCUBATOR – 2 STACK			19		•	20		
BIOSAFETY CABINET			21	•		22		
BIOSAFE CAB/FRIDGE/FRZ			23		•	24		
7VAV-1 , 7VAV-2			25	•		26		
7VAV-3 , 7VAV-4			27		•	28		
7VAV-5 , 7VAV-6			29	•		30		
GEV-8			31		•	32		
MAV-1 , MAV-5			33	•		34		
GEV-7 , HEV-2			35		•	36		
7VAV-8			37	•		38		
7VAV-7 , GEV-1 , MAV-3			39		•	40		
HEAT TRACE			41	•		42		

PANEL EMP7
• NORMAL – 120/208 VOLTS
SOURCE: 120/208V BUS DUCT

GMK ASSOCIATES, INC.
Design/Planning/Construction
1201 Main Street, Suite 2100
Columbia, S.C. 29201
tel. 803-256-0000
fax 803-255-7243

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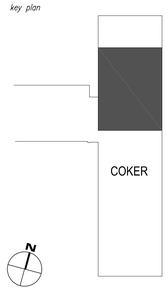

sheet title
SIXTH FLOOR RENOVATION PLAN AND SEVENTH FLOOR LIGHTING AND POWER PLANS

sheet number
E2.7

drawn by TLK
checked by JBF