MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING LIST

S000 STRUCTURAL GENERAL NOTES

S100 NORTH PLAN LAB UNITS
S101 SOUTH PLAN OFFICE UNITS
S102 NORTH PLAN OFFICE UNITS
S103 PARTIAL PLANS

S200 STRUCTURAL DETAILS

M000 MECHANICAL SYMBOLS & ABBREVIATIONS

M108 MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 1 - AHU0-6 & 0-8
M118 MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 1 - AHU0-6 & 0-8
M109 MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 1 - AHU0-6 & 0-8
M119 MECHANICAL ROOF PLAN PHASE 1 - AHU0-6 & 0-8

M208 MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 2 - AHU0-5 & 0-7
M218 MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 2 - AHU0-5 & 0-7
M209 MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 2 - AHU0-5 & 0-7
M219 MECHANICAL ROOF PLAN PHASE 2 - AHU0-5 & 0-7

M308 MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 3 - AHU-L3 & L4
M318 MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 3 - AHU-L3 & L4
M309 MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 3 - AHU-L3 & L4
M319 MECHANICAL ROOF PLAN PHASE 3 - AHU-L3 & L4

M408 MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 4 - AHU-L1 & L2
M418 MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 4 - AHU-L1 & L2
M409 MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 4 - AHU-L1 & L2
M419 MECHANICAL ROOF PLAN PHASE 4 - AHU-L1 & L2

M508 MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 5 - AHU0-2 & 0-4
M518 MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 5 - AHU0-2 & 0-4
M509 MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 5 - AHU0-2 & 0-4
M519 MECHANICAL ROOF PLAN PHASE 5 - AHU0-2 & 0-4

M608 MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 6 - AHU0-1 & 0-3
M618 MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 6 - AHU0-1 & 0-3
M609 MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 6 - AHU0-1 & 0-3
M619 MECHANICAL ROOF PLAN PHASE 6 - AHU0-1 & 0-3

M700 MECHANICAL AHU PLANS

M800 MECHANICAL SCHEDULES

M900 MECHANICAL DETAILS
M901 MECHANICAL DETAILS
M902 MECHANICAL DETAILS
M903 MECHANICAL DETAILS
M904 MECHANICAL DETAILS

M990 MECHANICAL CONTROL DIAGRAMS
M991 MECHANICAL CONTROL DIAGRAMS

ISSUE FOR:			
Area	Rev.	Date	Description
		04/13/18	CONSTRUCTION

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Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
COVER SHEET

DRAWING NO.

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GENERAL NOTES

I. DESIGN CRITERIA

A. GENERAL BUILDING CODE

1. The Documents are based on the requirements of the International Building Code 2012.
2. Hanging Ceiling and Mechanical Loads: An allowance of 20 PSF has been made for hanging ceiling and mechanical equipment loads such as duct work and sprinkler pipes.

B. LIVE LOADS

1. Design live loads are based on the more restrictive of the uniform load listed below or the concentrated load listed acting over an area 2.5 feet.
   a. Roofs: 20 PSF
2. Reduction of Live Loads:
   a. Live loads have been reduced using the standard procedure from the building code.

C. WIND LOADS

1. Wind pressures are based on the provisions of the American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures, ASCE 7-10 and the following criteria:
   a. Ultimate design wind speed (Vult): 139 MPH (3 second gust)
   b. Building risk category: II
   c. Wind exposure category: B

   Notes:
   a. Pressures act normal to the surface. Positive pressures act towards the surface and negative pressures act away from the surface.
   b. Design pressure for components and cladding shall not be less than 16 PSF acting in either direction normal to the surface.
   c. The design pressures listed above are calculated using a value of Kd of 0.85. The values must be increased by 18% unless load combinations specified in ASCE 7-10 are used in design.

II. NON-DESTRUCTIVE EVALUATION

A. ITEMS EMBEDDED IN CONCRETE STRUCTURES

1. Items embedded in concrete structures shall not be damaged during repair work or installation of new members requiring post-installed anchors. Embedded items may include mild reinforcement, prestressing reinforcement, dowels, embedded connections, electrical conduits, plumbing, etc.
2. Items embedded in concrete shall be located by non-destructive evaluation prior to performing any work. Contractor shall mark on the structure the location of embedded prior to coring in concrete.
3. Contractor shall not start fabrication of new members until items embedded in concrete have been located. Contact Engineer if existing embedded items interfere with location of post-installed anchors specified in drawings.

III. SELECTIVE DEMOLITION

A. RESPONSIBILITY OF THE CONTRACTOR FOR STABILITY OF THE STRUCTURE DURING DECONSTRUCTION / DEMOLITION

1. It is the responsibility of the Contractor to maintain the stability and safety of all structural elements during the demolition process.

B. MATERIAL OWNERSHIP

1. Except for items or materials indicated to be reused, salvaged, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site. The materials removed shall be disposed in a proper and legal manner per federal/state or local ordinances.

C. QUALITY ASSURANCE

1. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
2. Regulatory Requirements: Comply with governing Owner, Local, State, Federal, and EPA notifications and regulations before beginning selective deconstruction / demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

D. PROJECT CONDITIONS

1. Conduct selective demolition so Owner's operations will not be disrupted. Provide not less than 72-hour notice to Owner of activities that will affect Owner's operations.
2. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
3. Owner assumes no responsibility for condition of areas to be selectively demolished.
   a. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   b. Before selective demolition, Owner will remove items within space as needed.
4. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. These materials shall be removed as disposed as approved by governing agency.
5. Storage or sale of removed items or materials on-site will not be permitted.
6. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations. Maintain fire-protection facilities in service during selective demolition operations.
7. All areas outside of demolition scope to be protected from damage by contractor. Restore areas subject to incidental damage to their pre-demolition condition.

E. PREPARATION

1. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
2. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   a. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of adjacent facilities.
3. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
4. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and to prevent unexpected or uncontrolled movement or collapse of construction being demolished. Strengthen or add temporary supports when required during progress of selective demolition.

F. EXECUTION OF SELECTIVE DEMOLITION

1. General: Demolish existing construction as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   a. Use cutting methods least likely to damage construction to remain or adjoining construction.
   b. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
   c. Maintain adequate ventilation when using cutting torches.
   d. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, slabs, or framing.
   e. Dispose of demolished items and materials promptly.
2. Existing Facilities: Comply with Owner's requirements for using and protecting other building facilities during selective demolition operations.

G. DISPOSAL OF DEMOLISHED MATERIALS

1. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
2. Burning: Do not burn demolished materials.
3. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

IV. CONCRETE

A. CONCRETE REPAIR MATERIALS

1. Concrete shall conform to the following requirements:

Classes of Concrete Matrix

Location	Comp Strength PSI	Type	Exposure Class	Max W/C Ratio	Air Content	Max Agg. Size (in.)	Notes
Housekeeping Pads	3,000	LWC	-	0.45	-	3/4	
Infill	4,000	NWC	C1	0.45	-	1	

B. HORIZONTAL CONSTRUCTION JOINTS IN CONCRETE POURS

1. There shall be no horizontal construction joints in any concrete pours unless shown on the drawings. The Engineer shall approve all deviations or additional joints in writing.

C. REINFORCING STEEL

1. All Reinforcing Steel shall be ASTM A 615 Grade 60 unless noted otherwise on the drawings or in these notes.
2. Deformed Welded Wire Reinforcement: ASTM A 497, yield strength 70,000 PSI.

D. PLACEMENT OF WELDED WIRE REINFORCEMENT

1. Wherever welded wire reinforcement is specified as reinforcement, it shall be continuous across the entire concrete surface [and not interrupted by beams or girders] and properly lapped per ACI 318, 12.18 and 12.19.

E. REINFORCEMENT IN TOPPING SLABS

1. Provide minimum reinforcement as noted below in all topping slabs unless specified otherwise on the drawings.
   a. Welded smooth wire reinforcement 6x6-W2.9xW2.9.

F. REINFORCING STEEL COVERAGE

1. Reinforcing steel coverage should conform to the requirements specified on the drawings. Cover in structural members not specified in the details shall conform to the requirements of ACI 318 unless specified otherwise on the drawings.

V STRUCTURAL STEEL

A. MATERIAL

1. Hot Rolled Structural Members: All hot rolled steel plates, shapes, sheet piling, and bars shall be new steel conforming to ASTM Specification A 6.
2. ASTM Specification and Grade: Clearly mark the grade of steel on each piece, with a distinguishing mark visible from floor surfaces, for the purpose of field inspection of proper grade of steel. Unless noted otherwise on the drawings, structural steel shall be as follows:

   a. W- and WT-Shapes: ASTM A 992.
   b. Plates: All plates shall conform to ASTM A 36 unless noted otherwise on the drawings.
   c. Angles, Bent Plates: ASTM A 36.
   d. Other Steel: Any other steel not indicated otherwise shall conform to ASTM A 992 or ASTM A 572, Grade 50, except plates and angles that shall be ASTM A 36.

B. STRUCTURAL BOLTS AND THREADED FASTENERS

1. A 325 Bolts: All bolts in structural connections shall conform to ASTM A 325 Type 1, unless indicated otherwise on the drawings.

C. WELDING

1. Unless noted otherwise, electrodes for welding shall conform to E70XX (SMAW), F7XX-EXXX (SAW), ER70S-X (GMAW), or E7XT-X (FCAW).

D. GROUT

1. Grout below structural steel base plates shall be non-metallic, non-shrink grout with a minimum strength of 8,000 psi.

VI. STEEL DECKS

A. COMPOSITE DECK

1. All deck shall be 40 KSI unless noted otherwise.
2. Attachment of Deck:
   a. Minimum Attachment at Supports: Steel deck units shall be welded to the support members with 5/8" diameter puddle welds at each end of sheet and each intermediate support at each low flute, unless noted otherwise. At members parallel to deck span, spacing of puddle welds shall be 12". A shear connector welded through the deck can replace a required deck weld.
   b. Minimum Attachment at Side Laps: Side laps of adjacent units shall be fastened by welding, sheet metal screws, or button punching at a maximum of one-half the span or 36", whichever is less, unless noted otherwise.

VII. SPECIAL INSPECTIONS

A. The Owner's testing laboratory shall provide special inspection services in accordance with the International Building Code for the items listed below. Special inspection shall be provided by an intendent testing laboratory employed by the Owner.

B. The Special Inspector shall furnish inspection reports to the Engineer of Record

C. Once corrections are performed by the Contractor, the special inspector shall submit a final report to the Engineering that to the best of the Special Inspector's knowledge the work is in accordance with the construction documents and applicable workmanship.

1. Steel Construction:
   a. Welding Inspection
      (i) Periodic verification of welding procedure
      (ii)Periodic verification of material type and grade
      (iii) Periodic verification of welder qualifications
      (iv)Continuous verification of filet welds
   b. High-Strength Bolting
      (i) Periodic verification of bolt size, location and torque
   c. Steel members
      (i) Continuous verification of size and strength

2. Concrete Construction:
   a. Continuous Inspection of Reinforcing Steel Placing
      (i) Verify size, clearances and proper ties
   b. Periodic Inspection of concrete mix
      (i) Verify mix design meets strength and exposure
   c. Continuous Inspection of concrete placement/sampling
      (i) Include sampling for slump, strength and temperature

VIII. SUBMITTALS

A. SUBMITTAL LIST AND SCHEDULE

1. The Contractor shall prepare a detailed list and schedule of all submittal items to be sent to the Structural Engineer prior to the start of construction. This list shall be updated and revised and kept current as the job progresses. The submittal list shall be organized as shown below:
   a. Shop Drawings
   b. Product Data, Certificates, Reports, and Other Literature

B. SUBMITTALS TO BE PROVIDED TO STRUCTURAL ENGINEER

1. The following submittals shall be provided:
   a. Concrete mix.
   b. Structural steel.
   c. Roof (sheet metal, flashing etc...)

   Notes:

   (S&S) Items marked thus shall have the shop drawings and delegated design submittals (including calculations) sealed per the project specifications by an engineer registered in the state where the project is located.

   (REC) Items marked thus shall be submitted to Engineer for Record Only and will not have the Engineer's shop drawing stamp affixed.
2. Submittal Requirements:
   a. All shop drawings must be reviewed and electronically stamped by the Contractor prior to submittal.
   b. Contractor shall provide the submittal in electronic portable document format (PDF) per the Specifications.
   c. The omission from the shop drawings of any materials required by the Contract Documents to be furnished shall not relieve the Contractor of the responsibility of furnishing and installing such materials, regardless of whether the shop drawings have been reviewed and approved.

C. REPRODUCTION

1. The use of electronic files or reproductions of these contract documents by any contractor, subcontractor, erector, fabricator, or material supplier in lieu of preparation of shop drawings signifies their acceptance of all information shown hereon as correct, and obligates themselves to any job expense, real or implied, arising due to any errors that may occur hereon.

IX. MISCELLANEOUS

A. CONTRACT DOCUMENTS

1. It is the responsibility of the Contractor to obtain all Contract Documents and latest addenda and to submit such documents to all subcontractors and material suppliers prior to the submittal of shop drawings, fabrication of any structural members, and erection in the field.
2. The contract structural drawings and specifications represent the alteration made to the structure, and, except where specifically shown, do not indicate the method or means of construction. The Contractor shall supervise and direct the work and shall be solely responsible for all construction means, methods, procedures, techniques, and sequence.
3. Openings through floors, roofs, and walls for ducts, piping, and/or conduit shall be coordinated by the contractor. Contractor shall verify sizes and locations of holes and openings with the Mechanical, Electrical, Plumbing, and Fire Protection drawings and the respective subcontractors.

B. DRAWING CONFLICTS

1. The Contractor shall compare the Architectural and Structural drawings and report any discrepancy between each set of drawings and within each set of drawings to the Architect and Engineer prior to the fabrication and installation of any structural members.

C. CONFLICTS IN STRUCTURAL REQUIREMENTS

1. Where conflict exists among the various parts of the contract documents drawings, and general notes, the strictest requirements, as indicated by the Engineer, shall govern.

D. EXISTING CONDITIONS

1. The Contractor shall verify all dimensions and conditions of the existing building at the job site and report any discrepancies from assumed conditions shown on the drawings to the Engineer prior to the fabrication and erection of any members. Existing dimensions shown on the drawings are for general reference only and should not be used for final construction or detailing.
2. Existing construction shown on the drawings was obtained from existing construction documents and limited site observation. These drawings of existing construction are available for contractor use and shall be referenced for familiarization with existing conditions. However, the available drawings of existing construction are not necessarily complete. The contractor is responsible for being knowledgeable on information presented in available drawings and shall field verify all pertinent information.
3. Demolition, cutting, drilling, etc. of existing work shall be performed with great care so as not to jeopardize the structural integrity of the existing building. If any architectural, structural, or MEP members not designated for removal interfere with the new work, the Owner shall be notified immediately and approval obtained prior to removal of those members.
4. The contractor shall perform a survey to locate all existing utilities (including underground utilities) prior to the start of construction and take care to protect utilities that are to remain in service. Existing civil, mechanical, electrical, plumbing, and emergency protection system servicing any areas outside the work area are to be maintained in operable condition throughout the duration of construction. Contractor shall make necessary temporary connections to maintain existing utilities in service during the work. Temporary, localized interruption of these systems shall require approval by the Owner.
5. The contractor shall provide dust, odor, and noise protection, and safety measures as necessary for the duration of construction. Provide all measures necessary to protect the existing structure, building interior, facility patrons, and other persons during construction.
6. The contractor shall repair all damage caused during construction with similar materials and workmanship to restore conditions to levels acceptable to the Owner.

E. ADJACENT BUILDINGS AND PROPERTY

1. The Contractor shall ensure that all construction methods used will not cause damage to the adjacent buildings and property. This shall include all foundation installation.

F. RESPONSIBILITY OF THE CONTRACTOR FOR STABILITY OF THE STRUCTURE DURING CONSTRUCTION

1. Structural elements of the project have been designed by the Structural Engineer to resist the required code vertical and lateral forces that could occur in the final structure only. The ability of the structural frame to resist the required code forces derives from the complete installation of the new structural elements. It is the responsibility of the Contractor to provide all required bracing during construction to maintain the stability and safety of all structural elements during the construction.

G. RESPONSIBILITY OF THE CONTRACTOR FOR CONSTRUCTION LOADS

1. The structural elements has have been designed for the loads identified within these < drawings that are anticipated to be applied to the structure once work is completed. The Contractor shall not overload the structure during construction. The Contractor shall be responsible for checking the adequacy of the structure to support any applied construction loads. The Structural Engineer is not responsible to design or check the structure for loads applied to the structure for any construction activity.

H. THE STRUCTURAL ENGINEER'S ROLE DURING CONSTRUCTION

1. The Engineer shall not have control nor charge of, and shall not be responsible for, construction means, methods, techniques, sequences, or procedures, for safety precautions and programs in connection with the work, for the acts or omission of the Contractor, Subcontractor, or any other persons performing any of the work, or for the failure of any of them to carry out the work in accordance with the contract documents.
2. Periodic site observation by field representatives of Walter P. Moore and Associates is solely for the purpose of becoming generally familiar with the progress and quality of the Work completed and determining, in general, if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the structural contract documents. This limited site observation should not be construed as exhaustive or continuous to check the quality or quantity of the work, but rather periodic in an effort to guard the Owner against defects or deficiencies in the work of the Contractor.

I. MAINTENANCE STATEMENT

1. All structures require periodic maintenance to extend lifespan and to ensure structural integrity from exposure to the environment. A planned program of maintenance shall be established by the building owner. This program shall include such items such as but not limited to painting of structural steel, protective coating for concrete, sealants, caulked joints, expansion joints, control joints, spalls and cracks in concrete, and pressure washing of exposed structural elements exposed to a salt environment or other harsh chemicals.

X. DRAWING INTERPRETATION

A. DRAWING VIEWS LABELED AS "TYPICAL"

1. Partial plans, elevations, sections, details, or schedules labeled with "Typical" at the beginning of their title shall apply to all situations occurring on the project that are the same or similar to those specifically shown. The applicability of the content of these views to locations on the plan can be determined from the title of the views. Such views shall apply whether or not they are keyed in at each location. Decisions regarding applicability of these "Typical" views shall be determined by the Structural Engineer.

Walter P. Moore and Associates, Inc.
TBPE Firm Registration No. 1856

STATE OF TEXAS
ABDELHAKIM BOUADI
88445
LICENSED
PROFESSIONAL ENGINEER
04/13/18

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ISSUE FOR:			
Area	Rev.	Date	Description
		10/25/17	Progress Plot
		01/19/18	95% Construction
		04/13/18	Construction Drawings

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Date 04/13/18

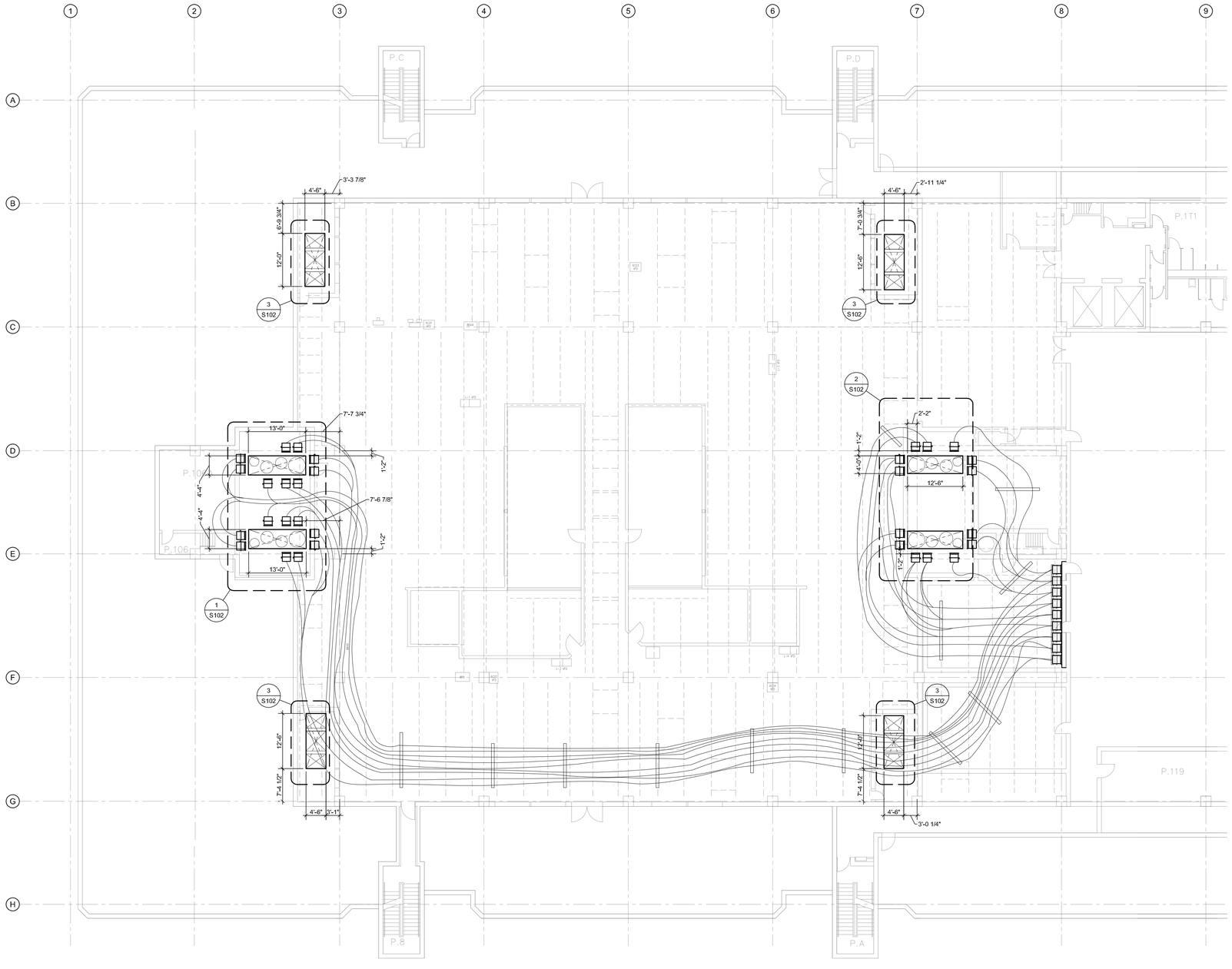
UTHSC Project No. 730022
E & C Project No. 3302.00
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
SOUTH PENTHOUSE

DRAWING TITLE
GENERAL NOTES

DRAWING NO.
S000



NOTES:
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2. COORDINATE LOCATION OF HOLD DOWNS WITH MEP DRAWINGS.
3. FIELD VERIFY EXISTING DIMENSIONS AND CONDITIONS.
4. COORDINATE PHASING WITH MEP DRAWINGS.

1 PENTHOUSE ROOF PLAN

NO SCALE

Walter P. Moore and Associates, Inc.
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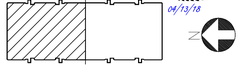
04/13/18



ISSUE FOR:			
Area	Rev.	Date	Description
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Date
04/13/18

UTHSC Project No.
730022
E & C Project No.
3302.00
File Name

UTHealth
The University of Texas
Health Science Center at Houston

MEDICAL SCHOOL BUILDING
SOUTH PENTHOUSE

DRAWING TITLE
NORTH PLAN

DRAWING NO.
S100

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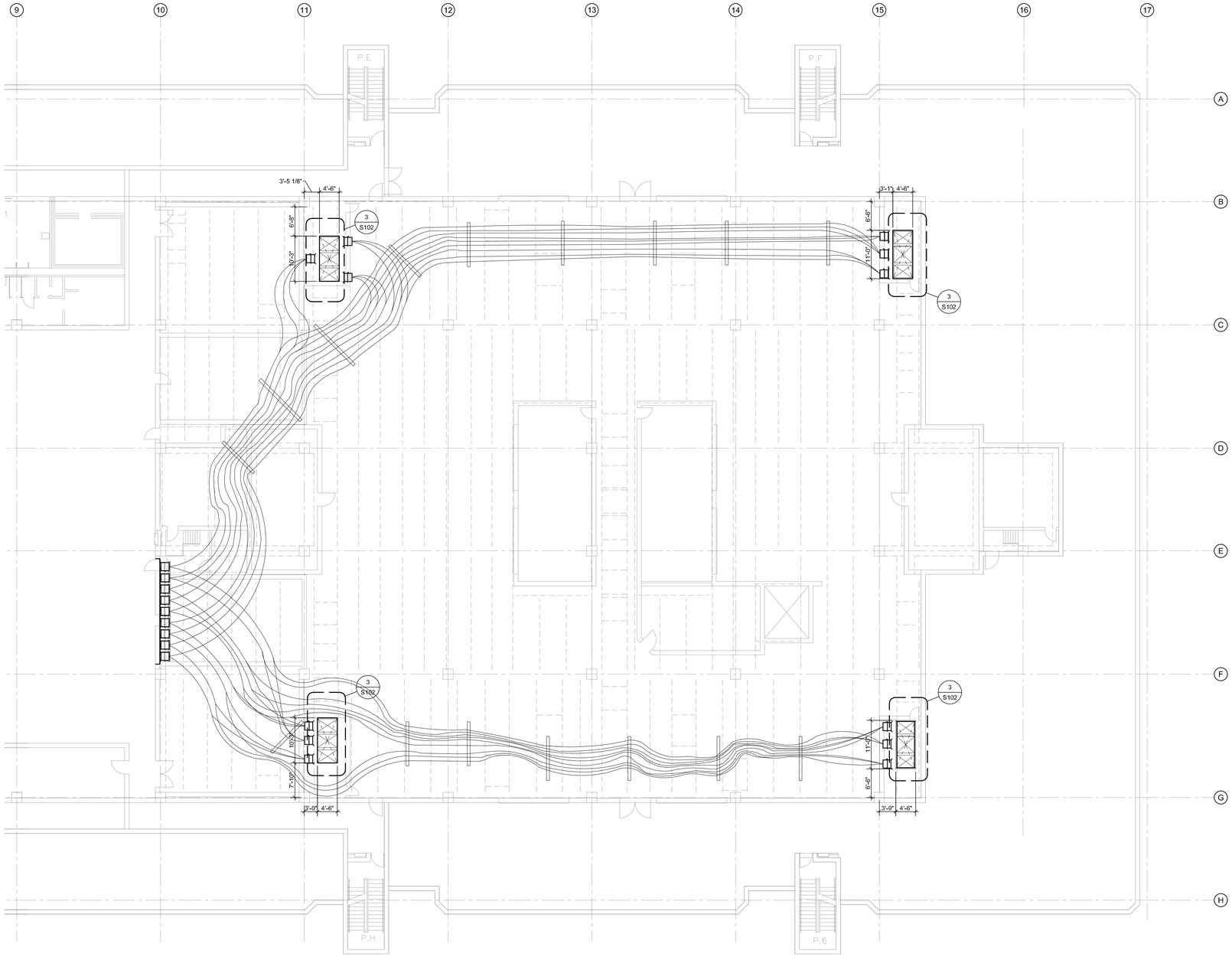

2 PENTHOUSE ROOF PLAN

NO SCALE

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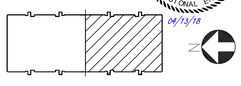
04/13/18



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UTHSC Project No.
730022
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3302.00
File Name

UTHealth
The University of Texas
Health Science Center at Houston

MEDICAL SCHOOL BUILDING
SOUTH PENTHOUSE

DRAWING TITLE
SOUTH PLAN

DRAWING NO.
S101

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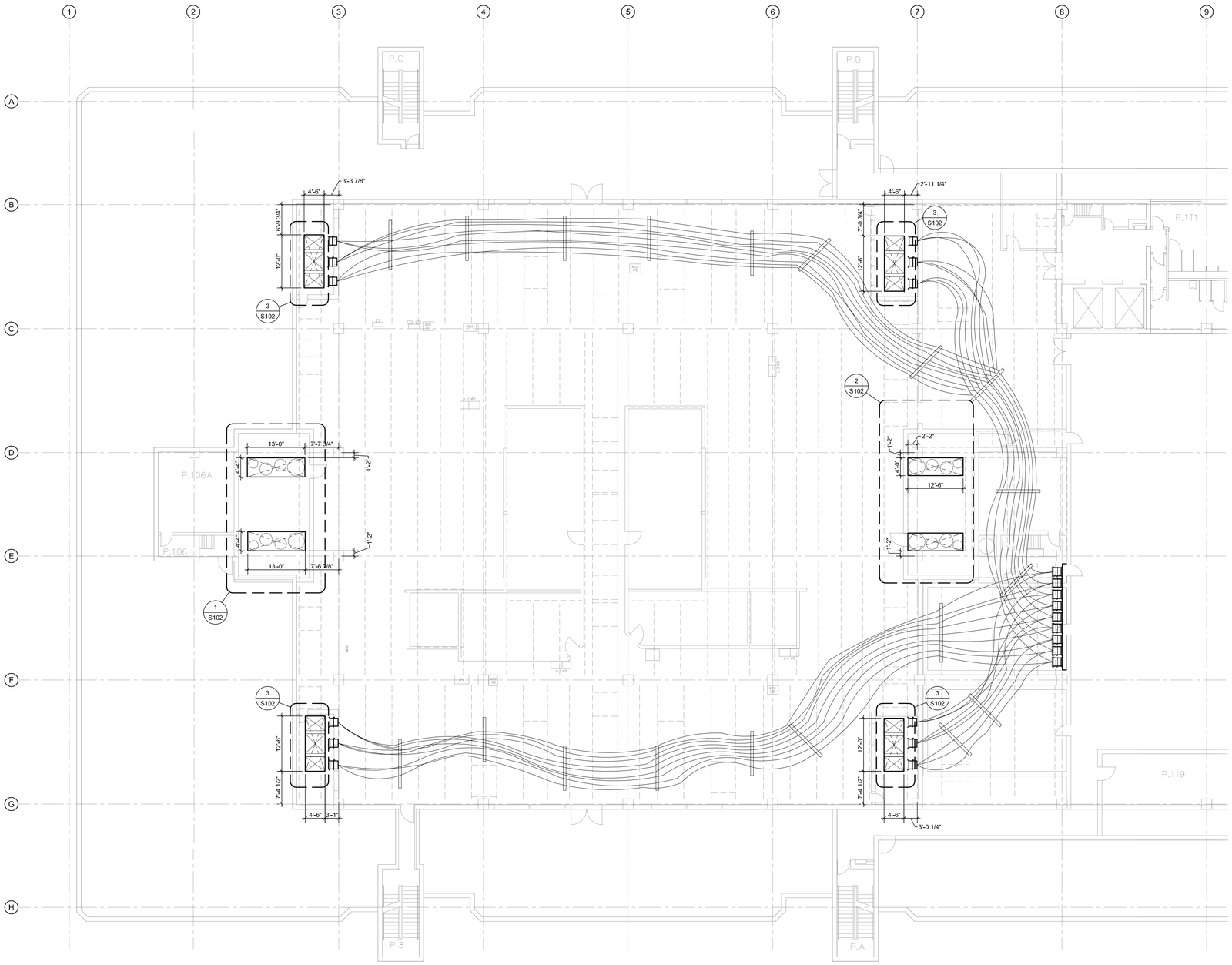

NOTES:
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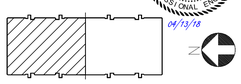
PROFESSIONAL ENGINEER
04/13/18



ISSUE FOR:			
Area	Rev.	Date	Description
		10/25/17	Progress Plot
		01/19/18	95% Construction
		04/13/18	Construction Drawings

E & C
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Date
04/13/18

UTHSC Project No.
730022
E & C Project No.
3302.00
File Name

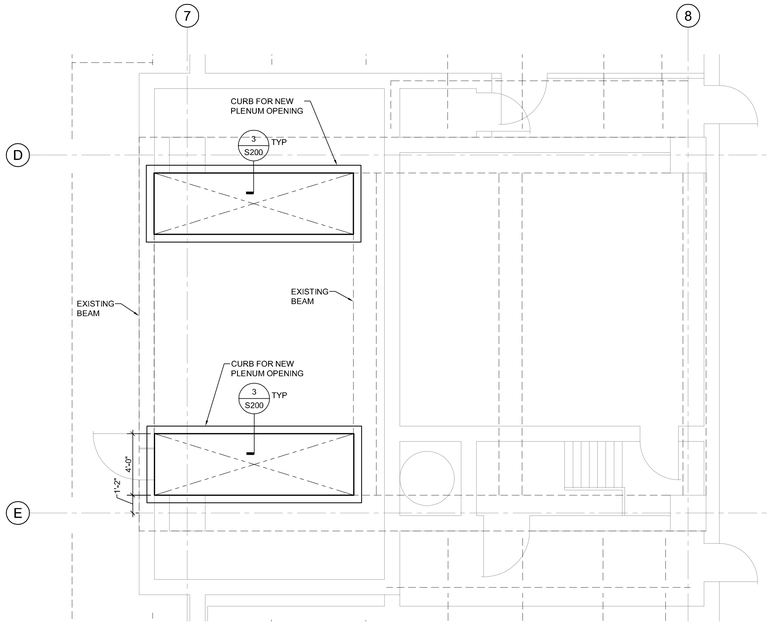
UTHealth
The University of Texas
Health Science Center at Houston

MEDICAL SCHOOL BUILDING
SOUTH PENTHOUSE

DRAWING TITLE
NORTH PLAN

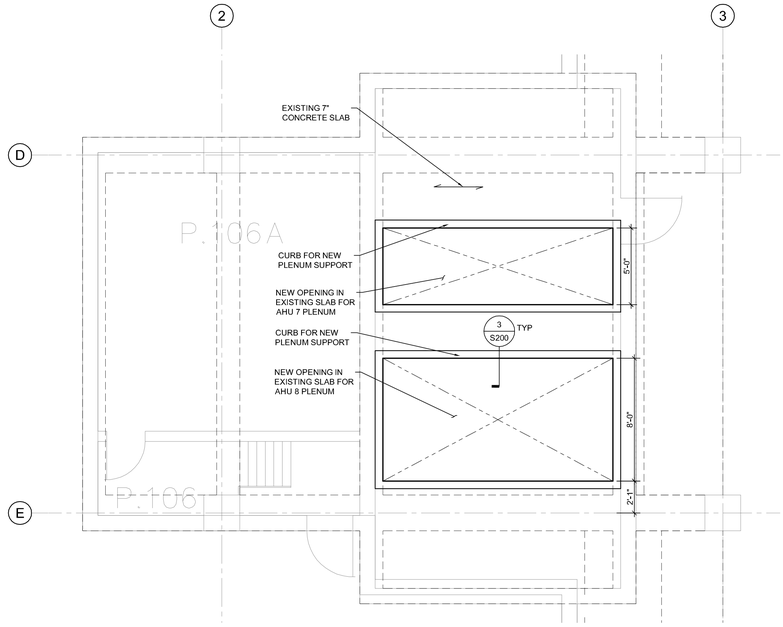
DRAWING NO.
S102

FILE: \\hou-server\projects\D03\2016\16013-02 MSB Roofing ASR2\3-Documentation\Drawings\AutoCAD\Phase III\Sheets\S100-S101.dwg



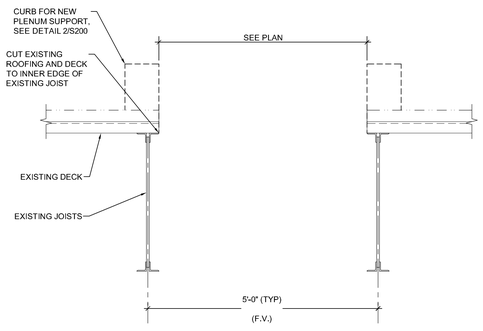
NOTES:
1. SEE NOTES ON 1/S102.

2 PARTIAL PLAN - PENTHOUSE 1
1/4" = 1'-0"

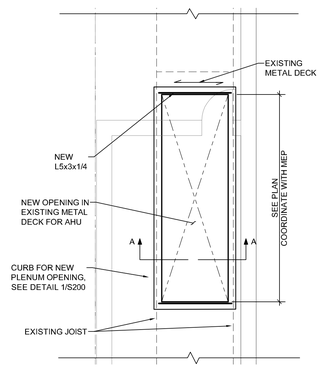


NOTES:
1. COORDINATE OPENING SIZE WITH MEP DRAWINGS.
2. COORDINATE LOCATION OF CURB WITH MEP DRAWINGS AND APPROVED EQUIPMENT SHOP DRAWINGS. CURB MAY BE SETBACK FROM OPENING EDGE.
3. DO NOT DAMAGE OR DISTURB THE EXISTING OPENING OR THE EXISTING DUCT.
4. FOR INFILL OF SLAB OPENING REFER TO DETAIL 7/S200.
5. DO NOT OVERCUT OPENINGS. CORE CORNERS, FIRST BEFORE SAW CUTTING OPENINGS.

1 PARTIAL PLAN - PENTHOUSE 2
1/4" = 1'-0"



SECTION "A-A"
(NO SCALE)

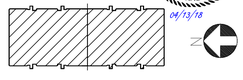


2. FOR CURB SUPPORT AT EXISTING JOIST, SEE 2/S200.
3. FOR CURB SUPPORT AT NEW STEEL ANGLES, SEE 1/S200.
4. FOR CONNECTIONS OF NEW ANGLE TO JOIST SEE 9/S200.

3 PARTIAL PLAN - PENTHOUSE 3
1/4" = 1'-0"

Walter P. Moore and Associates, Inc.
TBPE Firm Registration No. 1856

STATE OF TEXAS
ABDELHAKIM BOUADI
86445
LICENSED
PROFESSIONAL ENGINEER
04/13/18



ISSUE FOR:			
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Date 04/13/18

UTHSC Project No. 730022
E & C Project No. 3302.00
File Name

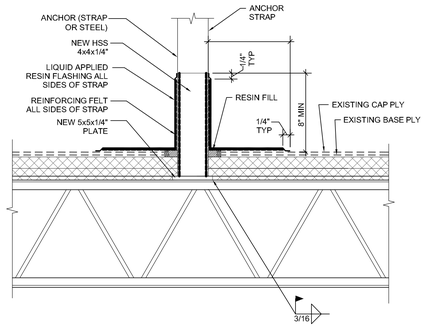
UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
SOUTH PENTHOUSE

DRAWING TITLE
PARTIAL PLANS

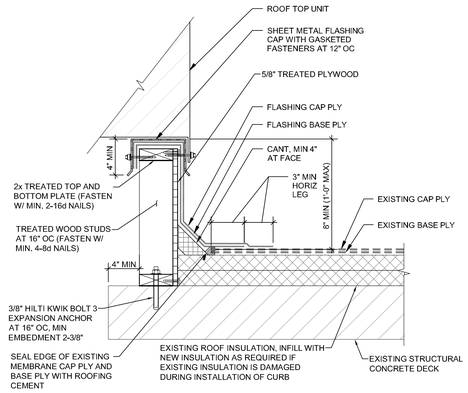
DRAWING NO.
S102

FILE: \\hou-server\projects\003\2016\16013-02 MSB Roofing ASR2\3-Documentation\Drawings\AutoCAD\Phase II\Sheets\S102.dwg

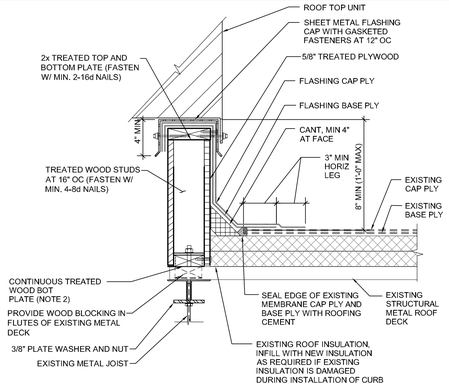


NOTE:
1. LOCATE HSS AT PANEL POINT OF EXISTING JOIST

4 TYPICAL ANCHOR CONNECTION TO ROOF STRUCTURE
1 1/2" = 1'-0"

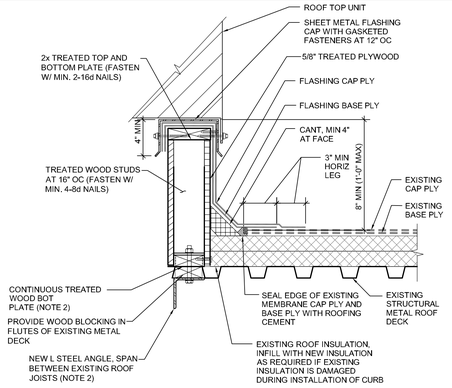


3 CURB DETAIL AT CONCRETE SLAB - WITH ROOF PENETRATION
1 1/2" = 1'-0"



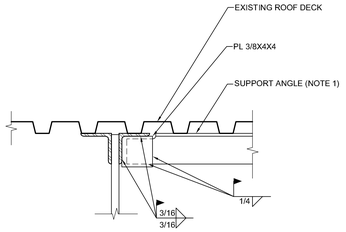
NOTE:
1. ANCHORAGE OF PLENUM TO CURB BY MECHANICAL CONTRACTOR.
2. CONNECT SUPPORT ANGLE TO CURB WITH 1/2" DIA. A307 BOLTS AT 16" O.C. PROVIDE PLATE WASHER AT BOTTOM PLATE.
3. SEE 9/S200 FOR ANGLE SUPPORT INFORMATION.

2 CURB DETAIL AT STEEL DECK - JOIST AT END PLENUM WITH ROOF OPENING
1 1/2" = 1'-0"



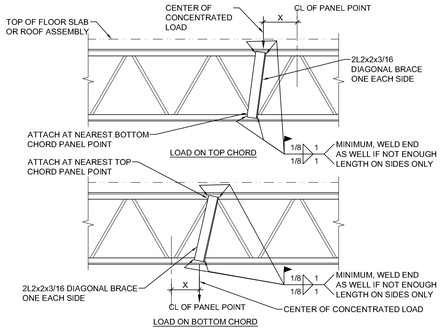
NOTE:
1. ANCHORAGE OF PLENUM TO CURB BY MECHANICAL CONTRACTOR.
2. CONNECT SUPPORT ANGLE TO CURB WITH 1/2" DIA. A307 BOLTS AT 16" O.C. PROVIDE PLATE WASHER AT BOTTOM PLATE.
3. SEE 9/S200 FOR ANGLE SUPPORT INFORMATION.

1 CURB DETAIL AT STEEL DECK - ANGLE AT END PLENUM WITH ROOF OPENING
1 1/2" = 1'-0"



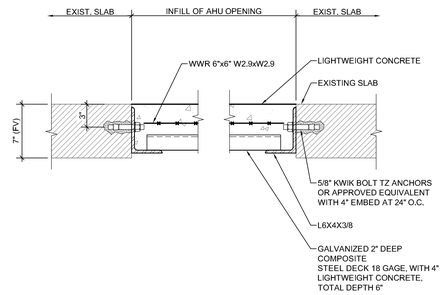
NOTES:
1. SEE DETAILS 3&4/S200 FOR INFORMATION ABOUT SUPPORT ANGLE.
2. APPLY THIS DETAIL AT ALL LOCATIONS OF ITEMS BEARING ON EXISTING STEEL ROOF DECK.
3. SEE PLAN AND MEP DRAWINGS FOR LOCATIONS OF ANY ITEMS REQUIRING SUCH SUPPORT.
4. SEE DETAIL 8/S200 FOR JOIST REINFORCEMENT AT LOCATION OF EACH NEW ANGLE.

9 ATTACHMENT OF SUPPORT ANGLE TO EXISTING JOISTS
1 1/2" = 1'-0"



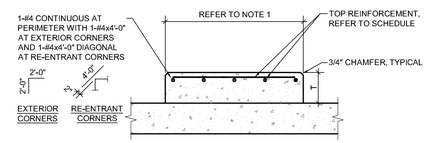
NOTES:
1. DIAGONAL BRACE IS NOT REQUIRED FOR "X" LESS THAN THREE INCHES.
2. PROVIDE DIAGONAL BRACE AT LOCATION OF CONCENTRATED LOADS SUCH AS PARTITIONS, HEAVY PIPES, MECHANICAL UNITS, HEAVY LIGHTS AND ANY OTHER CONCENTRATED LOADS AND AS NOTED ELSEWHERE IN THE STRUCTURAL DRAWINGS. LOADS MUST BE APPLIED CONCENTRICALLY TO JOIST BOTTOM CHORD.

8 TYPICAL STIFFENING OF JOIST FOR CONCENTRATED LOADS
NO SCALE



NOTES:
1. THIS DETAIL IS TO BE APPLIED AT THE AREAS OF SLAB OPENING (SHOWN ON 1/S102 AND 2/S102) WHICH WILL NEED TO BE INFILLED UPON COMPLETION OF WORK.
2. DECK SHALL NOT SPAN MORE THAN 8'-0".
3. FASTEN DECK TO STEEL SUPPORTS PER SDI REQUIREMENTS PRIOR TO POURING CONCRETE.
4. APPLY FIREPROOFING AS REQUIRED TO MEET FLOOR RATING.

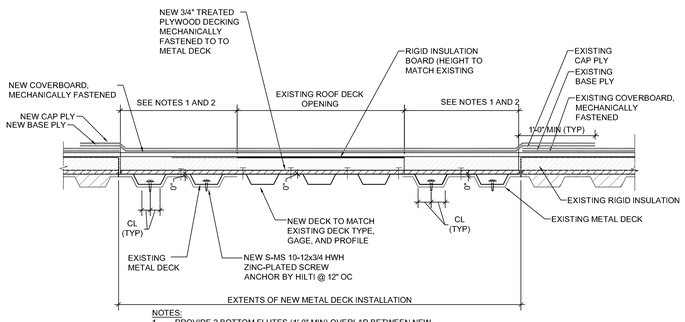
7 INFILL OF SLAB OPENING
1 1/2" = 1'-0"



HOUSEKEEPING PAD REINFORCEMENT SCHEDULE		
PAD THICKNESS	TOP REINFORCEMENT	BOTTOM REINFORCEMENT
T = 4"	WWR 4x4-W2.9xW2.9 OR #3@12" EACH WAY	NONE
4" < T <= 6"	WWR 4x4-W4xW4 OR #4@18" EACH WAY	NONE
6" < T <= 8"	WWR 4x4-W6xW6 OR #4@12" EACH WAY	NONE

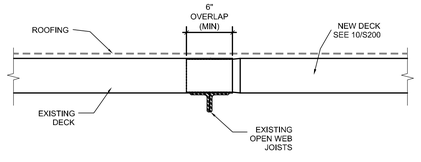
NOTES:
1. REFER TO ARCHITECTURAL OR MEP DRAWINGS FOR HOUSEKEEPING PAD PLAN DIMENSIONS AND THICKNESS (4" MINIMUM THICKNESS).
2. CONTRACTOR SHALL COORDINATE DIMENSIONS AND OTHER SPECIAL REQUIREMENTS WITH EQUIPMENT MANUFACTURERS AND PROVIDE WHERE REQUIRED WHETHER SHOWN ON STRUCTURAL DRAWINGS OR NOT.
3. HOUSEKEEPING PAD IS TO BE USED TO REPLACE THE EXISTING CONCRETE PAD AT THE PENTHOUSE FLOOR LEVEL, SUPPORTING UNITS 7&8.

6 TYPICAL HOUSEKEEPING PAD OVER SLAB
NO SCALE



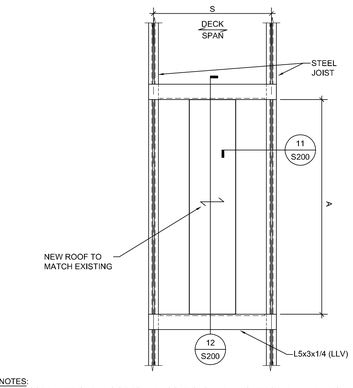
NOTES:
1. PROVIDE 2 BOTTOM FLUTES (1'-0" MIN) OVERLAP BETWEEN NEW DECK AND EXISTING DECK IN EACH DIRECTION.
2. APPLY OVERLAP OF NEW BASE PLY AND CAP PLY ON ALL FOUR SIDES OF OPENING.

12 METAL DECK INFILL AT EXISTING ROOF DECK OPENING
NTS



NOTE:
1. OVERLAP NEW DECK WITH EXISTING AS SHOWN
2. SEE DETAIL 12/S200 FOR NEW ROOFING AND OVERLAP WITH EXISTING ROOFING

11 TITLE
1 1/2" = 1'-0"



NOTES:
1. COORDINATE OPENING SIZES AND LOCATIONS WITH ARCHITECTURAL AND MECHANICAL DRAWINGS.
2. ROOF DECK SHALL BE CONTINUOUS OVER FRAMED OPENINGS. DO NOT CUT OPENINGS UNTIL IMMEDIATELY BEFORE THEY ARE NEEDED.
3. VERIFY FRAMING WITH ENGINEER WHERE DIMENSIONS EXCEED MAXIMUM DIMENSIONS SHOWN IN THIS DETAIL.
4. REFER TO SPECIFICATIONS FOR OPENINGS WHERE THE LONGEST DIMENSION IS 10" OR LESS.

10 TYPICAL FRAMED OPENING IN ROOF DECK WITH JOIST CONSTRUCTION
NO SCALE

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ABDELHAKIM BOUADI
88445
LICENSED PROFESSIONAL ENGINEER
04/13/18

ISSUE FOR:			
Area	Rev.	Date	Description
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Date 04/13/18
UTHSC Project No. 730022
E & C Project No. 3302.00
File Name

UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
SOUTH PENTHOUSE

DRAWING TITLE
DETAILS

DRAWING NO.
S200

FILE: \\hou-server\projects\D03\2016\16013-02 MSB Roofing ASR2\3-Documentation\Drawings\AutoCAD\Phase III\Sheets\S200.dwg

ABBREVIATIONS

AD	ACCESS DOOR, AREA DRAIN
AFC	ABOVE FINISHED CEILING
AFF	ABOVE FINISHED FLOOR
AP	ACCESS PANEL
APD	AIR PRESSURE DROP
BWV	BACK WATER VALVE
CIRC	CIRCULATING
COND	CONDENSER, CONDENSATE
CONN	CONNECTION
CW	COLD WATER
D	DEPTH, DRAIN
DET	DETAIL
DF	DRINKING FOUNTAIN
DISC	DISCONNECT
DPR	DAMPER
DWH	DOMESTIC WATER HEATER
EC	ELECTRICAL CONTRACTOR
ECC	ECCENTRIC
EDB	ENTERING DRY BULB
EHC	ELECTRIC HEATING COIL
ESP	EXTERNAL STATIC PRESSURE
ETR	EXISTING TO REMAIN
FCO	FLOOR CLEAN OUT
FCS	FLOOR CONTROL STATION
FD	FLOOR DRAIN, FIRE DAMPER
FLR	FLOOR
FUT	FUTURE
GLV	GLOBE VALVE
GV	GATE VALVE
HB	HOSE BIBB
HD	HEAD, HUB DRAIN
HSC	HORIZONTAL SPLIT CASE
HTG	HEATING
HWC	HOT WATER CIRCULATOR
IE	INVERT ELEVATION
IW	INDIRECT WASTE
JB	JUNCTION BOX
JP	JOCKEY PUMP
L	LENGTH, LAVATORY
LAV	LAVATORY
M	METER
MC	MECHANICAL CONTRACTOR
MTD	MOUNTED
MVD	MANUAL VOLUME DAMPER
N.C.	NORMALLY CLOSED
NIC	NOT IN CONTRACT
N.O.	NORMALLY OPEN
OBD	OPPOSED BLADE DAMPER
OD	OUTSIDE DIAMETER, OVERFLOW DRAIN
OPG	OPENING
PC	PLUMBING CONTRACTOR
PD	PRESSURE DROP, PLANTER DRAIN
PNL	PANEL
PT	PLUMBING TRIM
PV	PLUG VALVE
R	RISER
RED	REDUCER
RV	RELIEF VALVE
SAF	SUPPLY AIR FAN
SCR	SILICON CONTROLLED RECTIFIER
SECT	SECTION
SENS	SENSIBLE
SFCS	SPRINKLER FLOOR CONTROL STATION
SKVA	STARTING KILOVOLT-AMPS
SKW	STARTING KILOWATTS
SP	SUMP PUMP, STATIC PRESSURE
SPR	SPRINKLER
SS	SERVICE SINK
SSFU	SANITARY SEWER FIXTURE UNITS
SSSC	SOLID STATE SPEED CONTROL
STR	STRAINER
SUSP	SUSPEND
SV	SANITARY VENT
TC	TEMPERATURE CONTROL
TDH	TOTAL DYNAMIC HEAD
TF	TRANSFER FAN
TP	TRAP PRIMER
U	URINAL
UON	UNLESS OTHERWISE NOTED
U/F	UNDERFLOOR
U/S	UNDERSLAB
VD	VOLUME DAMPER
VOV	VALVE ON VERTICAL
W	WATT, WASTE, WIDTH
WC	WATER CLOSET
WCO	WALL CLEANOUT
WH	WALL HYDRANT
WM	WATER METER
WP	WEATHERPROOF
WPD	WATER PRESSURE DROP
Z	ZONE

USE INDUSTRY STANDARD
FOR OTHER THAN NOTED

MECHANICAL/PLUMBING SYMBOLS (ALL SYMBOLS SHOWN ARE NOT NECESSARILY USED ON THE DRAWINGS)

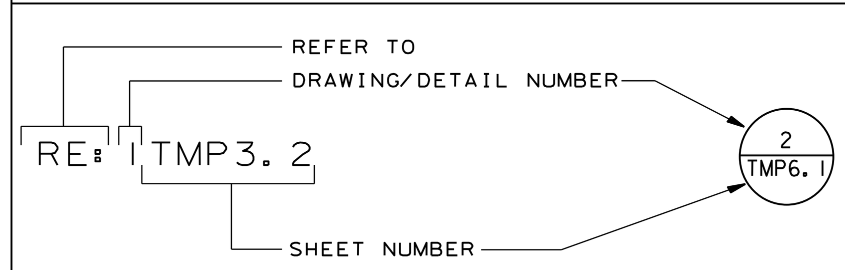
PIPING TYPES

CHS	CHILLED WATER SUPPLY
CHR	CHILLED WATER RETURN
S	STEAM S=0 TO 15#, 60HPS=60# HIGH PRESS. STEAM
C	CONDENSATE RETURN
PC	PUMPED CONDENSATE
RHG	REFRIGERANT HOT GAS LINE
RS	REFRIGERANT SUCTION LINE
RL	REFRIGERANT LIQUID LINE
— — —	SANITARY DRAIN BELOW FLOOR
——	SANITARY DRAIN ABOVE FLOOR
- - - -	SANITARY VENT
GW	GREASE (KITCHEN) WASTE
SD	STORM DRAIN
OD	OVERFLOW DRAIN
AW	ACID WASTE
AV	ACID VENT
— —	COLD WATER
— — —	HOT WATER
— — — —	HOT WATER RECIRCULATION
G	NATURAL GAS
A	COMPRESSED AIR
AA	"AA" DENOTES GAS TYPE
MA	MEDICAL AIR
DI	DEIONIZED WATER
V	VACUM
F	FIRE STANDPIPE, FIRE LINE
FS	FIRE SPRINKLER
TP	TRAP PRIMER
D	DRAIN LINE
······ aaa ······	EXISTING PIPE, "aaa" DENOTES TYPE
··X·· aaa ··X··	EXISTING PIPE TO BE REMOVED, "aaa" DENOTES TYPE

PIPING SYMBOLS

ELBOW UP
ELBOW DOWN
VALVE IN DROP
VALVE IN RISE
DIRECTION OF FLOW
DIRECTION OF SLOPE DOWN
CONCENTRIC REDUCER
ECCENTRIC REDUCER
TEE OUTLET UP
TEE OUTLET DOWN
UNION
PIPE ANCHOR
EXPANSION JOINT
STRAINER WITH BLOWDOWN VALVE
GATE VALVE, HVAC BALANCING/STOP VALVE
GLOBE VALVE
BALL VALVE
BALANCING VALVE WITH DIFFERENTIAL PRESSURE TAPS
OS&Y VALVE
CHECK VALVE
TWO POSITION CONTROL VALVE
TWO-WAY MODULATING CONTROL VALVE
THREE-WAY MODULATING CONTROL VALVE
PRESSURE REDUCING VALVE
FCS — SPRINKLER FLOOR CONTROL STATION
GAS VALVE
MANUAL AIR VENT
AUTOMATIC AIR VENT
T&P RELIEF VALVE
VACUUM BREAKER
LINE CLEANOUT
FLOOR CLEANOUT
PRESSURE GAUGE WITH GAUGE COCK
THERMOMETER
WATER METER
FLEXIBLE CONNECTION
PRESSURE AND TEMPERATURE TAP
FLOW VENTURI

DRAWING/DETAIL REFERENCE KEY



MISCELLANEOUS

FLOOR DRAIN
AREA DRAIN
ROOF DRAIN OR OVERFLOW DRAIN
HOSE BIBB
WALL HYDRANT
PLUMBING FIXTURES
POINT OF NEW CONNECTION TO EXISTING
(1) — DRAWING NOTE REFERENCE
[1] (R620) — OWNER OR CONTRACTOR FURNISHED EQUIPMENT REFERENCE
(aaabb) — MECHANICAL/PLUMBING EQUIPMENT REFERENCE. "aaa" DENOTES TYPE, "bb" DENOTES NUMBER.
(a) bbb cc/dd — AIR DISTRIBUTION DEVICE REFERENCE. "a" DENOTES TYPE, "bbb" DENOTES CFM, "cc/dd" DENOTES NECK SIZE
(aaa) bbb ccc KW — HVAC TERMINAL UNIT REFERENCE. "aaa" DENOTES TYPE, "bbb" DENOTES CFM, "ccc KW" DENOTES HEATING KW WHERE APPLICABLE
P/1 — RISER DESIGNATION. "P" DENOTES WASTE/VENT OR WASTE/VENT/WATER, "W" DENOTES WATER, "DS" DENOTES DOWNSPOUT, "F" DENOTES FIRE.
FS — FLOW SWITCH
VS — VALVE SUPERVISORY SWITCH
FIRE HOSE CABINET
FIRE HOSE RACK
FIRE DEPARTMENT SIAMESE CONNECTION
(T) — THERMOSTAT
(S) — TEMPERATURE SENSOR
(H) — HUMIDISTAT
(F) — FIRESTAT
(D) RA — DUCT SMOKE DETECTOR. "SA" DENOTES SUPPLY AIR, "RA" DENOTES RETURN AIR PROVIDED AND WIRED BY DIV. 16 - INSTALL BY DIV. 15
PNEUMATIC TUBING OR CONTROL WIRING
TC — TEMPERATURE CONTROL PANEL
DP — PRESSURE DIFFERENTIAL SENSOR (ANALOG)
F — FLOW SENSOR (ANALOG)
RH — RELATIVE HUMIDITY SENSOR (ANALOG)
P — PRESSURE SENSOR (ANALOG)
PI — POSITION INDICATOR (ANALOG)
HL T — HIGH LIMIT T=TEMP P=PRESS F=FLOW RH= REL HUMIDITY
LL T — LOW LIMIT T=TEMP P=PRESS F=FLOW RH= REL HUMIDITY

DUCTWORK

SUPPLY AIR DIFFUSER, NO LETTER DENOTES NEW, "R" DENOTES RELOCATED EXISTING.
EXISTING SUPPLY AIR DIFFUSER, NO LETTER DENOTES TO REMAIN, "R" DENOTES TO BE REMOVED AND REUSED AS APPLICABLE.
RETURN AIR OR EXHAUST GRILL, NO LETTER DENOTES NEW, "R" DENOTES RELOCATED EXISTING.
EXISTING RETURN AIR OR EXHAUST GRILL, NO LETTER DENOTES TO REMAIN, "R" DENOTES TO BE REMOVED AND REUSED AS APPLICABLE.
100 — LIGHT TROFFER SUPPLY AIR BOOTS, NO LETTER DENOTES NEW, "R" DENOTES RELOCATED EXISTING. NUMBER DENOTES CFM.
100 — EXISTING LIGHTING TROFFER SUPPLY AIR BOOTS, NO LETTER DENOTES TO REMAIN, "R" DENOTES TO BE REMOVED AND REUSED AS APPLICABLE. NUMBER DENOTES CFM.
SUPPLY AIR SLOT, NO LETTER DENOTES NEW, "R" DENOTES RELOCATED EXISTING.
EXISTING SUPPLY AIR SLOT, NO LETTER DENOTES TO REMAIN, "R" DENOTES TO BE REMOVED AND REUSED AS APPLICABLE.
RETURN AIR SLOT, NO LETTER DENOTES NEW, "R" DENOTES RELOCATED EXISTING.
EXISTING RETURN AIR SLOT, NO LETTER DENOTES TO REMAIN, "R" DENOTES TO BE REMOVED AND RELOCATED AS APPLICABLE.
NEW RECTANGULAR OR ROUND DUCTWORK
EXISTING DUCTWORK
EXISTING DUCTWORK TO BE CLEANED, TREATED & COATED
EXISTING RECTANGULAR OR ROUND DUCTWORK TO BE REMOVED AND RELOCATED AS APPLICABLE
NEW FLEXIBLE DUCT
EXISTING FLEXIBLE DUCT
EXISTING FLEXIBLE DUCT TO BE REMOVED
SUPPLY OR OUTSIDE AIR DUCT
RETURN, RELIEF, OR EXHAUST AIR DUCT
FLEXIBLE DUCT CONNECTION
UP — INCLINED RISE IN DUCT (TWO ELBOWS)
DN — INCLINED DROP IN DUCT (TWO ELBOWS)
TURNING VANES
DUCT EXTRACTOR
SPLITTER DAMPER
DUCT MOUNTED HEATING COIL
DUCT MOUNTED FILTER
IN-LINE FAN WITH FLEX CONNECTORS
(H) — DUCT MOUNTED HUMIDIFIER
DOUBLE DUCT HVAC TERMINAL UNIT
INDICATES FAN POWERED
SINGLE DUCT HVAC TERMINAL UNIT
INDICATES FAN POWERED
FIRE DAMPER
S — SMOKE DAMPER
FS — FIRE/SMOKE DAMPER
MANUAL BALANCING DAMPER
B — GRAVITY BACKDRAFT DAMPER
M — MOTORIZED DAMPER
------ HIDDEN LINES

GENERAL NOTES

A. REFER TO SPECIFICATIONS FOR MATERIALS AND METHODS FOR MECHANICAL/ELECTRICAL CONSTRUCTION.

B. REFER TO EXISTING SITE CONDITIONS. VISIT THE SITE TO DETERMINE ANY SPECIAL BUILDING CONDITIONS THAT ARE NOT INDICATED ON THE DOCUMENTS.

C. ALL DUCTWORK SIZES SHOWN ARE FREE AIR STREAM DIMENSIONS.

D. FURNISH AND INSTALL ACCESS DOORS IN DUCTS, WALL AND CEILINGS WHERE ACCESS IS REQUIRED TO CLEAN, TREAT AND COAT THE DUCTWORK.

E. COORDINATE ALL MECHANICAL WORK WITH THE OWNER'S REPRESENTATIVE. ALL MODIFICATIONS TO THE EXISTING ELECTRICAL SHALL BE DONE BY TRADES SPECIALIZING IN THAT WORK.

F. THE MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR PAINTING ANY MECHANICAL AND PLUMBING ITEMS WHICH ARE REQUIRED TO BE FIELD PAINTED. REFERENCE THE REQUEST FOR PROPOSAL (RFP).

G. THESE DOCUMENTS ARE BASED ON ACTUAL CONDITIONS DOCUMENTED DURING DESIGN. THE MECHANICAL CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY CONDITIONS WHICH VARY FROM THE DOCUMENTS AND BE RESPONSIBLE FOR COORDINATING THE LOCATION OF DUCTWORK WITH EXISTING CONDITIONS.

H. ALL MECHANICAL WORK SHALL COMPLY WITH APPLICABLE STATE & LOCAL BUILDING CODES & REQUIREMENTS.

I. THE MECHANICAL CONTRACTOR SHALL VISIT THE SITE & FAMILIARIZE THEMSELVES WITH EXISTING CONDITIONS WHICH WILL IMPACT CONSTRUCTION OF THIS PROJECT, PRIOR TO SUBMITTING PROPOSALS.

J. ALL INTERRUPTIONS TO SERVICES & ALL WORK IN OCCUPIED SPACES SHALL BE SCHEDULED WITH THE OWNER'S REPRESENTATIVE PER THE SPECIFICATIONS & SHALL BE PERFORMED AT TIMES WHICH ARE ACCEPTABLE TO THE OWNER.

K. COORDINATE THE EXACT LOCATION OF ALL WALL MOUNTED DEVICES WITH THE OWNER'S REPRESENTATIVE.

L. FURNISH ACCESS DOORS FOR INSTALLATION BY THE GENERAL CONTRACTOR WHERE ACCESS IS REQUIRED TO CONCEALED EQUIPMENT.

M. SECURE AND PROTECT EXISTING ELECTRICAL AND CONTROLS SERVING OTHER EQUIPMENT DURING DEMO AND REINSTALL CONDUIT AND WIRE AFTER NEW UNIT IS INSTALLED.

N. INTENT IS NOT TO REMOVE OR RELOCATE CONDUIT, SPRINKLER PIPE, ETC. CONTRACTOR MUST COORDINATE TEMPORARY RELOCATION OR REMOVAL OF SYSTEMS TO PERFORM CONSTRUCTION. CONTRACTOR SHALL RETURN ANY ITEMS RELOCATED AFTER CONSTRUCTION UNLESS INSTRUCTED BY OWNER.

DRAWING LIST

M000	MECHANICAL SYMBOLS & ABBREVIATIONS
M108	MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 1 - AHUO-6 & O-8
M118	MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 1 - AHUO-6 & O-8
M109	MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 1 - AHUO-6 & O-8
M119	MECHANICAL ROOF PLAN PHASE 1 - AHUO-6 & O-8
M208	MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 2 - AHUO-5 & O-7
M218	MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 2 - AHUO-5 & O-7
M209	MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 2 - AHUO-5 & O-7
M219	MECHANICAL ROOF PLAN PHASE 2 - AHUO-5 & O-7
M308	MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 3 - AHU-L3 & L4
M318	MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 3 - AHU-L3 & L4
M309	MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 3 - AHU-L3 & L4
M319	MECHANICAL ROOF PLAN PHASE 3 - AHU-L3 & L4
M408	MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 4 - AHU-L1 & L2
M418	MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 4 - AHU-L1 & L2
M409	MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 4 - AHU-L1 & L2
M419	MECHANICAL ROOF PLAN PHASE 4 - AHU-L1 & L2
M508	MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 5 - AHUO-2 & O-4
M518	MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 5 - AHUO-2 & O-4
M509	MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 5 - AHUO-2 & O-4
M519	MECHANICAL ROOF PLAN PHASE 5 - AHUO-2 & O-4
M608	MECHANICAL PENTHOUSE DEMOLITION/BYPASS PLAN PHASE 6 - AHUO-1 & O-3
M618	MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 6 - AHUO-1 & O-3
M609	MECHANICAL ROOF DEMOLITION/BYPASS PLAN PHASE 6 - AHUO-1 & O-3
M619	MECHANICAL ROOF PLAN PHASE 6 - AHUO-1 & O-3
M700	MECHANICAL AHU PLANS
M800	MECHANICAL SCHEDULES
M900	MECHANICAL DETAILS
M901	MECHANICAL DETAILS
M902	MECHANICAL DETAILS
M903	MECHANICAL DETAILS
M904	MECHANICAL DETAILS
M990	MECHANICAL CONTROL DIAGRAMS
M991	MECHANICAL CONTROL DIAGRAMS

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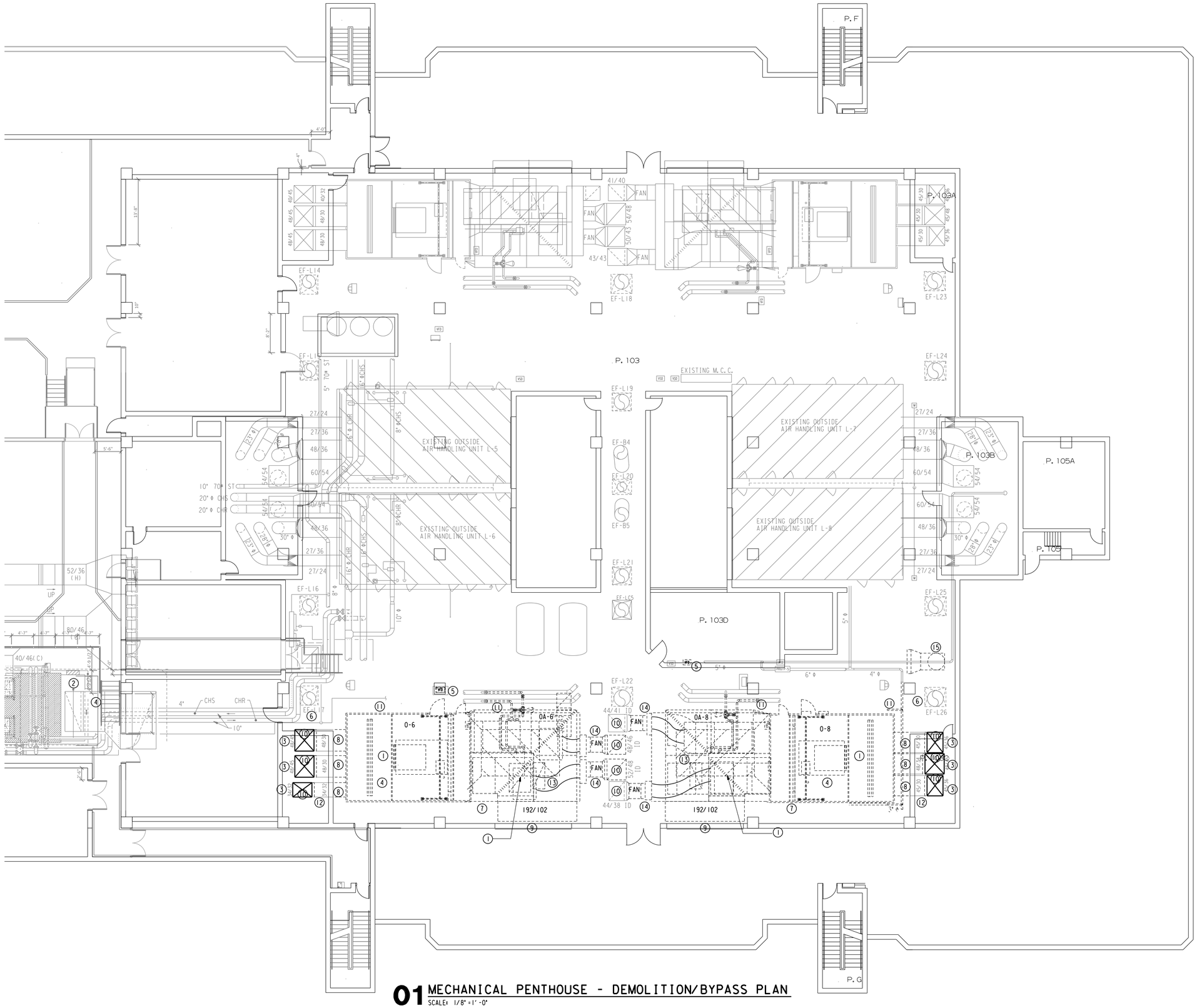
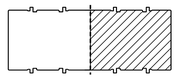


01 MECHANICAL PENTHOUSE - DEMOLITION/BYPASS PLAN

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

DRAWING NOTES:

1. REMOVE AHU. ALL PIPING, DUCT, ELECTRICAL AND CONTROLS SERVING THE DEMOLISHED AHU SHALL BE REMOVED AS REQUIRED FOR RECONNECTION. RE: M700.
2. TEMPORARY BYPASS AHU.
3. TEMPORARY BYPASS UNIT SHALL BE CONNECTED TO THE RISERS AS NOTED ON THE ROOF PLAN. FLEX MAY BE USED. REFER TO M903 & M904 FOR ISOMETRICS OF DUCT CONNECTIONS. REMOVE ANY DUCTWORK IN THE CHASE NECESSARY TO MAKE CONNECITONS.
4. ONCE THE DUCTWORK AT THE ROOF HAS BEEN CONNECTED TO THE RISERS AND THE FLEXIBLE DUCT HAS CONNECTED THE TEMPORARY BYPASS AHUS TO THE RISERS, THE TEMPORARY AHUS SHALL BE ENERGIZED AND THE AHU SHALL BE DE-ENERGIZED. THE BYPASS AHUS ARE SIZED FOR BOTH AHUS TO SERVICE BOTH OF THESE OFFICE AHUS. THE SEQUENCE OF THE UNITS TO BE REPLACED SHALL BE BASED ON CONSTRUCTABILITY AND CONFIRMED WITH UTHSC-H. ALL ISOLATION VALVES SHALL BE SHUT TO THE AHU AND THE AHU SHALL BE REPLACED AS DETAILED ON M700.
5. REMOVE EXISTING VSD. REPLACE WITH NEW VSD ON AHU-08. AHU-06 VFD TO REMAIN FOR RECONNECTION. RE: ELECTRICAL DRAWINGS.
6. PROVIDE A TAP INTO THE EXHAUST DUCT AS NOTED FOR VENTILLATION DURING CUTTING OF THE EXISTING UNITS. PROVIDE A 12" ϕ MANUAL BALANCING DAMPER (LOW LEAK) WITH FLEXIBLE DUCT TO ALLOW FOR MOVEMENT TO WHERE THE CUTTING IS TAKING PLACE. COORDINATE ANY NEEDED SHUT-DOWNS WITH THE OWNER.
7. REMOVE THE EXISTING CONCRETE PAD AND REPOUR. RE: STRUCTURAL DRAWINGS FOR FURTHER INFO.
8. REMOVE DUCTWORK AS NOTED FOR REPLACEMENT. EXISTING FIRE DAMPERS TO REMAIN.
9. EXISINTG LOUVER SERVING THE UNITS. VACUUM, CLEAN AND REPLACE THE BIRDSCREENS.
10. FIELD VERIFY ACTUAL INTERNAL FREE AREA DUCT SIZES. DUCT SIZE SHOWN IS AN ESTIMATE BASED OFF OF FIELD MEASUREMENTS WHERE THE DUCT COULD BE REACHED AND ORIGINAL AS-BUILTS.
11. REMOVE EXISTING PIPING AS REQUIRED TO INSTALL NEW PIPE TO THE NEW UNITS PER THE PIPING DIAGRAMS ON DETAIL SHEET M900.
12. REMOVE EXISTING SMOKE DETECTOR IN THE DUCTWORK. SAVE FOR REPLACEMENT INTO THE NEW DUCT.
13. REMOVE EXISTING OUTSIDE AIR PRETREATMENT UNIT, CONTROLS, PIPING, VFD ,ETC. TURN OVER ALL CONTROLLERS AND VFD TO THE OWNER.
14. CONNECT THE RETURN/RELIEF DUCTS TO THE EXISTING ROOF HOODS TO ALLOW THE FLOOR TO RELIEVE PRESSURIZATION CAUSED BY THE TEMPORARY UNITS BEING 100% OUTSIDE AIR. THE RETURN/RELIEF FANS SHALL REMAIN AS LONG AS POSSIBLE TO MAINTAIN PRESSURE IN THE BUILDING UNTIL THE NEW UNIT IS CONSTRUCTED AND THE NEW RETURN FANS AND PLENUMS ARE TO BE INSTALLED. INSTALL PLENUM AT FAN DISCHARGE AND CAP DUCT AT THE RELIEF HOOD ON THE ROOF. TWO 20" ϕ IM FLEX DUCTS PER RELIEF FAN TO CONNECT.
15. ONCE THE NEW AHU IS OPERATIONAL SO THAT THE FLOOR IS NOT OVER-PRESSURIZED, THE LAB CHASE EXHUAST FAN SHALL BE REMOVED FOR REPLACEMENT.



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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENT DEMO/BYPASS PLAN PHASE 1 - AHUO-6 & O-8

DRAWING NO.
M108

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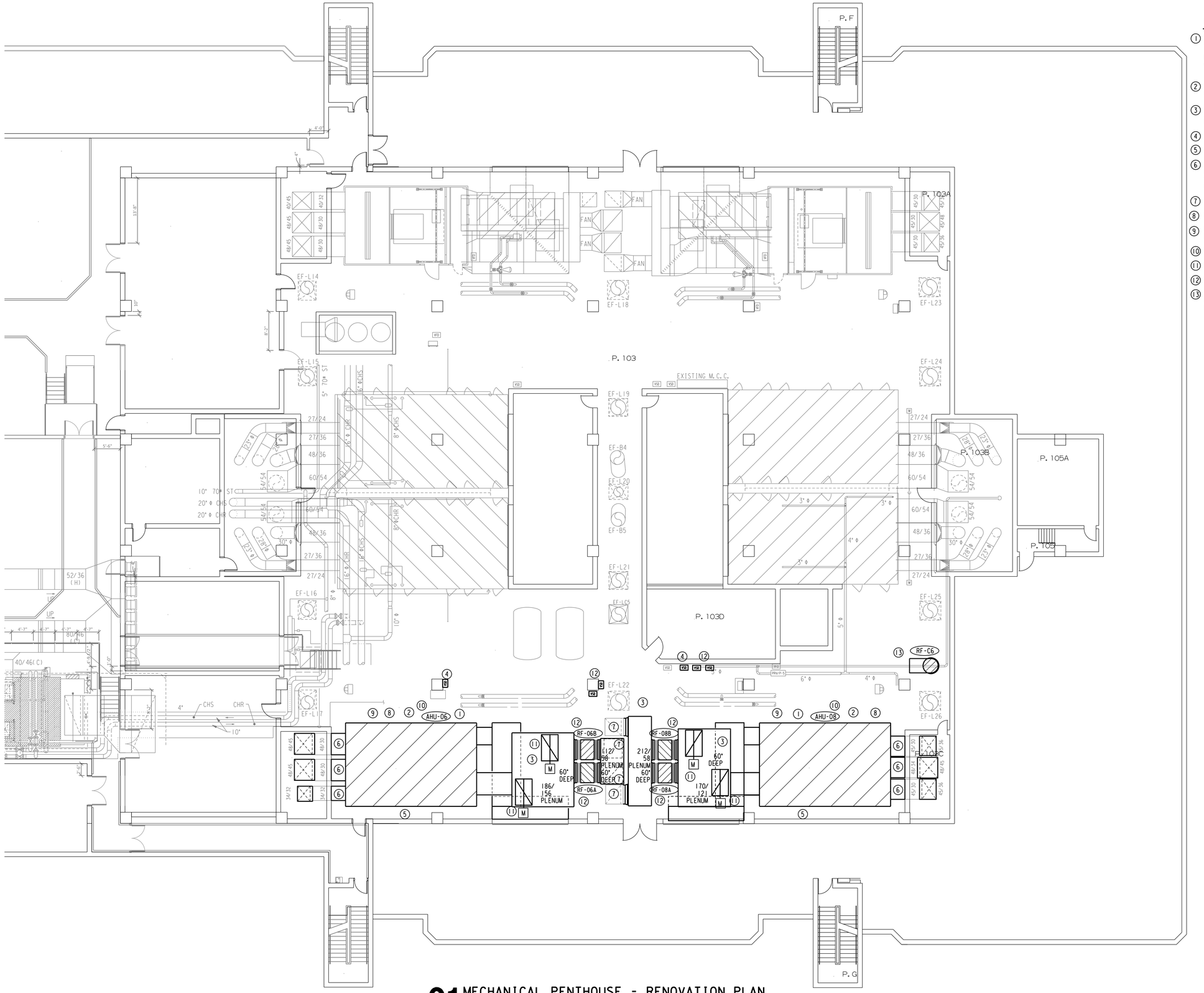
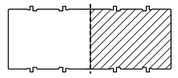


01 MECHANICAL PENTHOUSE - RENOVATION PLAN

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

DRAWING NOTES:

1. ONCE THE AHU HAS BEEN REPLACED, TIE BACK INTO THE CHILLED WATER, STEAM AND DUCTWORK. RECONNECT THE NEW FANS TO THE NEW VFD (REFER TO ELECTRICAL DRAWINGS). DE-ENERGIZE THE TEMPORARY UNIT AND REMOVE THE TEMPORARY DUCT FROM THE PLENUM TO THE RISERS AND CAP TO MATCH EXISITNG. NEW COILS WILL BE IN DIFERENT LOCATIONS. ROUTE PIPE THORUGH STRUCTURAL OPENINGS AS NECESSARY TO PROVIDE PIPING TO NEW UNITS. ALL CONTROL VALVING SHALL BE PIPED AT THE UNITS AS NOTED. REINSTALL THE SMOKE DETECTOR INTO THE NEW DUCTWORK.
2. NEW AHU SHALL BE STARTED UP WITH A REPRESENTATIVE FROM THE FACTORY AND COMMISSIONED WITH A MEMBER OF THE UTHSC-H STAFF IN ATTENDANCE.
3. REFER TO THE AHU DETAIL DRAWING FOR DUCTWORK ELEVATIONS SHOWING HOW THE OUTSIDE AIR, RETURN AIR, ECONOMIZER MODE OUTSIDE AIR AND RELIEF AIR DUCT AND PLENUMS AS WELL AS RELIEF/RETURN FANS ARE TO BE INSTALLED.
4. INSTALL NEW VSD FOR AHU-08 AND REUSE VSD FOR AHU-06. RECONNECT TO ELEC AS NEEDED.
5. CONTROL SEQUENCE FOR THE NEW AHU SHALL BE AS NOTED ON DRAWING M990 & M991 - CONTROL DIAGRAMS.
6. PROVIDE NEW DUCT AS NOTED FROM THE AHU TO THE CHASE CONNECTION. DUCT SHALL BE AS HIGH AS POSSIBLE OUT FORM THE UNIT AND TRANSITION DOWN TO THE EXISINTG FIRE DAMPER. RELOCATE SPRINKLER HEADS AS NEEDED. TRYING TO MAINTAIN AS MUCH HEAD HEIGHT AS POSSIBLE CLOSE TO THE COLUMNS.
7. INSTALL NEW SMOKE DETECTORS IN THE RETURN AIR RISERS NEAR THE EXISITNG ACCESS DOOR.
8. POUR NEW PADS 3" LARGER THAN THE AHU FOOTPRINT ON EACH SIDE AND 6" TALL. REFER TO STRUCTURAL.
9. REPIPE THE NEW UNIT AS NOTED ON M900 - MECHANICAL DETAILS AND AS REQUIRED FOR LOCATION OF THE NEW UNIT CONNECTIONS.
10. NEW CONDENSATE RETURN TO BE ROUTED AS TO PENETRATE THE FLOOR IN THE EXISTING LOCATION.
11. MOTORIZED DAMPERS SHALL BE ACCESSIBLE FROM THE ROOF THROUGH THE RELIEF VENTS.
12. ENSURE FANS ARE LOCATED WITH CLEARANCE UNDER FOR ACCESS. INSTALL NEW VFD FOR EACH FAN.
13. INSTALL NEW FAN. FLOOR-SUPPORTED. DUCT A 3'0" STRAIGHT DUCT OFF OF THE FAN OUTLET AND AN ELBOW TERMINATED IN BUGSCREEN TO SEMI-CONDITION THE PENTHOUSE. RECONNECT TO EXISTING UNIT ELECTRICAL. REINSTALL SMOKE DETECTOR FOR SHUT-DOWN.



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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 1 AHUO-6 & O-8

DRAWING NO.
M118

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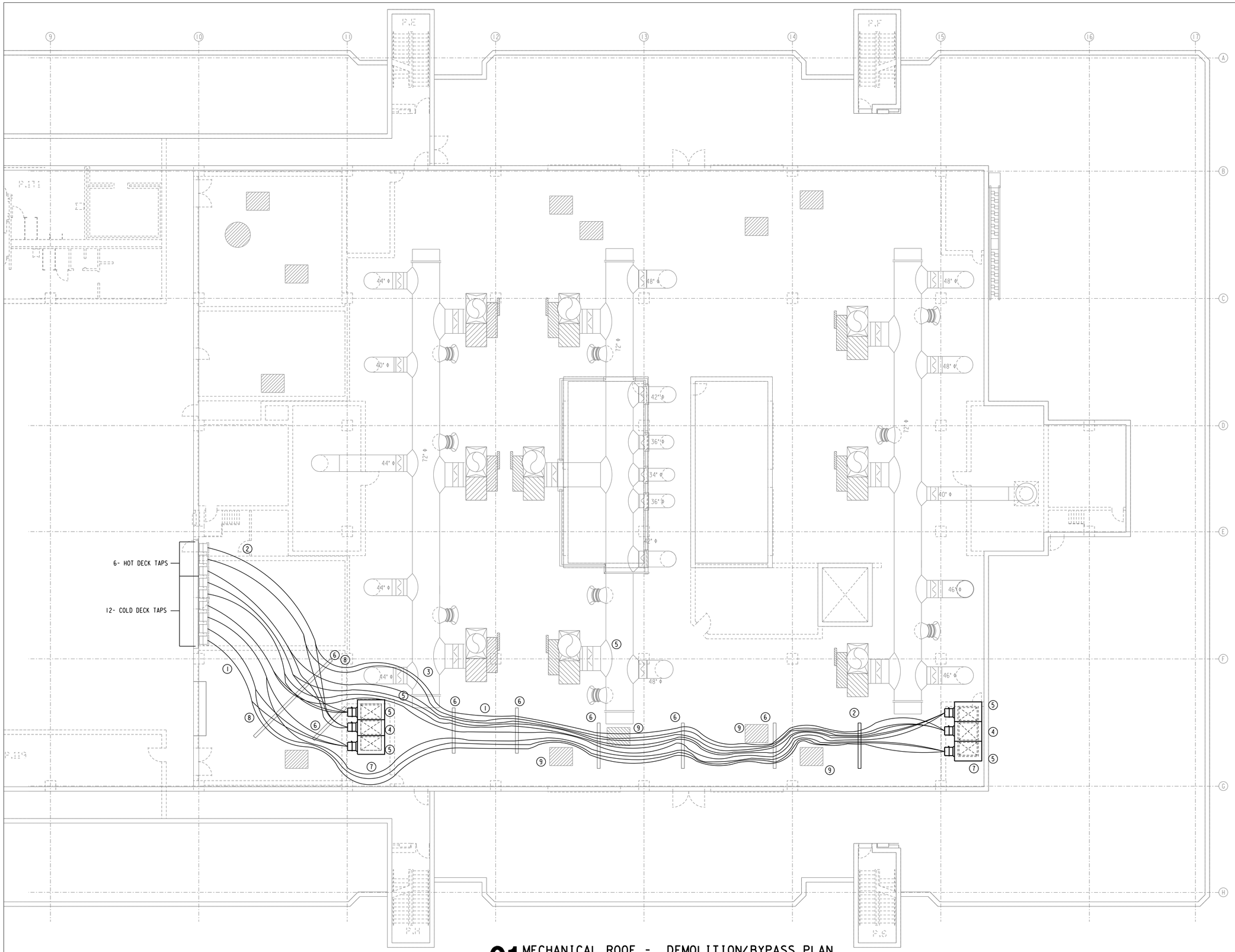

DRAWING NOTES:

1. FLEX DUCTS SIMILAR TO MASTERDUCT MD ALL-WEATHER FLEXIBLE DUCT R8. FLEX TO BE 20" ϕ. FLEX FROM PREVIOUS PROJECT WILL BE STORED BY UTHSC-H. REUSE APPROXIMATELY 50%, THE ADDITIONAL WILL NEED TO BE NEW DUE TO DAMAGE.
2. STRUCTURAL HOLD-DOWN LOCATIONS. RE: DETAIL 8 M901 & STRUCTURAL DRAWINGS.
3. FLEX TO RUN UNDER MANIFOLDS.
4. HOT DUCT.
5. COLD DUCT.
6. EXISITNG STRUCTURAL TIE-DOWNS.
7. NEW MANIFOLD AS DETAILED IN M901 & M902.
8. TAKE BOTTOM DUCTS OFF FOR CONNECTION TO PLENUM. RUN TOP DUCTS ON TO PLENUM FARTHER SOUTH.
9. ENSURE VENTS ARE CLEAR FOR RELIEF OF BUILDING.

01 MECHANICAL ROOF - DEMOLITION/BYPASS PLAN

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

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MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF DEMO/BYPASS PLAN PHASE 1 AHUO-6 & 0-8

DRAWING NO.
M109

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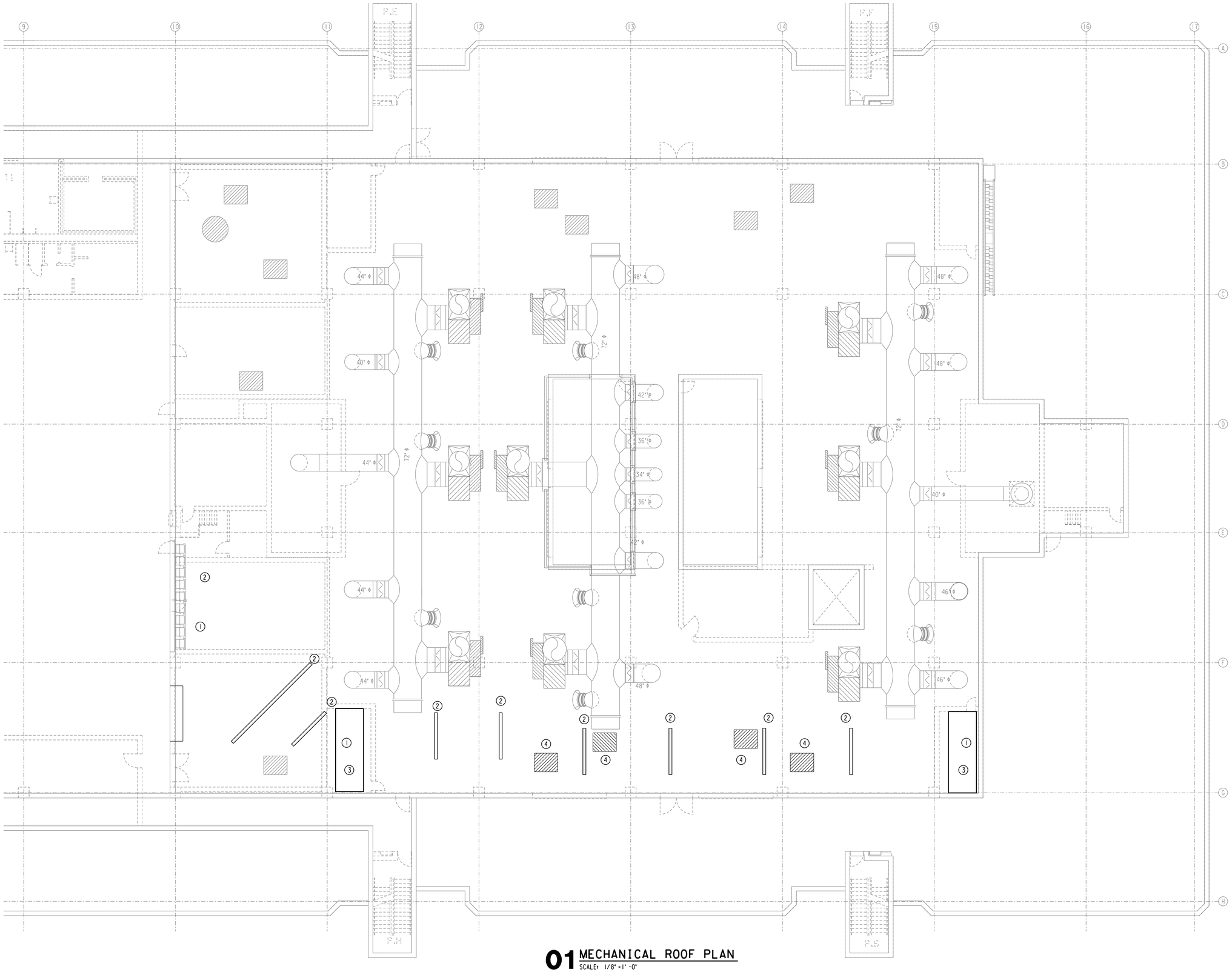
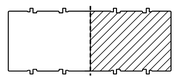


DRAWING NOTES:

1. DISCONNECT THE PLENUMS FROM THE RISERS. CAP THE RISERS AIRTIGHT. REMOVE FLEX DUCT FROM THE ROOF AND TURN OVER TO THE OWNER FOR USE ON FUTURE PHASES. IF THE OWNER FINDS THE DUCT UNUSABLE, CONTRACTOR TO DISPOSE.
2. CAP TAPS THROUGH EXTERIOR WALL FOR USE ON FUTURE PHASES.
3. REMOVE THE PLENUM ON TOP OF THE RISERS ON THE ROOF. PATCH THE ROOF TO MATCH EXISTING. REPLACE CURB AROUND EXISTING EXHAUST DUCT PENETRATION.
4. VERIFY EXISTING ROOF OPENING SIZES PRIOR TO ORDERING NEW RELIEF HOODS. REPLACE HOODS AFTER FLEX HAS BEEN REMOVED WITH NEW ALUMINUM COOK MODEL GR GRAVITY HOOD.

01 MECHANICAL ROOF PLAN

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



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MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF PLAN PHASE 1 AHUO-6 & O-8

DRAWING NO.
M119

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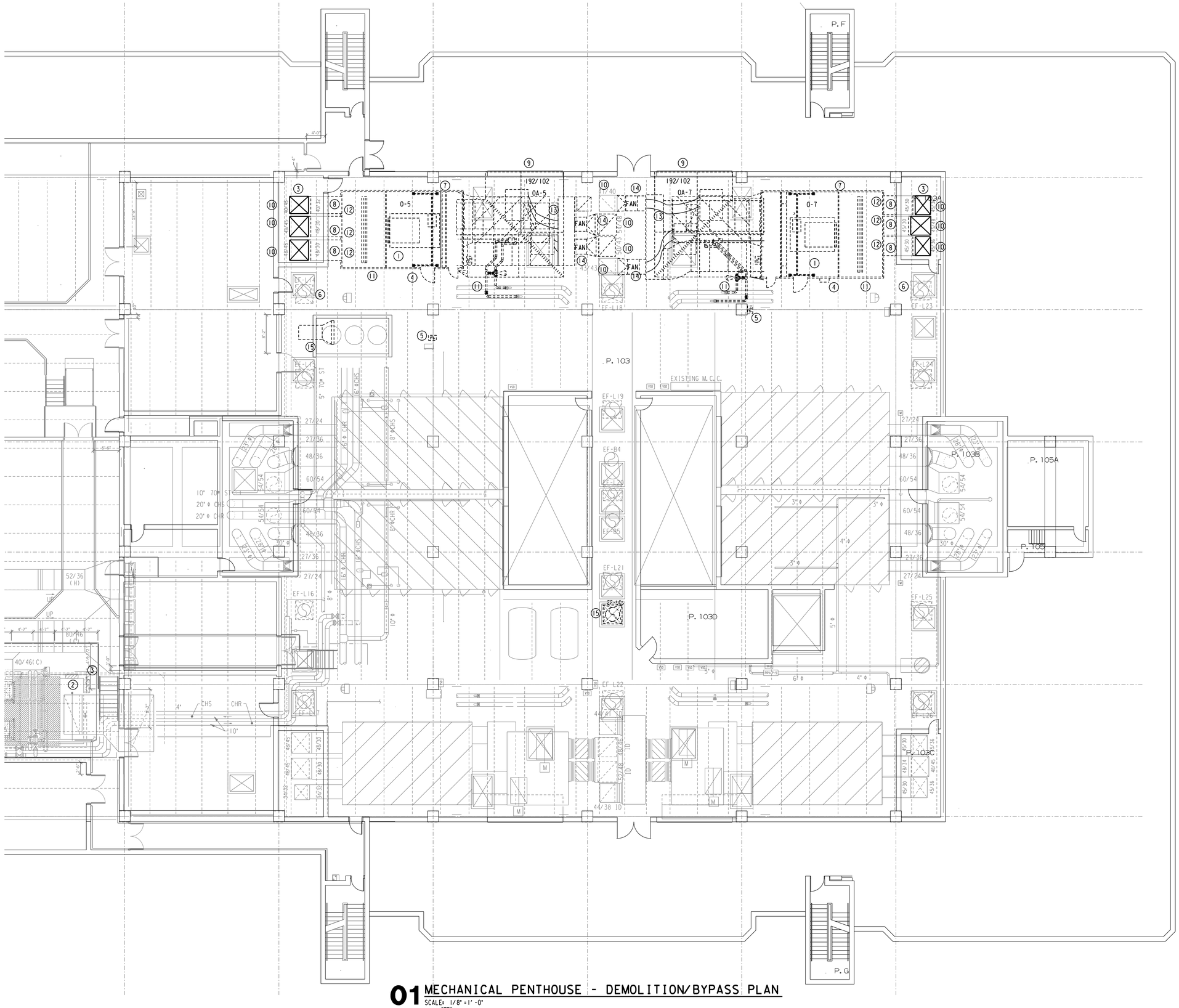
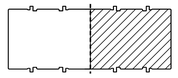


01 MECHANICAL PENTHOUSE - DEMOLITION/BYPASS PLAN

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

DRAWING NOTES:

1. REMOVE AHU. ALL PIPING, DUCT, ELECTRICAL AND CONTROLS SERVING THE DEMOLISHED AHU SHALL BE REMOVED AS REQUIRED FOR RECONNECTION. RE: M700.
2. TEMPORARY BYPASS AHU.
3. TEMPORARY BYPASS UNIT SHALL BE CONNECTED TO THE RISERS AS NOTED ON THE ROOF PLAN. FLEX MAY BE USED. REFER TO M903 & M904 FOR ISOMETRICS OF DUCT CONNECTIONS. REMOVE ANY DUCTWORK IN THE CHASE NECESSARY TO MAKE CONNECITONS.
4. ONCE THE DUCTWORK AT THE ROOF HAS BEEN CONNECTED TO THE RISERS AND THE FLEXIBLE DUCT HAS CONNECTED THE TEMPORARY BYPASS AHUS TO THE RISERS, THE TEMPORARY AHUS SHALL BE ENERGIZED AND THE AHU SHALL BE DE-ENERGIZED. THE BYPASS AHUS ARE SIZED FOR BOTH AHUS TO SERVICE BOTH OFFICE AHUS. THE SEQUENCE OF THE UNITS TO BE REPLACED SHALL BE BASED ON CONSTRUCTABILITY AND CONFIRMED WITH UTHSC-H. ALL ISOLATION VALVES SHALL BE SHUT TO THE AHU AND THE AHU SHALL BE REPLACED AS DETAILED ON M700.
5. REMOVE EXISTING VSD. REPLACE WITH NEW VSD. REFER TO ELECTRICAL DRAWINGS.
6. PROVIDE A TAP INTO THE EXHUAST DUCT AS NOTED FOR VENTILLATION DURING CUTTING OF THE EXISITING UNITS. PROVIDE A 12" ϕ MANUAL BALANCING DAMPER (LOW LEAK) WITH FLEXIBLE DUCT TO ALLOW FOR MOVEMENT TO WHERE THE CUTTING IS TAKING PLACE. COORDINATE ANY NEEDED SHUT-DOWNS WITH THE OWNER.
7. REMOVE THE EXISTING CONCRETE PAD AND REPOUR. RE: STRUCTURAL DRAWINGS FOR FURTHER INFO.
8. REMOVE DUCTWORK AS NOTED FOR REPLACEMENT. EXISTING FIRE DAMPERS TO REMAIN.
9. EXISTING LOUVER SERVING THE UNITS. VACUUM, CLEAN AND REPLACE THE BIRDSCREENS.
10. FIELD VERIFY ACTUAL INTERNAL FREE AREA DUCT SIZES. DUCT SIZE SHOWN IS AN ESTIMATE BASED OFF OF FIELD MEASUREMENTS WHERE THE DUCT COULD BE REACHED AND ORIGINAL AS-BUILTS.
11. REMOVE EXISTING PIPING AS REQUIRED TO INSTALL NEW PIPE TO THE NEW UNITS PER THE PIPING DIAGRAMS ON DETAIL SHEET M900.
12. REMOVE EXISTING SMOKE DETECTOR IN THE DUCTWORK. SAVE FOR REPLACEMENT INTO THE NEW DUCT.
13. REMOVE EXISTING OUTSIDE AIR PRETREATMENT UNIT, CONTROLS, PIPING, VFD ,ETC. TURN OVER CONTROLLERS AND VSDS TO OWNER.
14. CONNECT THE RETURN/RELIEF DUCTS TO THE EXISTING ROOF HOODS TO ALLOW THE FLOOR TO RELIEVE PRESSURIZATION CAUSED BY THE TEMPORARY UNITS BEING 100% OUTSIDE AIR. THE RETURN/RELIEF FANS SHALL REMAIN AS LONG AS POSSIBLE TO MAINTAIN PRESSURE IN THE BUILDING UNTIL THE NEW UNIT IS CONSTRUCTED AND THE NEW RETURN FANS AND PLENUMS ARE TO BE INSTALLED. INSTALL PLENUM AT FAN DISCHARGE AND CAP DUCT AT THE RELIEF HOOD ON THE ROOF. TWO 20" ϕ 1M FLEX DUCTS PER RELIEF FAN TO CONNECT.
15. ONCE THE NEW AHU IS OPERATIONAL SO THAT THE FLOOR IS NOT OVER-PRESSURIZED, THE LAB CHASE EXHUAST FAN SHALL BE REMOVED FOR REPLACEMENT.



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STATE OF TEXAS — HEATHER CAMDEN — 86883 — LICENSED — PROFESSIONAL ENGINEER

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E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENT DEMO/BYPASS PLAN PHASE 2 AHUO-5 & O-7

DRAWING NO.
M208

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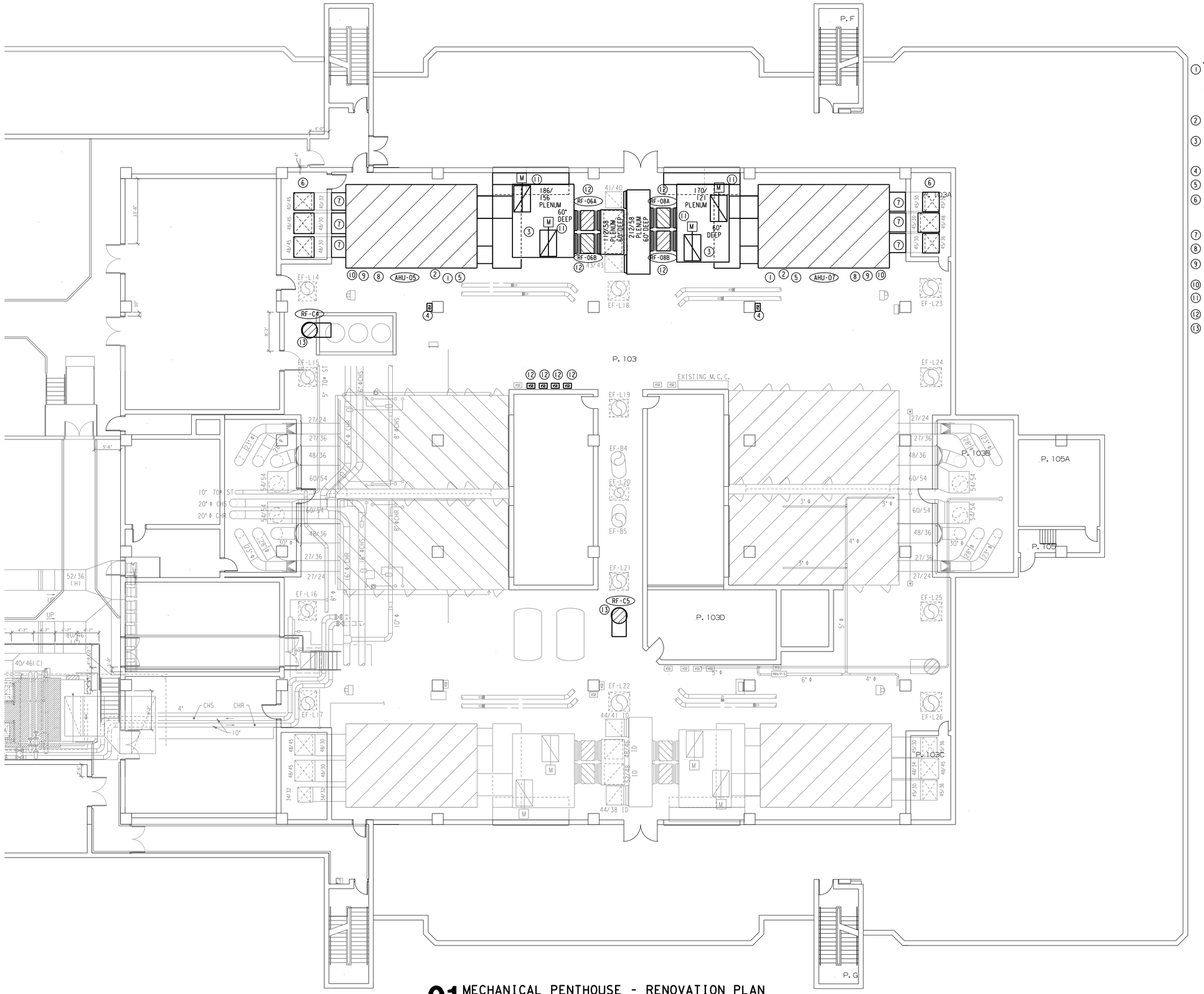
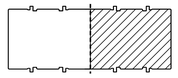


DRAWING NOTES:

1. ONCE THE AHU HAS BEEN REPLACED, TIE BACK INTO THE CHILLED WATER, STEAM AND DUCTWORK. RECONNECT THE NEW FANS TO THE NEW VFD (REFER TO ELECTRICAL DRAWINGS) . DE-ENERGIZE THE TEMPORARY UNIT AND REMOVE THE TEMPORARY DUCT FROM THE PLENUM TO THE RISERS AND CAP TO MATCH EXISITNG. NEW COILS WILL BE IN DIFERENT LOCATIONS. ROUTE PIPE THOROUGH STRUCTURAL OPENINGS AS NECESSARY TO PROVIDE PIPING TO NEW UNITS. ALL CONTROL VALVING SHALL BE PIPED AT THE UNITS AS NOTED. REINSTALL THE SMOKE DETECTOR INTO THE NEW DUCTWORK.
2. NEW AHU SHALL BE STARTED UP WITH A REPRESENTATIVE FROM THE FACTORY AND COMMISSIONED WITH A MEMBER OF THE UTHSC-H STAFF IN ATTENDANCE.
3. REFER TO THE AHU DETAIL DRAWING FOR DUCTWORK ELEVATIONS SHOWING HOW THE OUTSIDE AIR, RETURN AIR, ECONOMIZER MODE OUTSIDE AIR AND RELIEF AIR DUCT AND PLENUMS AS WELL AS RELIEF/RETURN FANS ARE TO BE INSTALLED.
4. INSTALL NEW VSD. RECONNECT TO ELEC AS NEEDED.
5. CONTROL SEQUENCE FOR THE NEW AHU SHALL BE AS NOTED ON DRAWING M990 & M991 - CONTROL DIAGRAMS.
6. PROVIDE NEW DUCT AS NOTED FROM THE AHU TO THE CHASE CONNECTION. DUCT SHALL BE AS HIGH AS POSSIBLE OUT FORM THE UNIT AND TRANSITION DOWN TO THE EXISINTG FIRE DAMPER. RELOCATE SPRINKLER HEADS AS NEEDED. TRYING TO MAINTAIN AS MUCH HEAD HEIGHT AS POSSIBLE CLOSE TO THE COLUMNS.
7. INSTALL NEW SMOKE DETECTORS IN THE RETURN AIR RISERS NEAR THE EXISITNG ACCESS DOOR.
8. POUR NEW PADS 3" LARGER THAN THE AHU FOOTPRINT ON EACH SIDE AND 6" TALL. REFER TO STRUCTURAL.
9. REPIPE THE NEW UNIT AS NOTED ON M900 - MECHANICAL DETAILS AND AS REQUIRED FOR LOCATION OF THE NEW UNIT CONNECTIONS.
10. NEW CONDENSATE RETURN TO BE ROUTED AS TO PENETRATE THE FLOOR IN THE EXISTING LOCATION.
11. MOTORIZED DAMPERS SHALL BE ACCESSIBLE FROM THE ROOF THROUGH THE RELIEF VENTS.
12. ENSURE FANS ARE LOCATED WITH CLEARANCE UNDER FOR ACCESS. INSTALL NEW VFD FOR EACH FAN.
13. INSTALL NEW FAN. FLOOR-SUPPORTED. DUCT A 3'0" STRAIGHT DUCT OFF OF THE FAN OUTLET AND AN ELBOW TERMINATED IN BUGSCREEN TO SEMI-CONDITION THE PENTHOUSE. RECONNECT TO EXISTING UNIT ELECTRICAL. REINSTALL SMOKE DETECTOR FOR SHUT-DOWN.

01 MECHANICAL PENTHOUSE - RENOVATION PLAN

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



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STATE OF TEXAS — HEATHER CAMDEN — 86883 — LICENSED PROFESSIONAL ENGINEER

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Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 2 AHUO-5 & O-7

DRAWING NO.
M218

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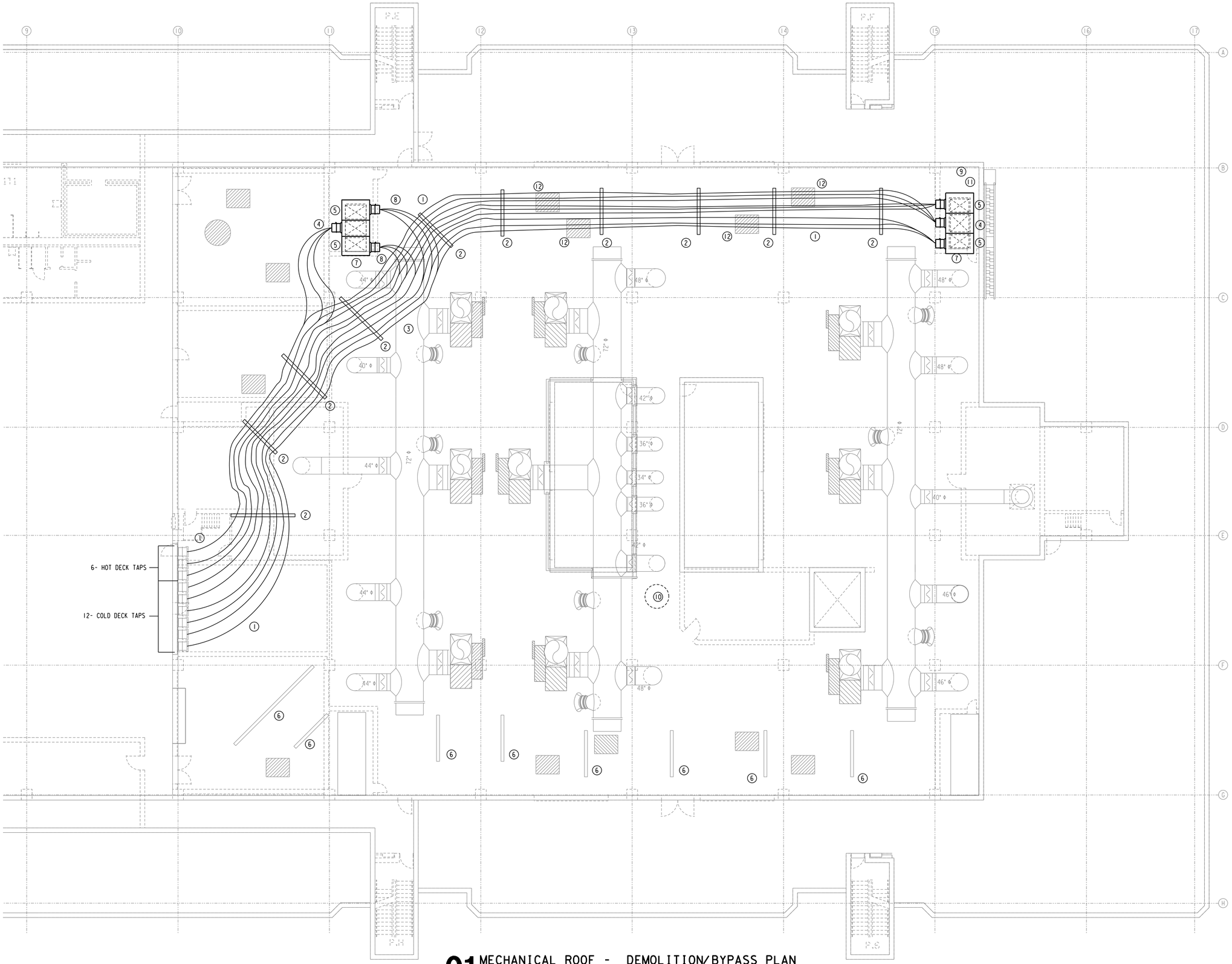

DRAWING NOTES:

1. FLEX DUCTS SIMILAR TO MASTERDUCT MD ALL-WEATHER FLEXIBLE DUCT R8. FLEX TO BE 20"ϕ. FLEX FROM PREVIOUS PROJECT WILL BE STORED BY UTHSC-H. REUSE APPROXIMATELY 50%. THE ADDITIONAL WILL NEED TO BE NEW DUE TO DAMAGE.
2. STRUCTURAL HOLD-DOWN LOCATIONS. RE: DETAIL 8 M901 & STRUCTURAL DRAWINGS.
3. FLEX TO RUN UNDER MANIFOLDS.
4. HOT DUCT.
5. COLD DUCT.
6. EXISITNG STRUCTURAL TIE-DOWNS.
7. NEW MANIFOLD AS DETAILED IN M901 & M902.
8. TAKE BOTTOM DUCTS OFF FOR CONNECTION TO PLENUM. RUN TOP DUCTS ON TO PLENUM FARTHER SOUTH.
9. ENSURE THE NEW PLENUM DOES NOT BLOCK ACCESS FROM THE SHIPS LADDER TO THE ROOF.
10. REMOVE EXISITNG CHASE EXHUAST VENT HOOD AND PATCH THE ROOF TO MATCH EXISTING.
11. PROVIDE A MEATHOD TO TRANSVERSE THE ROOF. THE TEMPORARY DUCTS WILL BLOCK ACCESS TO MANY AREAS FROM THE EXISITNG SHIPS LADDER. EITHER PROVIDE A TEMPORARY SHIPS LADDER FOR THE OTHER SIDE OF THE ROOF, PROVIDE A LADDER TO THE HIGH ROOF AND ANOTHER BACK DOWN TO GET UP AND OVER THE DUCTS WHERE THEY TAP OUT OF THE WALL OR PROVIDE A LADDER UP FROM ONE OF THE OUTSIDE AIR INTAKE PITS.
12. VERIFY VENTS ARE CLEAR FOR RELIEF OF BUIILDING.

01 MECHANICAL ROOF - DEMOLITION/BYPASS PLAN

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

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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF DEMO/BYPASS PLAN PHASE 2 AHU0-5 & 0-7

DRAWING NO.
M209

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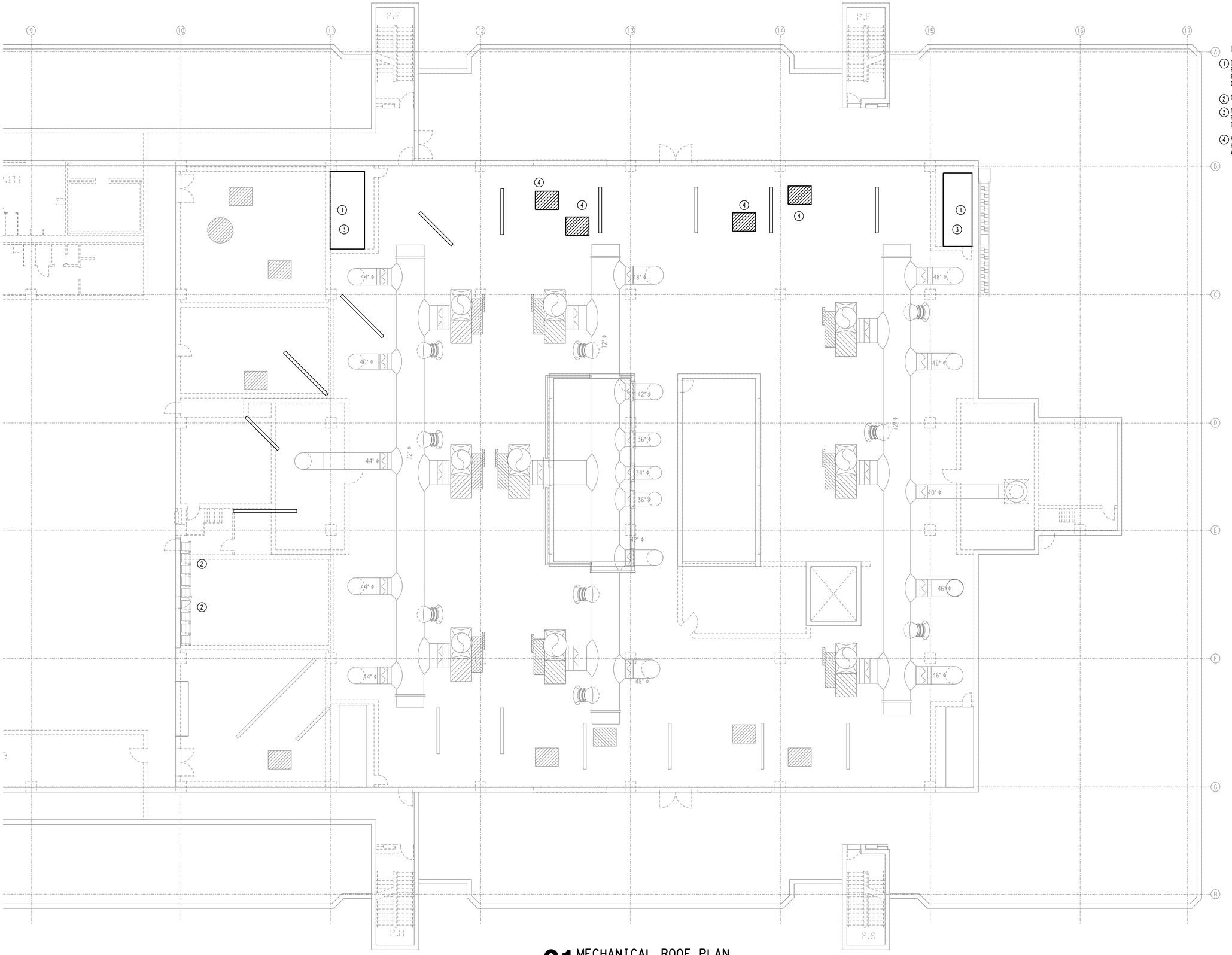
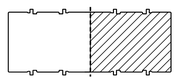


DRAWING NOTES:

1. DISCONNECT THE PLENUMS FROM THE RISERS. CAP THE RISERS AIRTIGHT. REMOVE FLEX DUCT FROM THE ROOF AND TURN OVER TO THE OWNER FOR USE ON FUTURE PHASES. IF THE OWNER FINDS THE DUCT UNUSABLE, CONTRACTOR TO DISPOSE.
2. CAP TAPS THROUGH EXTERIOR WALL FOR USE ON FUTURE PHASES.
3. REMOVE THE PLENUM ON TOP OF THE RISERS ON THE ROOF. PATCH THE ROOF TO MATCH EXISTING. REPLACE CURB AROUND EXISTING EXHAUST DUCT PENETRATION.
4. VERIFY EXISTING ROOF OPENING SIZES PRIOR TO ORDERING NEW RELIEF HOODS. REPLACE HOODS AFTER FLEX HAS BEEN REMOVED WITH NEW ALUMINUM COOK MODEL GR GRAVITY HOOD.

01 MECHANICAL ROOF PLAN

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



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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF PLAN PHASE 2 AHUO-5 & O-7

DRAWING NO.
M219

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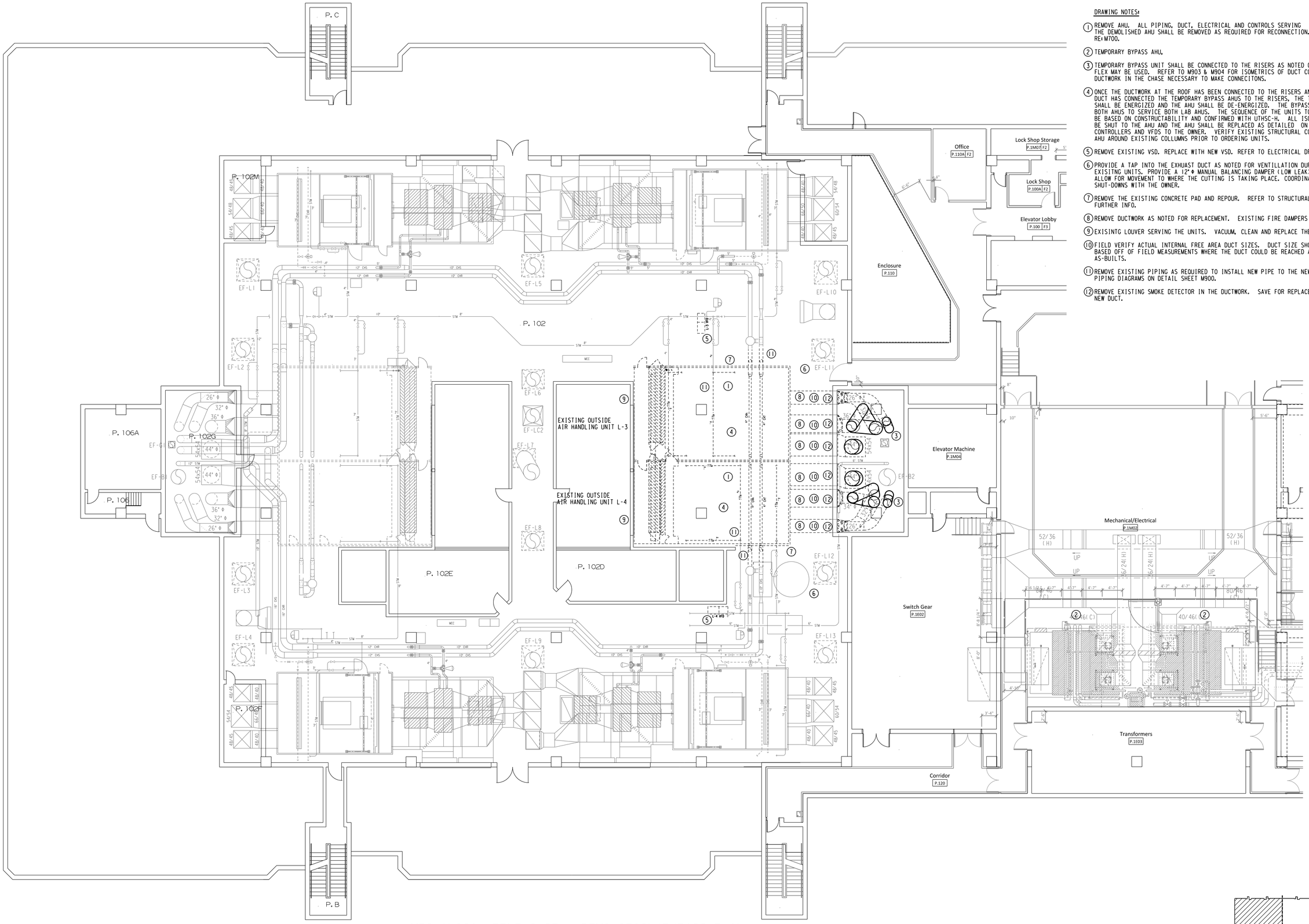

DRAWING NOTES:

1. REMOVE AHU. ALL PIPING, DUCT, ELECTRICAL AND CONTROLS SERVING THE DEMOLISHED AHU SHALL BE REMOVED AS REQUIRED FOR RECONNECTION. RE: M700.
2. TEMPORARY BYPASS AHU.
3. TEMPORARY BYPASS UNIT SHALL BE CONNECTED TO THE RISERS AS NOTED ON THE ROOF PLAN. FLEX MAY BE USED. REFER TO M903 & M904 FOR ISOMETRICS OF DUCT CONNECTIONS. REMOVE ANY DUCTWORK IN THE CHASE NECESSARY TO MAKE CONNECITONS.
4. ONCE THE DUCTWORK AT THE ROOF HAS BEEN CONNECTED TO THE RISERS AND THE FLEXIBLE DUCT HAS CONNECTED THE TEMPORARY BYPASS AHUS TO THE RISERS, THE TEMPORARY AHUS SHALL BE ENERGIZED AND THE AHU SHALL BE DE-ENERGIZED. THE BYPASS AHUS ARE SIZED FOR BOTH AHUS TO SERVICE BOTH LAB AHUS. THE SEQUENCE OF THE UNITS TO BE REPLACED SHALL BE BASED ON CONSTRUCTABILITY AND CONFIRMED WITH UTHSC-H. ALL ISOLATION VALVES SHALL BE SHUT TO THE AHU AND THE AHU SHALL BE REPLACED AS DETAILED ON M700. TURN OVER ALL CONTROLLERS AND VFDS TO THE OWNER. VERIFY EXISTING STRUCTURAL COLLUMNS AND BUILD AHU AROUND EXISTING COLLUMNS PRIOR TO ORDERING UNITS.
5. REMOVE EXISTING VSD. REPLACE WITH NEW VSD. REFER TO ELECTRICAL DRAWINGS.
6. PROVIDE A TAP INTO THE EXHUAST DUCT AS NOTED FOR VENTILLATION DURING CUTTING OF THE EXISITNG UNITS. PROVIDE A 12"Φ MANUAL BALANCING DAMPER (LOW LEAK) WITH FLEXIBLE DUCT TO ALLOW FOR MOVEMENT TO WHERE THE CUTTING IS TAKING PLACE. COORDINATE ANY NEEDED SHUT-DOWNS WITH THE OWNER.
7. REMOVE THE EXISTING CONCRETE PAD AND REPOUR. REFER TO STRUCTURAL DRAWINGS FOR FURTHER INFO.
8. REMOVE DUCTWORK AS NOTED FOR REPLACEMENT. EXISTING FIRE DAMPERS TO REMAIN.
9. EXISINTG LOUVER SERVING THE UNITS. VACUUM, CLEAN AND REPLACE THE BIRDSCREENS.
10. FIELD VERIFY ACTUAL INTERNAL FREE AREA DUCT SIZES. DUCT SIZE SHOWN IS AN ESTIMATE BASED OFF OF FIELD MEASUREMENTS WHERE THE DUCT COULD BE REACHED AND ORIGINAL AS-BUILTS.
11. REMOVE EXISTING PIPING AS REQUIRED TO INSTALL NEW PIPE TO THE NEW UNITS PER THE PIPING DIAGRAMS ON DETAIL SHEET M900.
12. REMOVE EXISTING SMOKE DETECTOR IN THE DUCTWORK. SAVE FOR REPLACEMENT INTO THE NEW DUCT.

01 MECHANICAL PENTHOUSE - DEMOLITION/BYPASS PLAN

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

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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE DEMO/BYPASS PLAN PHASE 3 AHU-L3 & L4

DRAWING NO.
M308

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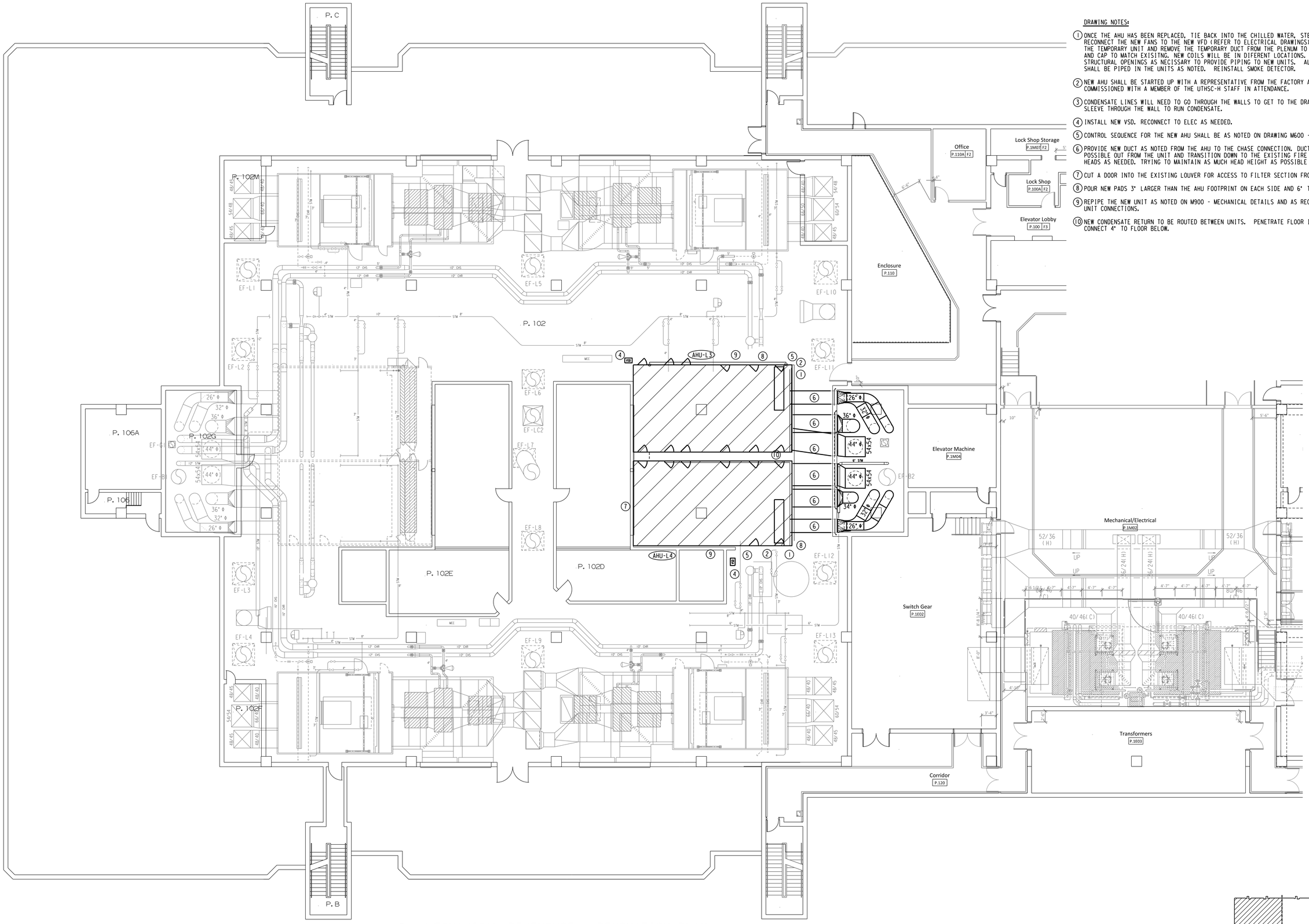

DRAWING NOTES:

1. ONCE THE AHU HAS BEEN REPLACED, TIE BACK INTO THE CHILLED WATER, STEAM AND DUCTWORK. RECONNECT THE NEW FANS TO THE NEW VFD (REFER TO ELECTRICAL DRAWINGS) . DE-ENERGIZE THE TEMPORARY UNIT AND REMOVE THE TEMPORARY DUCT FROM THE PLENUM TO THE RISERS AND CAP TO MATCH EXISITNG. NEW COILS WILL BE IN DIFERENT LOCATIONS. ROUTE PIPE THORUGH STRUCTURAL OPENINGS AS NECISSARY TO PROVIDE PIPING TO NEW UNITS. ALL CONTROL VALVING SHALL BE PIPED IN THE UNITS AS NOTED. REINSTALL SMOKE DETECTOR.
2. NEW AHU SHALL BE STARTED UP WITH A REPRESENTATIVE FROM THE FACTORY AND COMMISSIONED WITH A MEMBER OF THE UTHSC-H STAFF IN ATTENDANCE.
3. CONDENSATE LINES WILL NEED TO GO THROUGH THE WALLS TO GET TO THE DRAIN. PROVIDE A 4" SLEEVE THROUGH THE WALL TO RUN CONDENSATE.
4. INSTALL NEW VSD. RECONNECT TO ELEC AS NEEDED.
5. CONTROL SEQUENCE FOR THE NEW AHU SHALL BE AS NOTED ON DRAWING M600 - CONTROL DIAGRAMS.
6. PROVIDE NEW DUCT AS NOTED FROM THE AHU TO THE CHASE CONNECTION. DUCT SHALL BE AS HIGH AS POSSIBLE OUT FROM THE UNIT AND TRANSITION DOWN TO THE EXISTING FIRE DAMPER. RELOCATE SPRINKLER HEADS AS NEEDED. TRYING TO MAINTAIN AS MUCH HEAD HEIGHT AS POSSIBLE CLOSE TO THE COLUMNS.
7. CUT A DOOR INTO THE EXISTING LOUVER FOR ACCESS TO FILTER SECTION FROM OUTSIDE.
8. POUR NEW PADS 3" LARGER THAN THE AHU FOOTPRINT ON EACH SIDE AND 6" TALL. REFER TO STRUCTURAL.
9. REPIPE THE NEW UNIT AS NOTED ON M900 - MECHANICAL DETAILS AND AS REQUIRED FOR LOCATION OF THE NEW UNIT CONNECTIONS.
10. NEW CONDENSATE RETURN TO BE ROUTED BETWEEN UNITS. PENETRATE FLOOR IN THE CHASE BELOW AND CONNECT 4" TO FLOOR BELOW.

01 MECHANICAL PENTHOUSE - RENOVATION PLAN

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

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UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 3 AHU-L3 & L4

DRAWING NO.
M318

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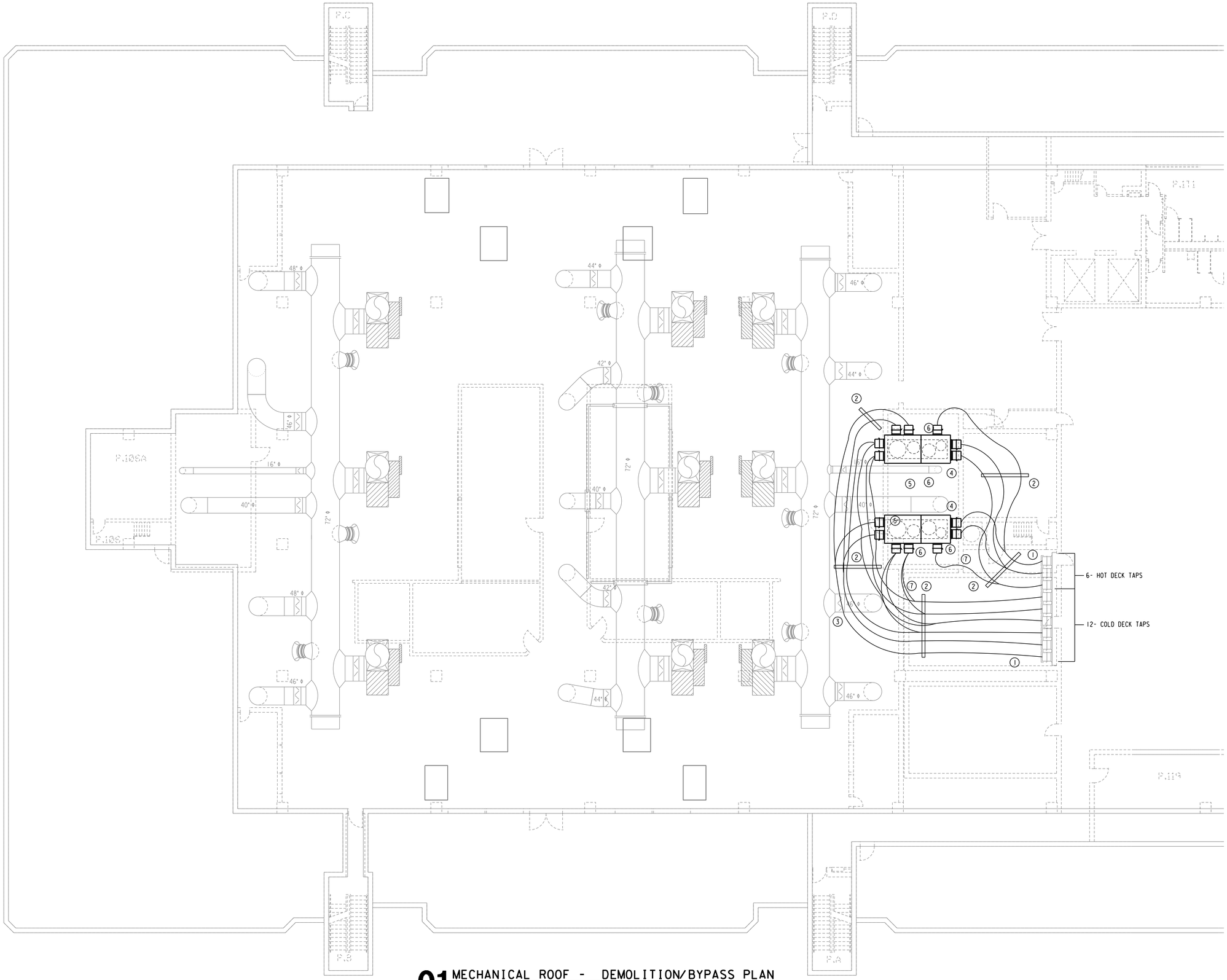
DRAWING NOTES:

1. FLEX DUCTS SIMILAR TO MASTERDUCT MD ALL-WEATHER FLEXIBLE DUCT R8. FLEX TO BE 20" ϕ. FLEX FROM PREVIOUS PROJECT WILL BE STORED BY UTHSC-H. REUSE APPROXIMATELY 50%. THE ADDITIONAL WILL NEED TO BE NEW DUE TO DAMAGE.
2. STRUCTURAL HOLD-DOWN LOCATIONS. RE: DETAIL 8 M901 & STRUCTURAL DRAWINGS.
3. FLEX TO RUN UNDER MANIFOLDS.
4. HOT DUCT.
5. COLD DUCT.
6. NEW MANIFOLD AS DETAILED IN M901 & M902.
7. TAKE BOTTOM DUCTS OFF FOR CONNECTION TO PLENUM. RUN TOP DUCTS ON TO PLENUM FARTHER EAST.



01 MECHANICAL ROOF - DEMOLITION/BYPASS PLAN

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

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UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL DEMO/BYPASS PLAN PHASE 3 AHU-L3 & L4

DRAWING NO.
M309

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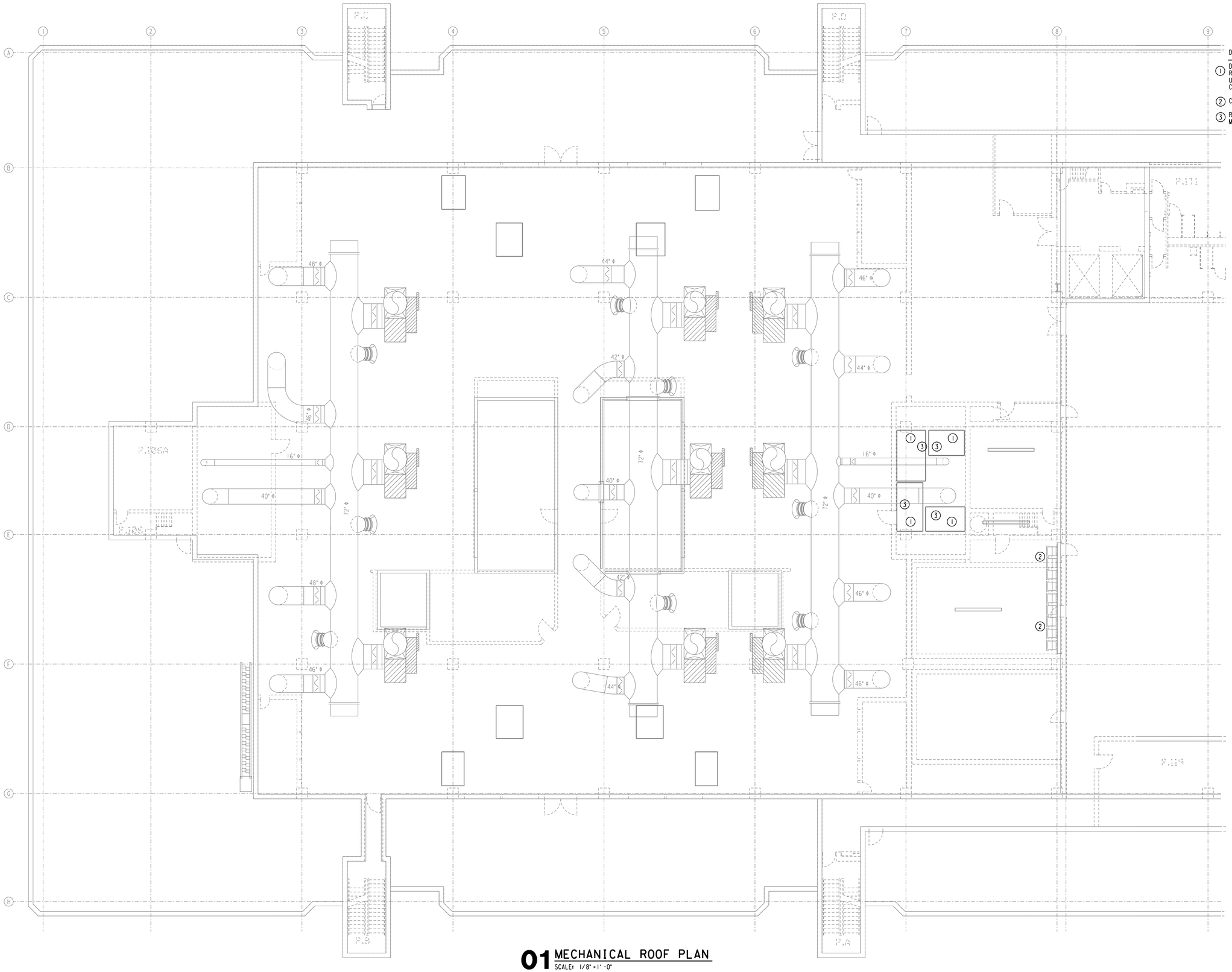

DRAWING NOTES:

1. DISCONNECT THE PLENUMS FROM THE RISERS. CAP THE RISERS AIRTIGHT. REMOVE FLEX DUCT FROM THE ROOF AND TURN OVER TO THE OWNER FOR USE ON FUTURE PHASES. IF THE OWNER FINDS THE DUCT UNUSABLE, CONTRACTOR TO DISPOSE.
2. CAP TAPS THROUGH EXTERIOR WALL FOR USE ON FUTURE PHASES.
3. REMOVE THE PLENUM ON TOP OF THE RISERS ON THE ROOF. PATCH THE ROOF TO MATCH EXISTING. REPLACE CURB AROUND EXISTING EXHAUST DUCT PENETRATION.

01 MECHANICAL ROOF PLAN

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

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MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF PLAN PHASE 3 AHU-L3 & L4

DRAWING NO.
M319

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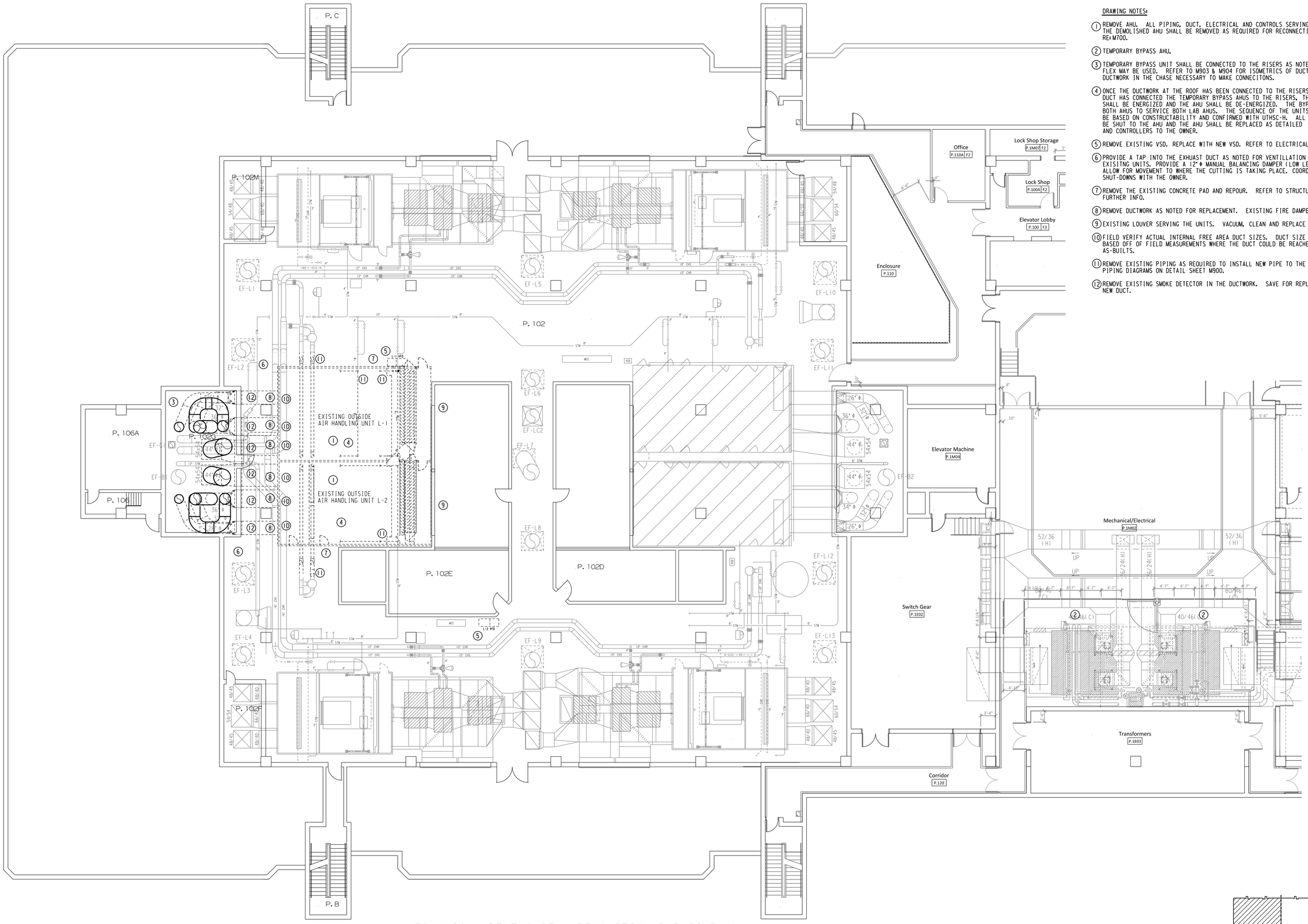

DRAWING NOTES:

1. REMOVE AHU. ALL PIPING, DUCT, ELECTRICAL AND CONTROLS SERVING THE DEMOLISHED AHU SHALL BE REMOVED AS REQUIRED FOR RECONNECTION. RE:M700.
2. TEMPORARY BYPASS AHU,
3. TEMPORARY BYPASS UNIT SHALL BE CONNECTED TO THE RISERS AS NOTED ON THE ROOF PLAN. FLEX MAY BE USED. REFER TO M903 & M904 FOR ISOMETRICS OF DUCT CONNECTIONS. REMOVE ANY DUCTWORK IN THE CHASE NECESSARY TO MAKE CONNECITONS.
4. ONCE THE DUCTWORK AT THE ROOF HAS BEEN CONNECTED TO THE RISERS AND THE FLEXIBLE DUCT HAS CONNECTED THE TEMPORARY BYPASS AHUS TO THE RISERS, THE TEMPORARY AHUS SHALL BE ENERGIZED AND THE AHU SHALL BE DE-ENERGIZED. THE BYPASS AHUS ARE SIZED FOR BOTH AHUS TO SERVICE BOTH LAB AHUS. THE SEQUENCE OF THE UNITS TO BE REPLACED SHALL BE BASED ON CONSTRUCTABILITY AND CONFIRMED WITH UTHSC-H. ALL ISOLATION VALVES SHALL BE SHUT TO THE AHU AND THE AHU SHALL BE REPLACED AS DETAILED ON M700. TURN OVER VSDS AND CONTROLLERS TO THE OWNER.
5. REMOVE EXISTING VSD. REPLACE WITH NEW VSD. REFER TO ELECTRICAL DRAWINGS.
6. PROVIDE A TAP INTO THE EXHUAST DUCT AS NOTED FOR VENTILLATION DURING CUTTING OF THE EXISITNG UNITS. PROVIDE A 12"Φ MANUAL BALANCING DAMPER (LOW LEAK) WITH FLEXIBLE DUCT TO ALLOW FOR MOVEMENT TO WHERE THE CUTTING IS TAKING PLACE. COORDINATE ANY NEEDED SHUT-DOWNS WITH THE OWNER.
7. REMOVE THE EXISTING CONCRETE PAD AND REPOUR. REFER TO STRUCTURAL DRAWINGS FOR FURTHER INFO.
8. REMOVE DUCTWORK AS NOTED FOR REPLACEMENT. EXISTING FIRE DAMPERS TO REMAIN.
9. EXISTING LOUVER SERVING THE UNITS. VACUUM, CLEAN AND REPLACE THE BIRDSCREENS.
10. FIELD VERIFY ACTUAL INTERNAL FREE AREA DUCT SIZES. DUCT SIZE SHOWN IS AN ESTIMATE BASED OFF OF FIELD MEASUREMENTS WHERE THE DUCT COULD BE REACHED AND ORIGINAL AS-BUILTS.
11. REMOVE EXISTING PIPING AS REQUIRED TO INSTALL NEW PIPE TO THE NEW UNITS PER THE PIPING DIAGRAMS ON DETAIL SHEET M900.
12. REMOVE EXISTING SMOKE DETECTOR IN THE DUCTWORK. SAVE FOR REPLACEMENT INTO THE NEW DUCT.

01 MECHANICAL PENTHOUSE - DEMOLITION/BYPASS PLAN

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

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ENGINEERS & CONSULTANTS, INC.
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STATE OF TEXAS — HEATHER CAMDEN — 86883 — LICENSED PROFESSIONAL ENGINEER

THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY: Digitally signed by Heather Camden Date: 2018.04.12 15:41:53-05'00'
E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE DEMO/BYPASS PLAN PHASE 4 AHU-L1 & L2

DRAWING NO.
M408

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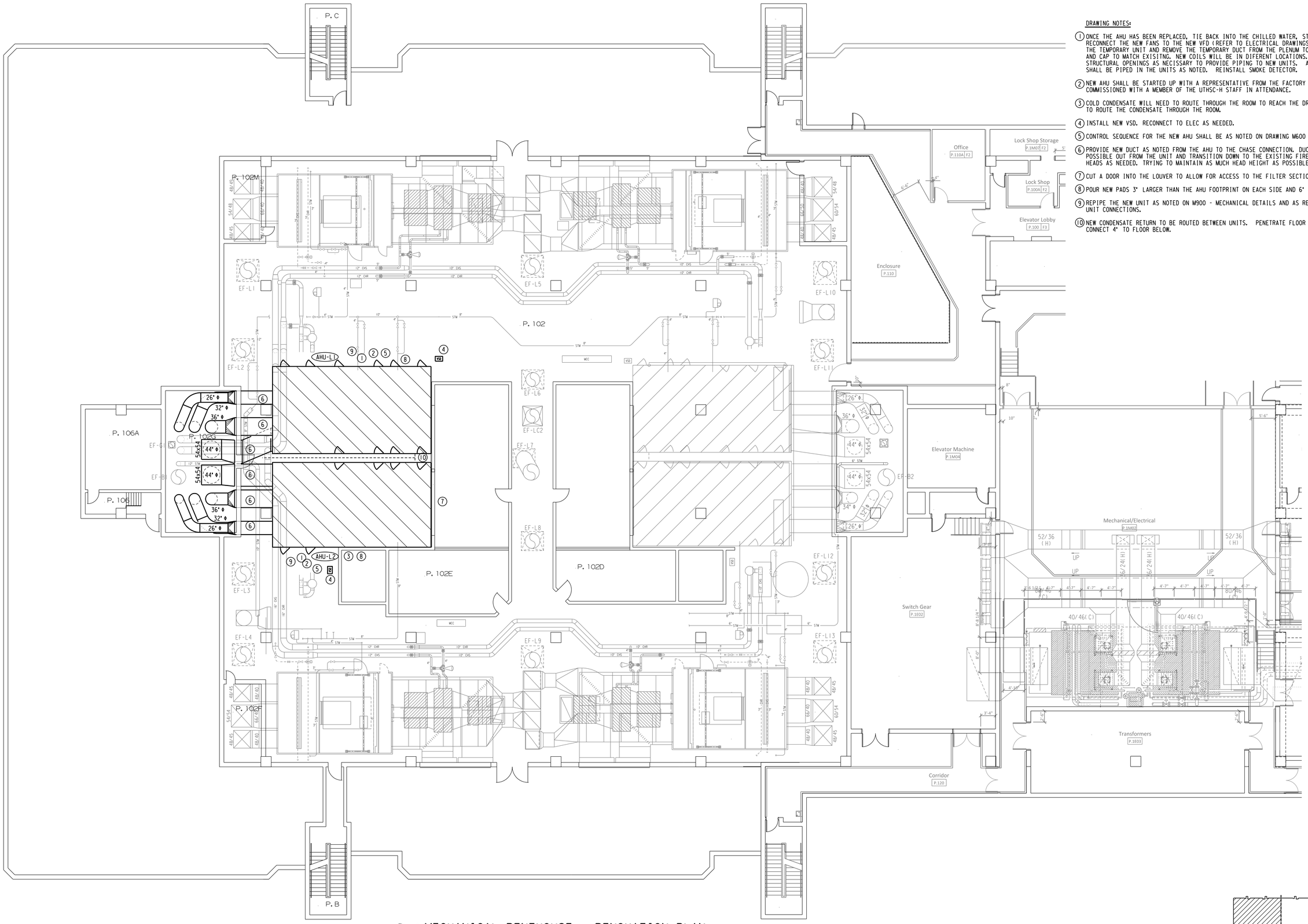

DRAWING NOTES:

1. ONCE THE AHU HAS BEEN REPLACED, TIE BACK INTO THE CHILLED WATER, STEAM AND DUCTWORK. RECONNECT THE NEW FANS TO THE NEW VFD (REFER TO ELECTRICAL DRAWINGS) . DE-ENERGIZE THE TEMPORARY UNIT AND REMOVE THE TEMPORARY DUCT FROM THE PLENUM TO THE RISERS AND CAP TO MATCH EXISITNG. NEW COILS WILL BE IN DIFERENT LOCATIONS. ROUTE PIPE THROUGH STRUCTURAL OPENINGS AS NECISSARY TO PROVIDE PIPING TO NEW UNITS. ALL CONTROL VALVING SHALL BE PIPED IN THE UNITS AS NOTED. REINSTALL SMOKE DETECTOR.
2. NEW AHU SHALL BE STARTED UP WITH A REPRESENTATIVE FROM THE FACTORY AND COMMISSIONED WITH A MEMBER OF THE UTHSC-H STAFF IN ATTENDANCE.
3. COLD CONDENSATE WILL NEED TO ROUTE THROUGH THE ROOM TO REACH THE DRAIN. USE A 4" SLEEVE TO ROUTE THE CONDENSATE THROUGH THE ROOM.
4. INSTALL NEW VSD. RECONNECT TO ELEC AS NEEDED.
5. CONTROL SEQUENCE FOR THE NEW AHU SHALL BE AS NOTED ON DRAWING M600 - CONTROL DIAGRAMS.
6. PROVIDE NEW DUCT AS NOTED FROM THE AHU TO THE CHASE CONNECTION. DUCT SHALL BE AS HIGH AS POSSIBLE OUT FROM THE UNIT AND TRANSITION DOWN TO THE EXISTING FIRE DAMPER. RELOCATE SPRINKLER HEADS AS NEEDED. TRYING TO MAINTAIN AS MUCH HEAD HEIGHT AS POSSIBLE CLOSE TO THE COLUMNS.
7. CUT A DOOR INTO THE LOUVER TO ALLOW FOR ACCESS TO THE FILTER SECTION FROM OUTSIDE.
8. POUR NEW PADS 3" LARGER THAN THE AHU FOOTPRINT ON EACH SIDE AND 6" TALL. REFER TO STRUCTURAL.
9. REPIPE THE NEW UNIT AS NOTED ON M900 - MECHANICAL DETAILS AND AS REQUIRED FOR LOCATION OF THE NEW UNIT CONNECTIONS.
10. NEW CONDENSATE RETURN TO BE ROUTED BETWEEN UNITS. PENETRATE FLOOR IN THE CHASE BELOW AND CONNECT 4" TO FLOOR BELOW.

01 MECHANICAL PENTHOUSE - RENOVATION PLAN

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

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E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 4 AHU-L1 & L2

DRAWING NO.
M418

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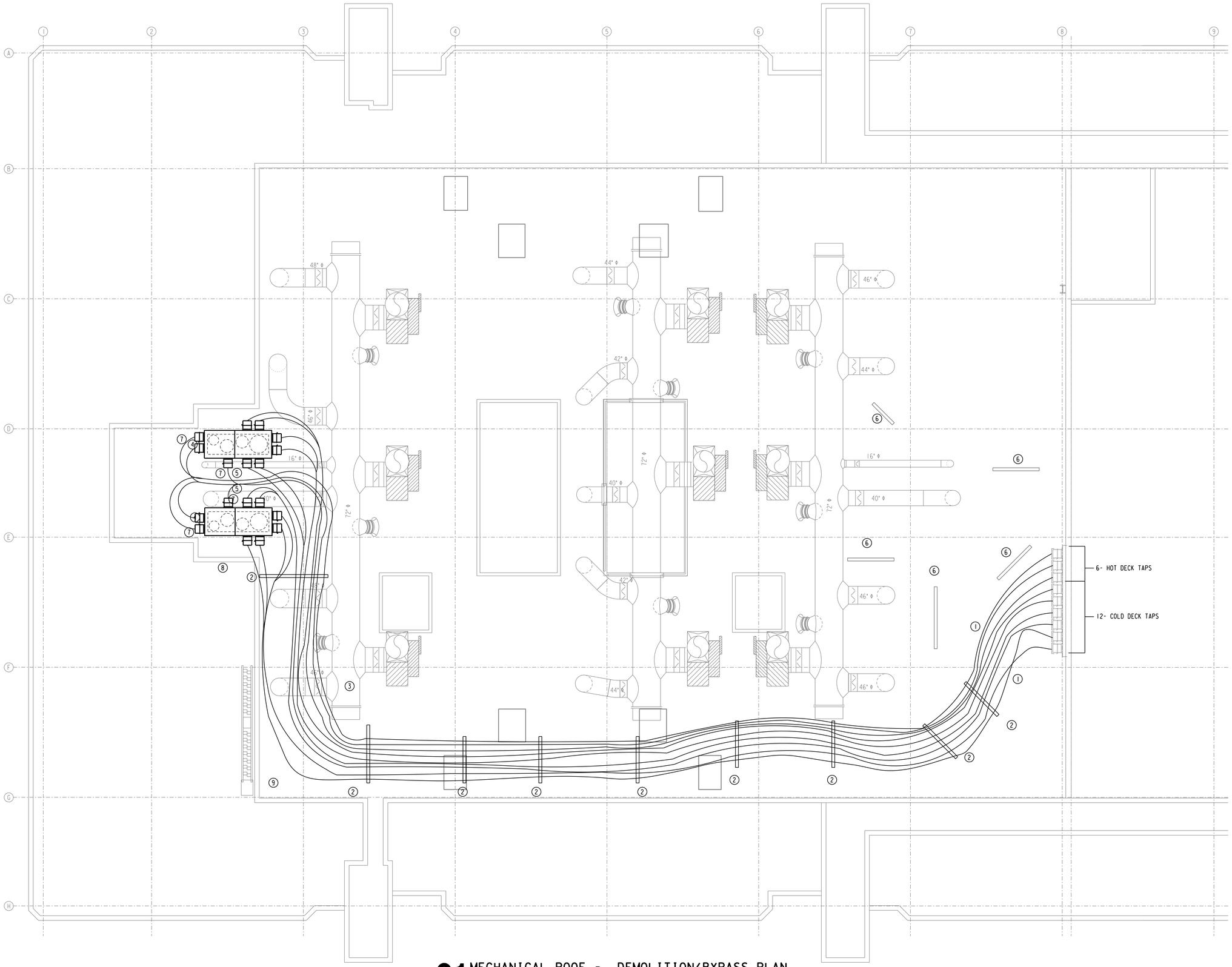

DRAWING NOTES:

1. FLEX DUCTS SIMILAR TO MASTERDUCT MD ALL-WEATHER FLEXIBLE DUCT R8. FLEX TO BE 20"ϕ. FLEX FROM PREVIOUS PROJECT WILL BE STORED BY UTHSC-H. REUSE APPROXIMATELY 50%, THE ADDITIONAL WILL NEED TO BE NEW DUE TO DAMAGE.
2. STRUCTURAL HOLD-DOWN LOCATIONS. RE: DETAIL 8 M901 & STRUCTURAL DRAWINGS.
3. FLEX TO RUN UNDER MANIFOLDS.
4. HOT DUCT.
5. COLD DUCT.
6. EXISTING STRUCTURAL TIE-DOWNS.
7. NEW MANIFOLD AS DETAILED IN M901 & M902.
8. TAKE BOTTOM DUCTS OFF FOR CONNECTION TO PLENUM. RUN TOP DUCTS ON TO PLENUM FARTHER EAST.
9. PROVIDE A MEATHOD TO TRANSVERSE THE ROOF. THE TEMPORARY DUCTS WILL BLOCK ACCESS TO MANY AREAS FROM THE EXISITNG SHIPS LADDER. EITHER PROVIDE A TEMPORARY SHIPS LADDER FOR THE OTHER SIDE OF THE ROOF, PROVIDE A LADDER TO THE HIGH ROOF AND ANOTHER BACK DOWN TO GET UP AND OVER THE DUCTS WHERE THEY TAP OUT OF THE WALL OR PROVIDE A LADDER UP FROM ONE OF THE OUTSIDE AIR INTAKE PITS. THIS SOLUTION SHOULD BE APPLICABLE FOR ALL PHASES WHERE THE PATH IS BLOCKED FROM THE SHIPS LADDER TO THE REST OF THE ROOF.

01 MECHANICAL ROOF - DEMOLITION/BYPASS PLAN

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

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E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL DEMO/BYPASS PLAN PHASE 4 AHU-L1 & L2

DRAWING NO.
M409

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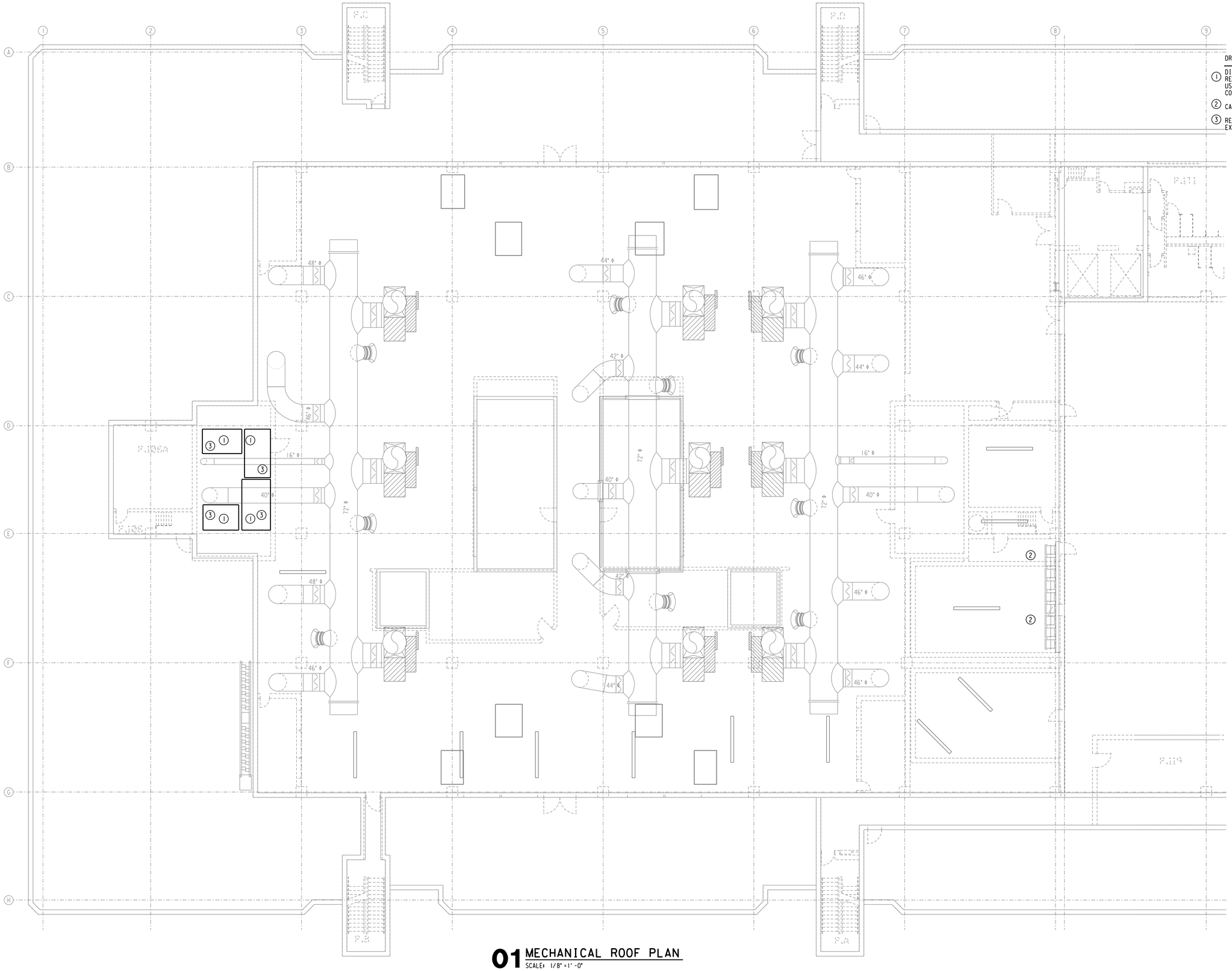
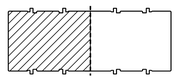


DRAWING NOTES:

1. DISCONNECT THE PLENUMS FROM THE RISERS. CAP THE RISERS AIRTIGHT. REMOVE FLEX DUCT FROM THE ROOF AND TURN OVER TO THE OWNER FOR USE ON FUTURE PHASES. IF THE OWNER FINDS THE DUCT UNUSABLE, CONTRACTOR TO DISPOSE.
2. CAP TAPS THROUGH EXTERIOR WALL FOR USE ON FUTURE PHASES.
3. REMOVE THE PLENUM ON TOP OF THE RISERS ON THE ROOF. PATCH THE ROOF TO MATCH EXISTING. REPLACE CURB AROUND EXISTING EXHAUST DUCT PENETRATION.

01 MECHANICAL ROOF PLAN

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



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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF PLAN PHASE 4 AHU-L1 & L2

DRAWING NO.
M419

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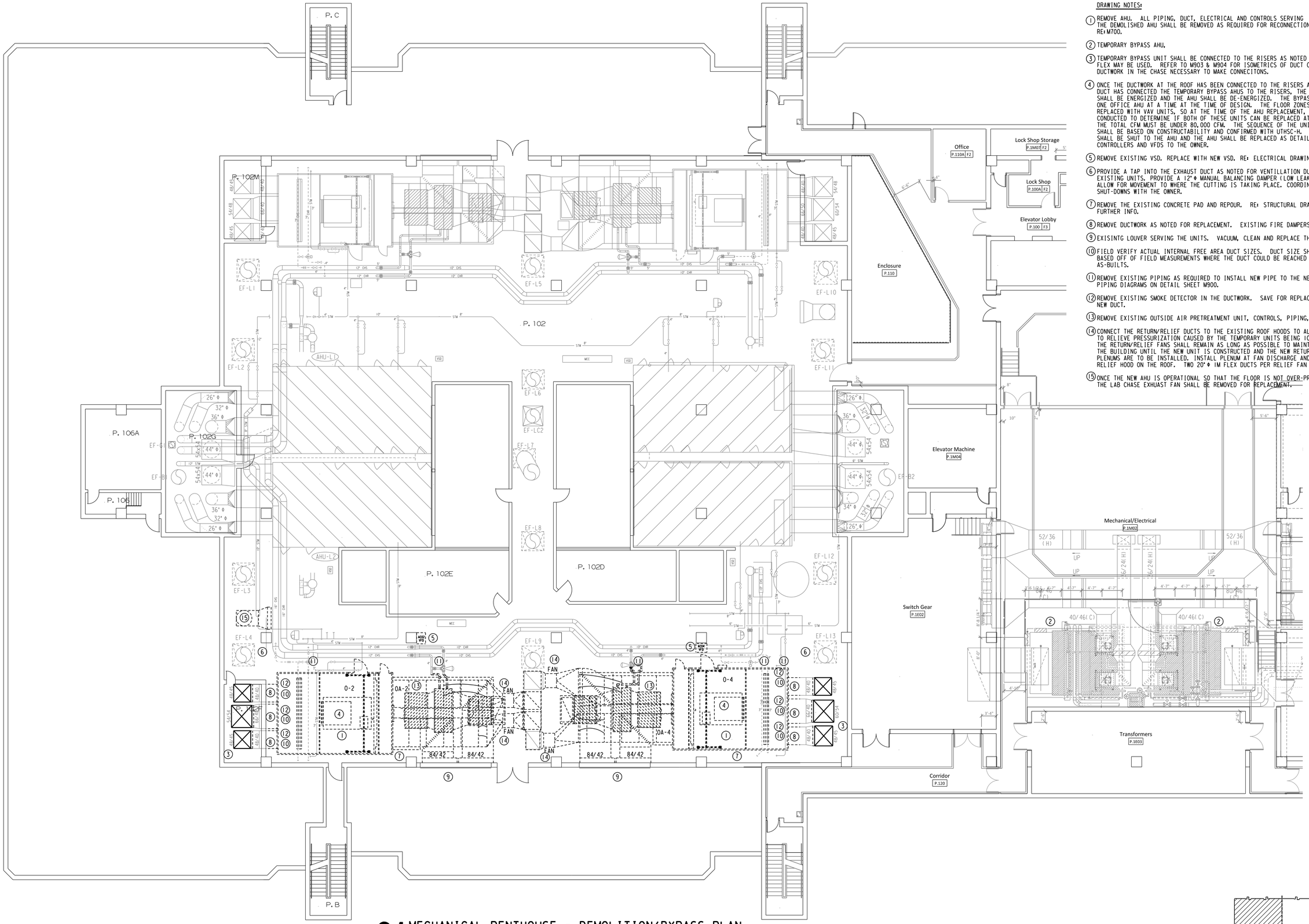

01 MECHANICAL PENTHOUSE - DEMOLITION/BYPASS PLAN

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

DRAWING NOTES:

1. REMOVE AHU. ALL PIPING, DUCT, ELECTRICAL AND CONTROLS SERVING THE DEMOLISHED AHU SHALL BE REMOVED AS REQUIRED FOR RECONNECTION. RE: M700.
2. TEMPORARY BYPASS AHU.
3. TEMPORARY BYPASS UNIT SHALL BE CONNECTED TO THE RISERS AS NOTED ON THE ROOF PLAN. FLEX MAY BE USED. REFER TO M903 & M904 FOR ISOMETRICS OF DUCT CONNECTIONS. REMOVE ANY DUCTWORK IN THE CHASE NECESSARY TO MAKE CONNECITONS.
4. ONCE THE DUCTWORK AT THE ROOF HAS BEEN CONNECTED TO THE RISERS AND THE FLEXIBLE DUCT HAS CONNECTED THE TEMPORARY BYPASS AHUS TO THE RISERS, THE TEMPORARY AHUS SHALL BE ENERGIZED AND THE AHU SHALL BE DE-ENERGIZED. THE BYPASS AHUS ARE SIZED FOR ONE OFFICE AHU AT A TIME AT THE TIME OF DESIGN. THE FLOOR ZONES ARE CURRENTLY BEING REPLACED WITH VAV UNITS, SO AT THE TIME OF THE AHU REPLACEMENT, A PRE-TAB MAY BE CONDUCTED TO DETERMINE IF BOTH OF THESE UNITS CAN BE REPLACED AT THE SAME TIME. THE TOTAL CFM MUST BE UNDER 80,000 CFM. THE SEQUENCE OF THE UNITS TO BE REPLACED SHALL BE BASED ON CONSTRUCTABILITY AND CONFIRMED WITH UTHSC-H. ALL ISOLATION VALVES SHALL BE SHUT TO THE AHU AND THE AHU SHALL BE REPLACED AS DETAILED ON M700. TURN OVER CONTROLLERS AND VFDS TO THE OWNER.
5. REMOVE EXISTING VSD. REPLACE WITH NEW VSD. RE: ELECTRICAL DRAWINGS.
6. PROVIDE A TAP INTO THE EXHAUST DUCT AS NOTED FOR VENTILLATION DURING CUTTING OF THE EXISTING UNITS. PROVIDE A 12"Φ MANUAL BALANCING DAMPER (LOW LEAK) WITH FLEXIBLE DUCT TO ALLOW FOR MOVEMENT TO WHERE THE CUTTING IS TAKING PLACE. COORDINATE ANY NEEDED SHUT-DOWNS WITH THE OWNER.
7. REMOVE THE EXISTING CONCRETE PAD AND REPOUR. RE: STRUCTURAL DRAWINGS FOR FURTHER INFO.
8. REMOVE DUCTWORK AS NOTED FOR REPLACEMENT. EXISTING FIRE DAMPERS TO REMAIN.
9. EXISINTG LOUVER SERVING THE UNITS. VACUUM, CLEAN AND REPLACE THE BIRDSCREENS.
10. FIELD VERIFY ACTUAL INTERNAL FREE AREA DUCT SIZES. DUCT SIZE SHOWN IS AN ESTIMATE BASED OFF OF FIELD MEASUREMENTS WHERE THE DUCT COULD BE REACHED AND ORIGINAL AS-BUILTS.
11. REMOVE EXISTING PIPING AS REQUIRED TO INSTALL NEW PIPE TO THE NEW UNITS PER THE PIPING DIAGRAMS ON DETAIL SHEET M900.
12. REMOVE EXISTING SMOKE DETECTOR IN THE DUCTWORK. SAVE FOR REPLACEMENT INTO THE NEW DUCT.
13. REMOVE EXISTING OUTSIDE AIR PRETREATMENT UNIT, CONTROLS, PIPING, VFD ,ETC.
14. CONNECT THE RETURN/RELIEF DUCTS TO THE EXISTING ROOF HOODS TO ALLOW THE FLOOR TO RELIEVE PRESSURIZATION CAUSED BY THE TEMPORARY UNITS BEING 100% OUTSIDE AIR. THE RETURN/RELIEF FANS SHALL REMAIN AS LONG AS POSSIBLE TO MAINTAIN PRESSURE IN THE BUILDING UNTIL THE NEW UNIT IS CONSTRUCTED AND THE NEW RETURN FANS AND PLENUMS ARE TO BE INSTALLED. INSTALL PLENUM AT FAN DISCHARGE AND CAP DUCT AT THE RELIEF HOOD ON THE ROOF. TWO 20"Φ 1M FLEX DUCTS PER RELIEF FAN TO CONNECT.
15. ONCE THE NEW AHU IS OPERATIONAL SO THAT THE FLOOR IS NOT OVER-PRESSURIZED, THE LAB CHASE EXHUAST FAN SHALL BE REMOVED FOR REPLACEMENT.

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Digitally signed by Howard E. Chambers
Date: 2018.04.12 09:58:54 -05'00'

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Texas Firm Registration No: F-003068

Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE DEMO/BYPASS PLAN PHASE 5 AHUO-2 & O-4

DRAWING NO.
M508

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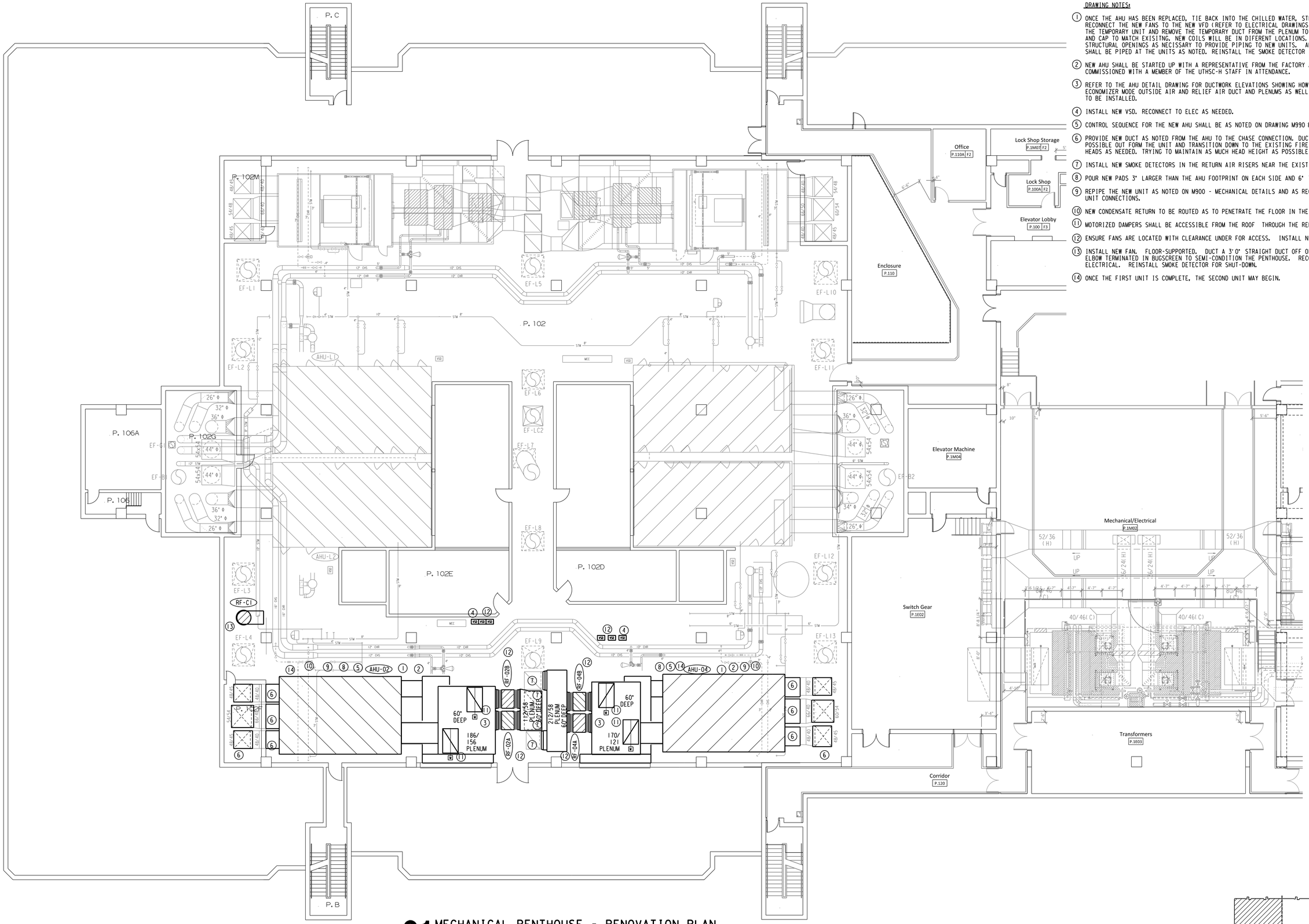

01 MECHANICAL PENTHOUSE - RENOVATION PLAN

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

DRAWING NOTES:

1. ONCE THE AHU HAS BEEN REPLACED, TIE BACK INTO THE CHILLED WATER, STEAM AND DUCTWORK. RECONNECT THE NEW FANS TO THE NEW VFD (REFER TO ELECTRICAL DRAWINGS) . DE-ENERGIZE THE TEMPORARY UNIT AND REMOVE THE TEMPORARY DUCT FROM THE PLENUM TO THE RISERS AND CAP TO MATCH EXISITNG. NEW COILS WILL BE IN DIFERENT LOCATIONS. ROUTE PIPE THORUGH STRUCTURAL OPENINGS AS NECISSARY TO PROVIDE PIPING TO NEW UNITS. ALL CONTROL VALVING SHALL BE PIPED AT THE UNITS AS NOTED. REINSTALL THE SMOKE DETECTOR INTO THE NEW DUCTWORK.
2. NEW AHU SHALL BE STARTED UP WITH A REPRESENTATIVE FROM THE FACTORY AND COMMISSIONED WITH A MEMBER OF THE UTHSC-H STAFF IN ATTENDANCE.
3. REFER TO THE AHU DETAIL DRAWING FOR DUCTWORK ELEVATIONS SHOWING HOW THE OUTSIDE AIR, RETURN AIR, ECONOMIZER MODE OUTSIDE AIR AND RELIEF AIR DUCT AND PLENUMS AS WELL AS RELIEF/RETURN FANS ARE TO BE INSTALLED.
4. INSTALL NEW VSD. RECONNECT TO ELEC AS NEEDED.
5. CONTROL SEQUENCE FOR THE NEW AHU SHALL BE AS NOTED ON DRAWING M990 & M991 - CONTROL DIAGRAMS.
6. PROVIDE NEW DUCT AS NOTED FROM THE AHU TO THE CHASE CONNECTION. DUCT SHALL BE AS HIGH AS POSSIBLE OUT FORM THE UNIT AND TRANSITION DOWN TO THE EXISTING FIRE DAMPER. RELOCATE SPRINKLER HEADS AS NEEDED. TRYING TO MAINTAIN AS MUCH HEAD HEIGHT AS POSSIBLE CLOSE TO THE COLUMNS.
7. INSTALL NEW SMOKE DETECTORS IN THE RETURN AIR RISERS NEAR THE EXISTING ACCESS DOOR.
8. POUR NEW PADS 3" LARGER THAN THE AHU FOOTPRINT ON EACH SIDE AND 6" TALL. REFER TO STRUCTURAL.
9. REPIPE THE NEW UNIT AS NOTED ON M900 - MECHANICAL DETAILS AND AS REQUIRED FOR LOCATION OF THE NEW UNIT CONNECTIONS.
10. NEW CONDENSATE RETURN TO BE ROUTED AS TO PENETRATE THE FLOOR IN THE EXISTING LOCATION.
11. MOTORIZED DAMPERS SHALL BE ACCESSIBLE FROM THE ROOF THROUGH THE RELIEF VENTS.
12. ENSURE FANS ARE LOCATED WITH CLEARANCE UNDER FOR ACCESS. INSTALL NEW VFD FOR EACH FAN.
13. INSTALL NEW FAN. FLOOR-SUPPORTED. DUCT A 3'0" STRAIGHT DUCT OFF OF THE FAN OUTLET AND AN ELBOW TERMINATED IN BUGSCREEN TO SEMI-CONDITION THE PENTHOUSE. RECONNECT TO EXISTING UNIT ELECTRICAL. REINSTALL SMOKE DETECTOR FOR SHUT-DOWN.
14. ONCE THE FIRST UNIT IS COMPLETE, THE SECOND UNIT MAY BEGIN.

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Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 5 AHUO-2 & O-4

DRAWING NO.
M518

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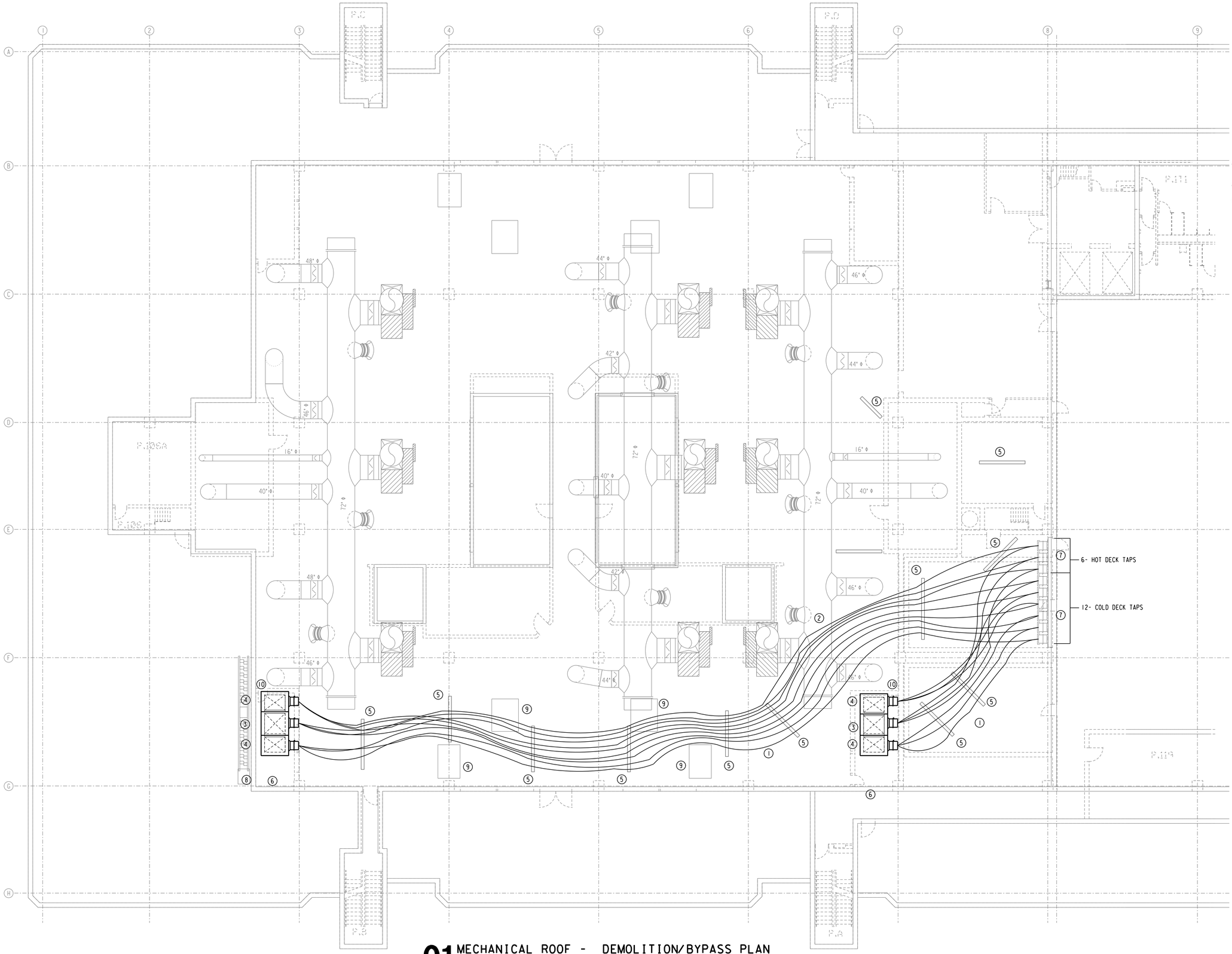

DRAWING NOTES:

1. FLEX DUCTS SIMILAR TO MASTERDUCT MD ALL-WEATHER FLEXIBLE DUCT R8. FLEX TO BE 20"ϕ. FLEX FROM PREVIOUS PROJECT WILL BE STORED BY UTHSC-H. REUSE APPROXIMATELY 50%. THE ADDITIONAL WILL NEED TO BE NEW DUE TO DAMAGE.
2. FLEX TO RUN UNDER MANIFOLDS.
3. HOT DUCT.
4. COLD DUCT.
5. EXISTING STRUCTURAL TIE-DOWNS.
6. NEW MANIFOLD AS DETAILED IN M901 & M902.
7. TAKE BOTTOM DUCTS OFF FOR CONNECTION TO PLENUM. RUN TOP DUCTS ON TO PLENUM FARTHER EAST.
8. ENSURE THE NEW PLENUM DOES NOT BLOCK ACCESS FROM THE SHIPS LADDER TO THE ROOF.
9. ENSURE VENTS ARE CLEAR FOR RELIEF OF BUILDING.
10. ONCE THE FIRST UNIT IS COMPLETE, THE SECOND UNIT MAY BEGIN. EACH UNIT WILL REQUIRE CONNECTIONS OF 8 COLD DECK (FOUR PER RISER) AND 4 HOT DECK FLEX CONNECTIONS.

01 MECHANICAL ROOF - DEMOLITION/BYPASS PLAN

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

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Drawn By MHMc
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UTHSC Project No. 730022
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File Name

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MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL DEMO/BYPASS PLAN PHASE 5 AHUO-2 & O-4

DRAWING NO.
M509

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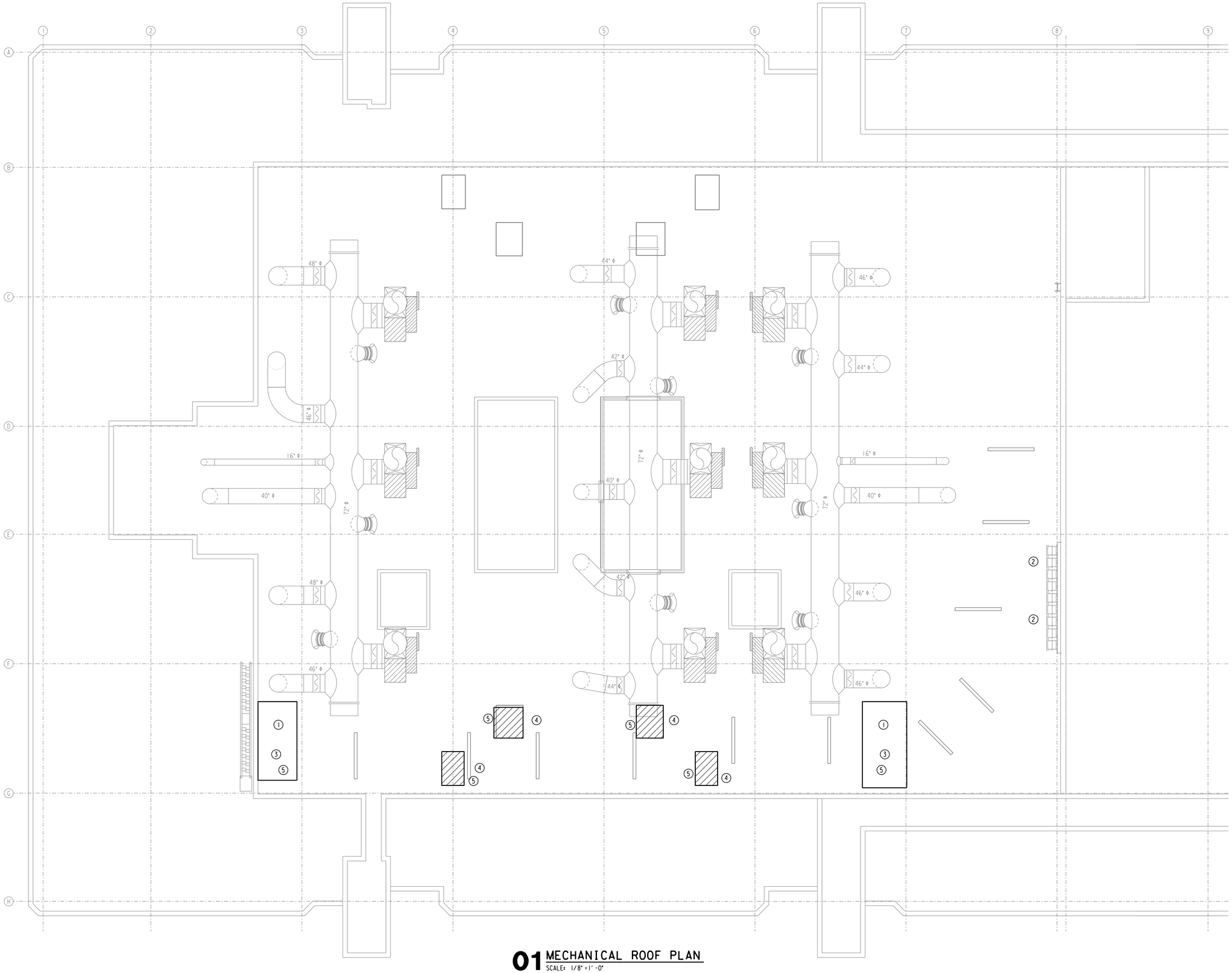
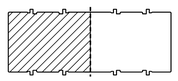


DRAWING NOTES:

1. DISCONNECT THE PLENUMS FROM THE RISERS. CAP THE RISERS AIRTIGHT. REMOVE FLEX DUCT FROM THE ROOF AND TURN OVER TO THE OWNER FOR USE ON FUTURE PHASES. IF THE OWNER FINDS THE DUCT UNUSABLE, CONTRACTOR TO DISPOSE.
2. CAP TAPS THROUGH EXTERIOR WALL FOR USE ON FUTURE PHASES.
3. REMOVE THE PLENUM ON TOP OF THE RISERS ON THE ROOF. PATCH THE ROOF TO MATCH EXISITNG. REPLACE CURB AROUND EXISTING EXHAUST DUCT PENETRATION.
4. VERIFY EXISTING ROOF OPENING SIZES PRIOR TO ORDERING NEW RELIEF HOODS. REPLACE HOODS AFTER FLEX HAS BEEN REMOVED WITH NEW ALUMINUM COOK MODEL GR GRAVITY HOOD.
5. ONCE ONE AHU HAS BEEN COMPLEETED, THE SECOND MAY START. ENSURE THE FLEX FROM THE SECOND UNIT DOES NOT DAMAGE THE RELIEF VENT FROM THE FIRST AHU.

01 MECHANICAL ROOF PLAN

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



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DN: cn=Charles Anderson, c=US, o=E&C Engineers & Consultants Inc., ou=Mechanical, email=canderson@ecinc.com
2018.04.12 20:54:04-05'00'
E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

Date	04/13/2018
Drawn By	MHMc
Checked By	HEC
UTHSC Project No.	730022
E & C Project No.	3302.00C
File Name	

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF PLAN
PHASE 5 AHUO-2 & O-4

DRAWING NO.
M519

I:\3300\3302\mech\Penthouse\3302 MROOF 02-4 PHASE 5.dgn
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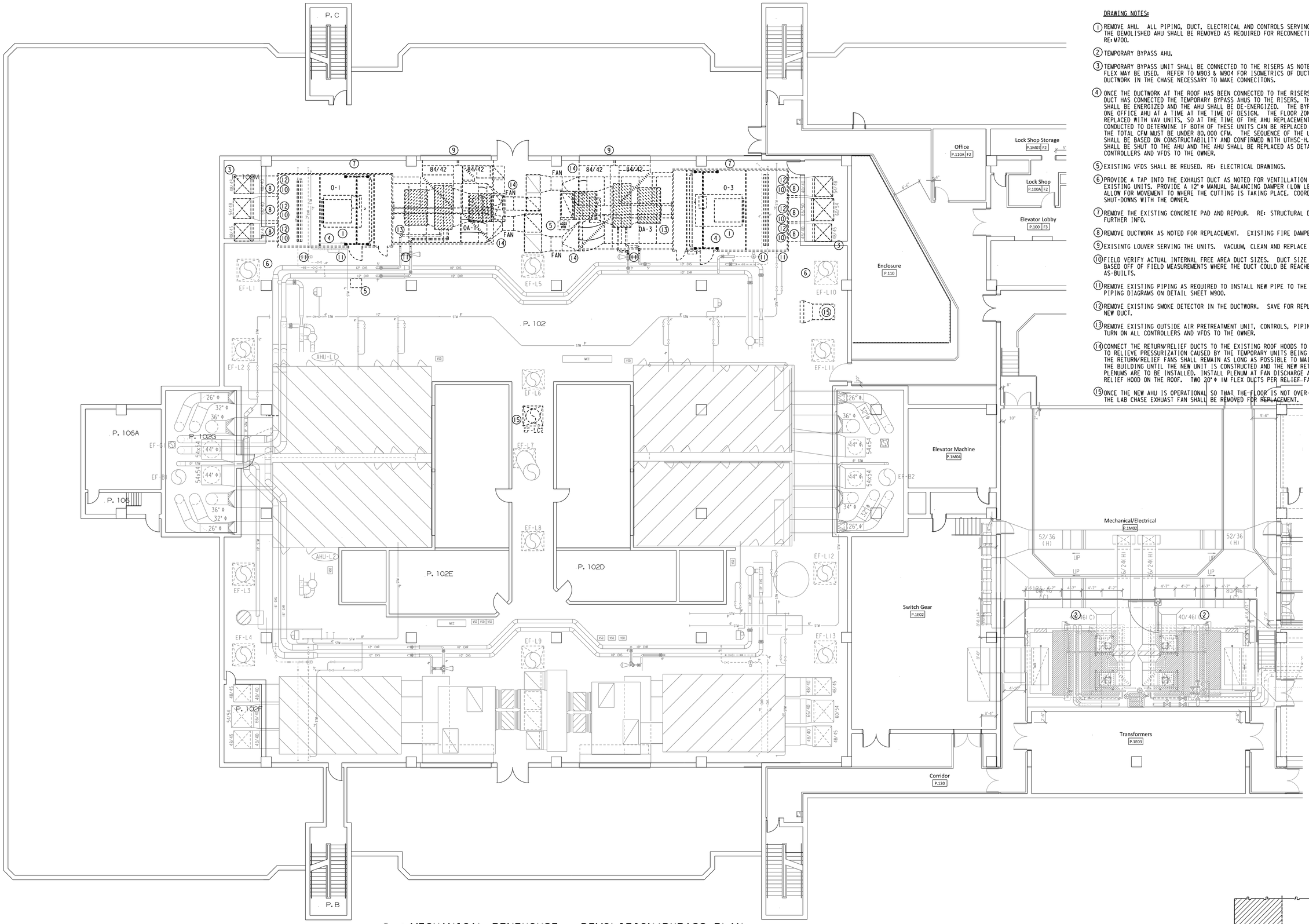

DRAWING NOTES:

1. REMOVE AHU. ALL PIPING, DUCT, ELECTRICAL AND CONTROLS SERVING THE DEMOLISHED AHU SHALL BE REMOVED AS REQUIRED FOR RECONNECTION. RE: M700.
2. TEMPORARY BYPASS AHU.
3. TEMPORARY BYPASS UNIT SHALL BE CONNECTED TO THE RISERS AS NOTED ON THE ROOF PLAN. FLEX MAY BE USED. REFER TO M903 & M904 FOR ISOMETRICS OF DUCT CONNECTIONS. REMOVE ANY DUCTWORK IN THE CHASE NECESSARY TO MAKE CONNECITONS.
4. ONCE THE DUCTWORK AT THE ROOF HAS BEEN CONNECTED TO THE RISERS AND THE FLEXIBLE DUCT HAS CONNECTED THE TEMPORARY BYPASS AHUS TO THE RISERS, THE TEMPORARY AHUS SHALL BE ENERGIZED AND THE AHU SHALL BE DE-ENERGIZED. THE BYPASS AHUS ARE SIZED FOR ONE OFFICE AHU AT A TIME AT THE TIME OF DESIGN. THE FLOOR ZONES ARE CURRENTLY BEING REPLACED WITH VAV UNITS, SO AT THE TIME OF THE AHU REPLACEMENT, A PRE-TAB MAY BE CONDUCTED TO DETERMINE IF BOTH OF THESE UNITS CAN BE REPLACED AT THE SAME TIME. THE TOTAL CFM MUST BE UNDER 80,000 CFM. THE SEQUENCE OF THE UNITS TO BE REPLACED SHALL BE BASED ON CONSTRUCTABILITY AND CONFIRMED WITH UTHSC-H. ALL ISOLATION VALVES SHALL BE SHUT TO THE AHU AND THE AHU SHALL BE REPLACED AS DETAILED ON M700. TURN OVER CONTROLLERS AND VFDS TO THE OWNER.
5. EXISTING VFDS SHALL BE REUSED. RE: ELECTRICAL DRAWINGS.
6. PROVIDE A TAP INTO THE EXHAUST DUCT AS NOTED FOR VENTILLATION DURING CUTTING OF THE EXISTING UNITS. PROVIDE A 12" ϕ MANUAL BALANCING DAMPER (LOW LEAK) WITH FLEXIBLE DUCT TO ALLOW FOR MOVEMENT TO WHERE THE CUTTING IS TAKING PLACE. COORDINATE ANY NEEDED SHUT-DOWNS WITH THE OWNER.
7. REMOVE THE EXISTING CONCRETE PAD AND REPOUR. RE: STRUCTURAL DRAWINGS FOR FURTHER INFO.
8. REMOVE DUCTWORK AS NOTED FOR REPLACEMENT. EXISTING FIRE DAMPERS TO REMAIN.
9. EXISINTG LOUVER SERVING THE UNITS. VACUUM, CLEAN AND REPLACE THE BIRDSCREENS.
10. FIELD VERIFY ACTUAL INTERNAL FREE AREA DUCT SIZES. DUCT SIZE SHOWN IS AN ESTIMATE BASED OFF OF FIELD MEASUREMENTS WHERE THE DUCT COULD BE REACHED AND ORIGINAL AS-BUILTS.
11. REMOVE EXISTING PIPING AS REQUIRED TO INSTALL NEW PIPE TO THE NEW UNITS PER THE PIPING DIAGRAMS ON DETAIL SHEET M900.
12. REMOVE EXISTING SMOKE DETECTOR IN THE DUCTWORK. SAVE FOR REPLACEMENT INTO THE NEW DUCT.
13. REMOVE EXISTING OUTSIDE AIR PRETREATMENT UNIT, CONTROLS, PIPING, VFD ,ETC. TURN ON ALL CONTROLLERS AND VFDS TO THE OWNER.
14. CONNECT THE RETURN/RELIEF DUCTS TO THE EXISTING ROOF HOODS TO ALLOW THE FLOOR TO RELIEVE PRESSURIZATION CAUSED BY THE TEMPORARY UNITS BEING 100% OUTSIDE AIR. THE RETURN/RELIEF FANS SHALL REMAIN AS LONG AS POSSIBLE TO MAINTAIN PRESSURE IN THE BUILDING UNTIL THE NEW UNIT IS CONSTRUCTED AND THE NEW RETURN FANS AND PLENUMS ARE TO BE INSTALLED. INSTALL PLENUM AT FAN DISCHARGE AND CAP DUCT AT THE RELIEF HOOD ON THE ROOF. TWO 20" ϕ 1M FLEX DUCTS PER RELIEF FAN TO CONNECT.
15. ONCE THE NEW AHU IS OPERATIONAL SO THAT THE FLOOR IS NOT OVER-PRESSURIZED, THE LAB CHASE EXHUAST FAN SHALL BE REMOVED FOR REPLACEMENT.

01 MECHANICAL PENTHOUSE - DEMOLITION/BYPASS PLAN

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

ISSUE FOR:			
Area	Rev.	Date	Description
		04/13/18	CONSTRUCTION

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ENGINEERS & CONSULTANTS, INC.
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STATE OF TEXAS — HEATHER CAMDEN — 86883 — LICENSED — PROFESSIONAL ENGINEER

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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE
DEMO/BYPASS PLAN
PHASE 6 AHUO-1 & O-3

DRAWING NO.
M608

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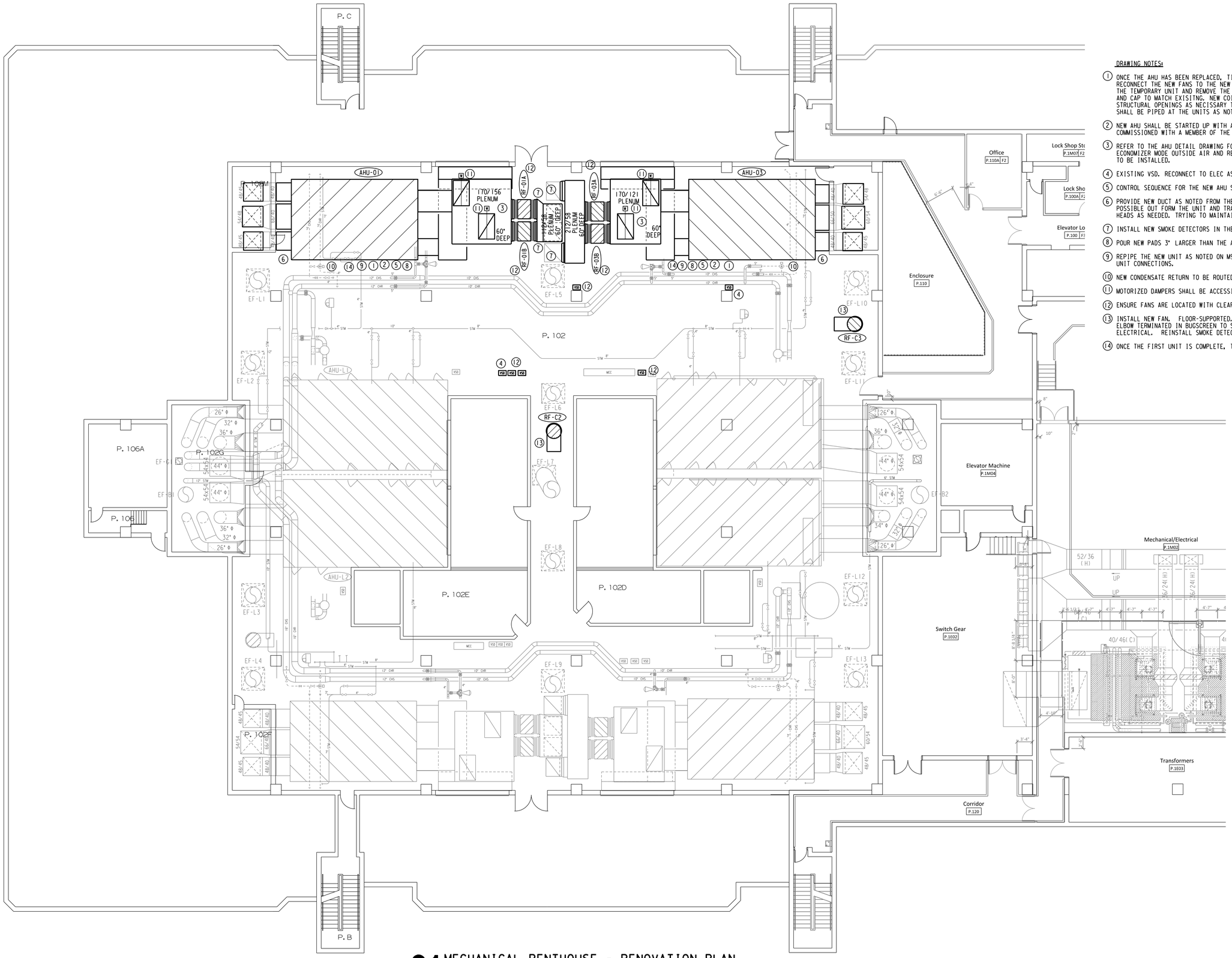

DRAWING NOTES:

1. ONCE THE AHU HAS BEEN REPLACED, TIE BACK INTO THE CHILLED WATER, STEAM AND DUCTWORK. RECONNECT THE NEW FANS TO THE NEW VFD (REFER TO ELECTRICAL DRAWINGS) . DE-ENERGIZE THE TEMPORARY UNIT AND REMOVE THE TEMPORARY DUCT FROM THE PLENUM TO THE RISERS AND CAP TO MATCH EXISITNG. NEW COILS WILL BE IN DIFERENT LOCATIONS. ROUTE PIPE THORUGH STRUCTURAL OPENINGS AS NECISSARY TO PROVIDE PIPING TO NEW UNITS. ALL CONTROL VALVING SHALL BE PIPED AT THE UNITS AS NOTED. REINSTALL THE SMOKE DETECTOR INTO THE NEW DUCTWORK.
2. NEW AHU SHALL BE STARTED UP WITH A REPRESENTATIVE FROM THE FACTORY AND COMMISSIONED WITH A MEMBER OF THE UTHSC-H STAFF IN ATTENDANCE.
3. REFER TO THE AHU DETAIL DRAWING FOR DUCTWORK ELEVATIONS SHOWING HOW THE OUTSIDE AIR, RETURN AIR, ECONOMIZER MODE OUTSIDE AIR AND RELIEF AIR DUCT AND PLENUMS AS WELL AS RELIEF/RETURN FANS ARE TO BE INSTALLED.
4. EXISTING VSD. RECONNECT TO ELEC AS NEEDED.
5. CONTROL SEQUENCE FOR THE NEW AHU SHALL BE AS NOTED ON DRAWING M990 & M991 - CONTROL DIAGRAMS.
6. PROVIDE NEW DUCT AS NOTED FROM THE AHU TO THE CHASE CONNECTION. DUCT SHALL BE AS HIGH AS POSSIBLE OUT FORM THE UNIT AND TRANSITION DOWN TO THE EXISTING FIRE DAMPER. RELOCATE SPRINKLER HEADS AS NEEDED. TRYING TO MAINTAIN AS MUCH HEAD HEIGHT AS POSSIBLE CLOSE TO THE COLUMNS.
7. INSTALL NEW SMOKE DETECTORS IN THE RETURN AIR RISERS NEAR THE EXISTING ACCESS DOOR.
8. POUR NEW PADS 3" LARGER THAN THE AHU FOOTPRINT ON EACH SIDE AND 6" TALL. REFER TO STRUCTURAL.
9. REPIPE THE NEW UNIT AS NOTED ON M900 - MECHANICAL DETAILS AND AS REQUIRED FOR LOCATION OF THE NEW UNIT CONNECTIONS.
10. NEW CONDENSATE RETURN TO BE ROUTED AS TO PENETRATE THE FLOOR IN THE EXISTING LOCATION.
11. MOTORIZED DAMPERS SHALL BE ACCESSIBLE FROM THE ROOF THROUGH THE RELIEF VENTS.
12. ENSURE FANS ARE LOCATED WITH CLEARANCE UNDER FOR ACCESS. INSTALL NEW VFD FOR EACH FAN.
13. INSTALL NEW FAN. FLOOR-SUPPORTED. DUCT A 3'0" STRAIGHT DUCT OFF OF THE FAN OUTLET AND AN ELBOW TERMINATED IN BUGSCREEN TO SEMI-CONDITION THE PENTHOUSE. RECONNECT TO EXISTING UNIT ELECTRICAL. REINSTALL SMOKE DETECTOR FOR SHUT-DOWN.
14. ONCE THE FIRST UNIT IS COMPLETE, THE SECOND UNIT MAY BEGIN.

01 MECHANICAL PENTHOUSE - RENOVATION PLAN

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

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STATE OF TEXAS — HEATHER CAMDEN 86883 — LICENSED PROFESSIONAL ENGINEER

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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL PENTHOUSE RENOVATION PLAN PHASE 6 AHUO-1 & O-3

DRAWING NO.
M618

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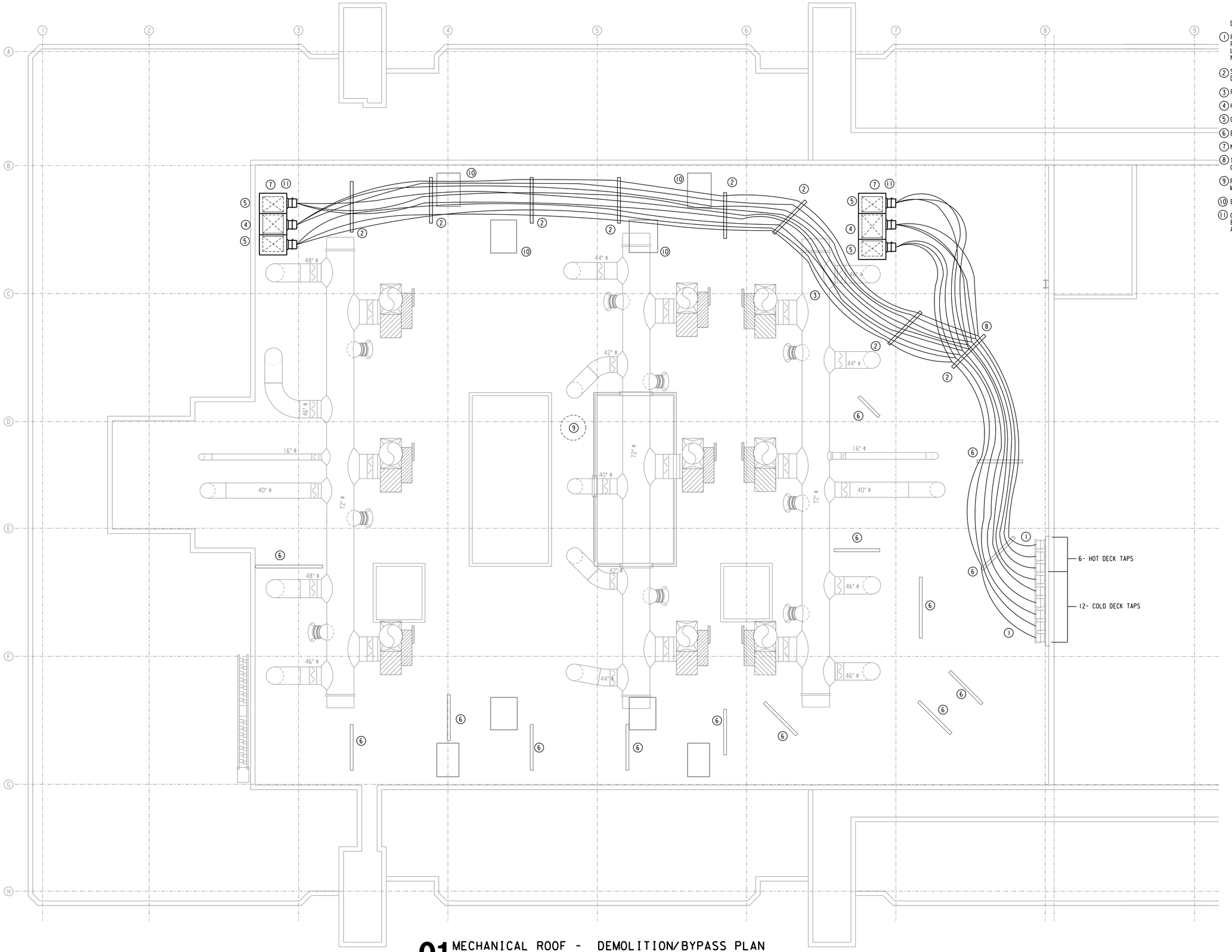

DRAWING NOTES:

1. FLEX DUCTS SIMILAR TO MASTERDUCT MD ALL-WEATHER FLEXIBLE DUCT R8. FLEX TO BE 20" ϕ. FLEX FROM PREVIOUS PROJECT WILL BE STORED BY UTHSC-H. REUSE APPROXIMATELY 50%. THE ADDITIONAL WILL NEED TO BE NEW DUE TO DAMAGE.
2. STRUCTURAL HOLD-DOWN LOCATIONS. RE: DETAIL 8 M901 & STRUCTURAL DRAWINGS.
3. FLEX TO RUN UNDER MANIFOLDS.
4. HOT DUCT.
5. COLD DUCT.
6. EXISTING STRUCTURAL TIE-DOWNS.
7. NEW MANIFOLD AS DETAILED IN M901 & M902.
8. TAKE BOTTOM DUCTS OFF FOR CONNECTION TO PLENUM. RUN TOP DUCTS ON TO PLENUM FARTHER NORTH.
9. REMOVE EXISTING CHASE EXHUAST VENT HOOD AND PATCH THE ROOF TO MATCH EXISTING.
10. ENSURE VENTS ARE CLEAR FOR RELIEF OF BUILDING.
11. ONCE THE FIRST UNIT IS COMPLETE, THE SECOND UNIT MAY BEGIN. EACH UNIT WILL REQUIRE CONNECTIONS OF 8 COLD DECK (FOUR PER RISER) AND 4 HOT DECK FLEX CONNECTIONS.

01 MECHANICAL ROOF - DEMOLITION/BYPASS PLAN

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

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MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL DEMO/BYPASS PLAN PHASE 6 AHUO-1 & O-3

DRAWING NO.
M609

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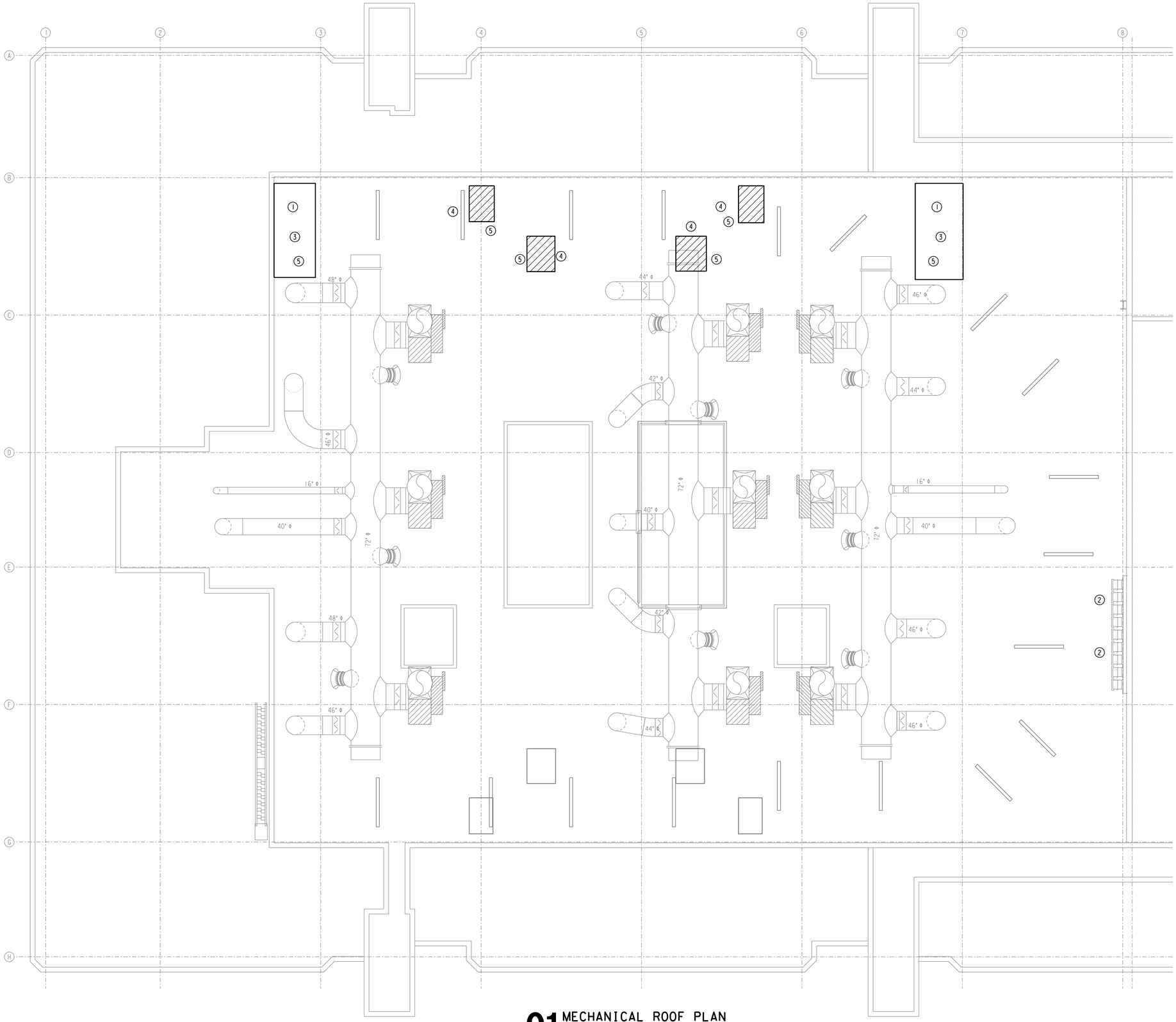

01 MECHANICAL ROOF PLAN

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

DRAWING NOTES:

1. DISCONNECT THE PLENUMS FROM THE RISERS. CAP THE RISERS AIRTIGHT. REMOVE FLEX DUCT FROM THE ROOF AND TURN OVER TO THE OWNER FOR USE ON FUTURE PHASES. IF THE OWNER FINDS THE DUCT UNUSABLE, CONTRACTOR TO DISPOSE.
2. CAP TAPS THROUGH EXTERIOR WALL FOR USE ON FUTURE PHASES.
3. REMOVE THE PLENUM ON TOP OF THE RISERS ON THE ROOF. PATCH THE ROOF TO MATCH EXISITNG. REPLACE CURB AROUND EXISTING EXHAUST DUCT PENETRATION.
4. VERIFY EXISTING ROOF OPENING SIZES PRIOR TO ORDERING NEW RELIEF HOODS. REPLACE HOODS AFTER FLEX HAS BEEN REMOVED WITH NEW ALUMINUM COOK MODEL GR GRAVITY HOOD.
5. ONCE ONE AHU HAS BEEN COMPLEETED, THE SECOND MAY START. ENSURE THE FLEX FROM THE SECOND UNIT DOES NOT DAMAGE THE RELIEF VENT FROM THE FIRST AHU.

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MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL ROOF PLAN PHASE 6 AHUO-1 & O-3

DRAWING NO.
M619

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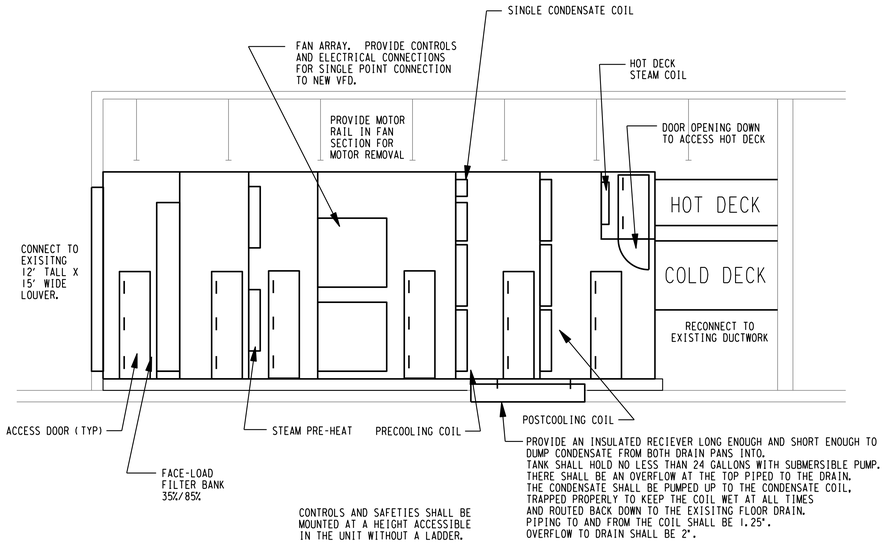
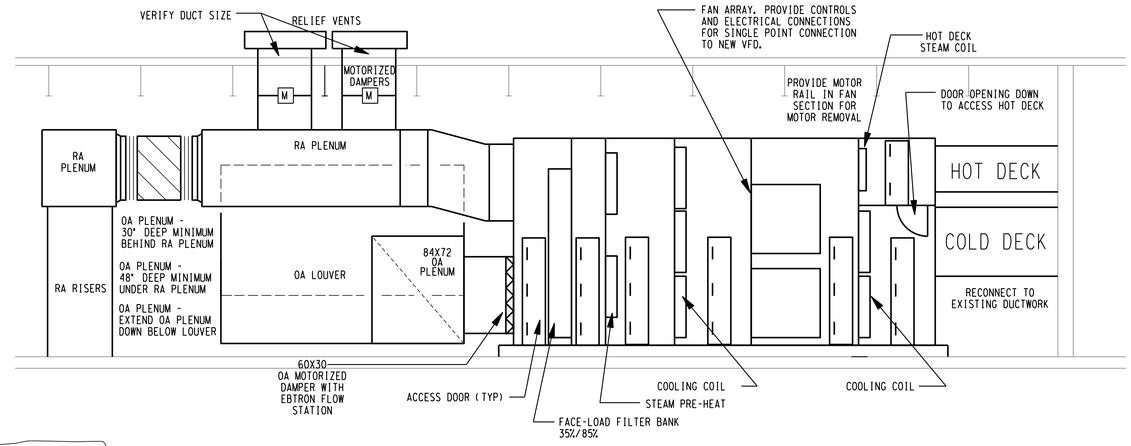
PROVIDE FANS WITH BALANCE STREAM DAMPERS

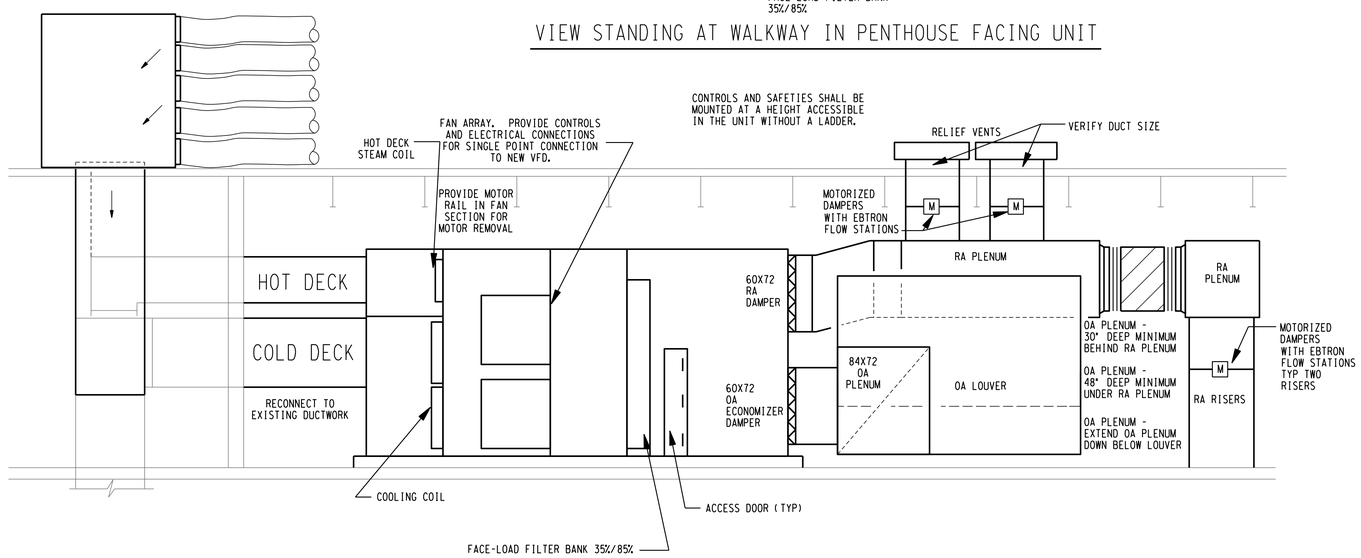


02 LABORATORY REPLACEMENT UNIT DETAIL W/ CONDENSATE RECOVERY

NOT TO SCALE



VIEW STANDING AT WALKWAY IN PENTHOUSE FACING UNIT



VIEW STANDING AT EXTERIOR WALL FACING UNIT

ALL LAB UNITS MAXIMUM DIMENSIONS ARE:
14'0" TALL
36'0" LONG
18'6" WIDE

ALL OFFICE UNITS MAXIMUM DIMENSIONS ARE:
14'0" TALL
27'6" LONG
17'6" WIDE

DUCT PENETRATIONS INTO CHASE APPROXIMATE LOCATIONS - FIELD VERIFY:
BOTTOM OF HOTDECK L1 EAST - 11'8"
BOTTOM OF COLDDECK L1 EAST - 5'2"
BOTTOM OF HOTDECK L1 WEST - 10'2"
BOTTOM OF COLDDECK L1 WEST - 4'9"

BOTTOM OF COLDDECK L2 EAST - 4'9"
BOTTOM OF HOTDECK L2 EAST - 10'2"
BOTTOM OF COLDDECK L2 WEST - 5'7"
BOTTOM OF HOTDECK L2 WEST - 11'11"

BOTTOM OF HOTDECK L3 EAST - ?
BOTTOM OF COLDDECK L3 EAST - 5'2"
BOTTOM OF HOTDECK L3 WEST - ?
BOTTOM OF COLDDECK L3 WEST - 4'9"

BOTTOM OF COLDDECK L4 EAST - 4'9"
BOTTOM OF HOTDECK L4 EAST - ?
BOTTOM OF COLDDECK L4 WEST - 5'2"
BOTTOM OF HOTDECK L4 WEST - ?

BOTTOM OF COLDDECK 01 EAST - 6'2"
BOTTOM OF HOTDECK 01 - 10'6"
BOTTOM OF COLDDECK 01 WEST - 6'2"

BOTTOM OF COLDDECK 02 EAST - 6'9"
BOTTOM OF HOTDECK 02 - 11'10"
BOTTOM OF COLDDECK 02 WEST - 6'9"

BOTTOM OF COLDDECK 03 EAST - 6'3"
BOTTOM OF HOTDECK 03 - 10'4"
BOTTOM OF COLDDECK 03 WEST - 6'3"

BOTTOM OF COLDDECK 04 EAST - 5'9"
BOTTOM OF HOTDECK 04 - 10'1"
BOTTOM OF COLDDECK 04 WEST - 5'9"

BOTTOM OF COLDDECK 05 EAST - 6'6"
BOTTOM OF HOTDECK 05 - 10'2"
BOTTOM OF COLDDECK 05 WEST - 6'6"

BOTTOM OF COLDDECK 06 EAST - 6'6"
BOTTOM OF HOTDECK 06 - 10'5"
BOTTOM OF COLDDECK 06 WEST - 6'6"

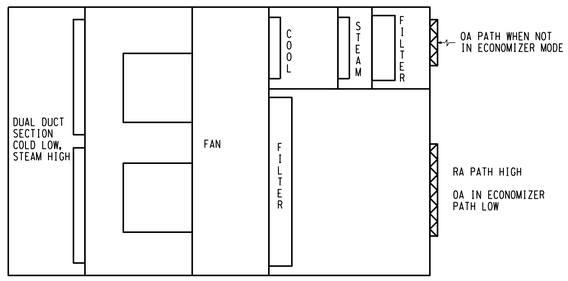
BOTTOM OF COLDDECK 07 EAST - 6'6"
BOTTOM OF HOTDECK 07 - 10'2"
BOTTOM OF COLDDECK 07 WEST - 6'6"

BOTTOM OF COLDDECK 08 EAST - 6'6"
BOTTOM OF HOTDECK 08 - 10'2"
BOTTOM OF COLDDECK 08 WEST - 6'6"

UNIT WILL SIT ON A 6" HOUSEKEEPING PAD.

LAB AHU COIL PIPING IS HOUSED INSIDE THE UNIT. THERE SHALL BE ONE PIPING INLET TO THE AHU ON EACH SIDE SERVED FROM THE TOP OF THE UNIT. THE MANIFOLD SHALL DROP AND COIL ISOLATION AND BALANCING VALVES SHALL BE ACCESSED INSIDE THE UNIT. COILS SHALL BE INTERNALLY DEMOUNTABLE TO BE REMOVED FROM INSIDE THE UNIT FORWARD AND OUT THE CLOSEST ACCESS DOOR.

REFER TO THE FLOOR PLANS TO NOTE WHERE DOORS ARE REQUIRED TO BE ON ONE OR BOTH SIDES OF THE UNIT.



PLAN VIEW DOWN ON UNIT

TYPICAL OF O-6 AND O-7
O-5 & O-8 ARE MIRRORED

01 REPLACEMENT UNIT DETAIL

NOT TO SCALE

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MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL AHU DETAILS

DRAWING NO.
M700

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AIR HANDLING UNIT SCHEDULE

UNIT INFORMATION	
UNIT NO.	AHU-O1, 2, 3, 4, 5, 6, 7 & 8
OPERATION TYPE	NORMAL
LOCATION	SOUTH PENTHOUSE OFFICE UNITS
MANUFACTURER (BASIS OF DESIGN)	TEMTROL
TYPE	WELDED FRAME OR BUILT ON SITE
CONFIGURATION	FANWALL DUAL DUCT
SERVICE	OFFICES
SUPPLY FAN DESIGN INFORMATION	
DESIGN SET FAN AIR QUANTITY	60,000
DESIGN MINIMUM FLOW	17,500
OUTSIDE AIR MIN	17,500
OUTSIDE AIR MAX	60,000
TOTAL STATIC PRESSURE (IN.W.G.)	6.5
EXTERNAL STATIC PRESSURE (IN.W.G.)	3
BASIS OF DESIGN	FANWALL
FAN DESCRIPTION	4@ PF11-30-74
VOLTAGE/PH/Hz	460/3/60
ARRAY	2 ROWS 2 COL
FAN MAX RPM	1,750
FAN OPERATING RPM	1,750
TOTAL BRAKE HP	90.04
TOTAL NOMINAL MOTOR HP	100
VFD SIZING HP	100
NOMINAL MOTOR RPM	1,750
EMERGENCY POWER REQUIRED (YES/NO)	NO
VFD REQUIRED	YES
DRIVE ARRANGEMENT TYPE	DIRECT DRIVE
OA PREHEAT COIL DESIGN INFORMATION	
COIL POSITION	OUTSIDE AIR PATH HEATING
COIL DESCRIPTION	9NS-42X48X1-4AL
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	2.0
COIL AIRFLOW AT FULL HEATING	17,500
MAX FACE VELOCITY AT FULL HEATING	625.0
MINIMUM NUMBER ROWS	1
MAXIMUM NUMBER OF FINS PER INCH	6
MAXIMUM AIR PRESSURE DROP AT FULL HEAT	0.12
ENTERING AIR TEMP (DB) (°F)	18.0
LEAVING AIR TEMP (DB) (°F)	51.0
STEAM PRESSURE	10#
CONDENSATE RATE (LB/HR)	729.0
MINIMUM COIL SENSIBLE HEAT (MBTU)	694.6
TUBE/FIN MATERIAL	CU/AL
UV LIGHTS (YES/NO)	NO
OA PRECOOLING COIL DESIGN INFORMATION	
COIL POSITION	OUTSIDE AIR PATH COOLING
COIL DESCRIPTION	5WC-10-45X50X6-8CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	3.0
COIL AIRFLOW	17,500
MAX FACE VELOCITY	373.0
MINIMUM NUMBER ROWS	6
MAXIMUM NUMBER OF FINS PER INCH	8
MAXIMUM AIR PRESSURE DROP	0.44
ENTERING AIR TEMP (DB) (°F)	95.0
ENTERING AIR TEMP (WB) (°F)	80.0
LEAVING AIR TEMP (DB) (°F)	52.4
LEAVING AIR TEMP (WB) (°F)	52.2
ENTERING WATER TEMP (°F)	42.0
LEAVING WATER TEMP (°F)	56.0
CHILLED WATER PRESSURE DROP (FT OF WATER)	16.3
MAXIMUM GPM	227.2
MINIMUM COIL LATENT HEAT (MHB)	825
MINIMUM COIL SENSIBLE HEAT (MBH)	771
MINIMUM COIL TOTAL HEAT (MBH)	1,596
TUBE MATERIAL/FIN MATERIAL	CU/CU
UV LIGHTS (YES/NO)	YES
COOLING COIL DESIGN INFORMATION	
COIL POSITION	COLD DECK
COIL DESCRIPTION	5WC-10-51X84X6-8CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	4.0
COIL AIRFLOW	60,000
MAX FACE VELOCITY	504.0
MINIMUM NUMBER ROWS	6
MAXIMUM NUMBER OF FINS PER INCH	8
MAXIMUM AIR PRESSURE DROP	0.66
ENTERING AIR TEMP (DB) (°F)	69.0
ENTERING AIR TEMP (WB) (°F)	62.0
LEAVING AIR TEMP (DB) (°F)	51.1
LEAVING AIR TEMP (WB) (°F)	50.7
ENTERING WATER TEMP (°F)	42.0
LEAVING WATER TEMP (°F)	56.0
CHILLED WATER PRESSURE DROP (FT OF WATER)	16.0
MAXIMUM GPM	268.1
MINIMUM COIL LATENT HEAT (MHB)	719
MINIMUM COIL SENSIBLE HEAT (MBH)	1,165
MINIMUM COIL TOTAL HEAT (MBH)	1,883
TUBE MATERIAL/FIN MATERIAL	CU/CU
UV LIGHTS (YES/NO)	YES
HEATING COIL DESIGN INFORMATION	
COIL POSITION	HOT DECK HEATING
COIL DESCRIPTION	9NS-33X84X1-6CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	2.0
COIL AIRFLOW AT FULL HEATING	30,000
MAX FACE VELOCITY AT FULL HEATING	779.0
MINIMUM NUMBER ROWS	1
MAXIMUM NUMBER OF FINS PER INCH	6
MAXIMUM AIR PRESSURE DROP AT FULL HEAT	0.23
ENTERING AIR TEMP (DB) (°F)	55.0
LEAVING AIR TEMP (DB) (°F)	96.2
STEAM PRESSURE	10#
CONDENSATE RATE (LB/HR)	1449.0
MINIMUM COIL SENSIBLE HEAT (MBTU)	1381.1
TUBE/FIN MATERIAL	CU/CU
UV LIGHTS (YES/NO)	NO
FILTER SECTION	
2" - 30% PLEATED PRE FILTER	YES
4" - FINAL FILTER	YES - 85%

NOTES

UNIT SHALL BE PROVIDED WITH FACTORY INSTALLED JUNCTION BOXES AUXILIARIES,

FACTORY INSTALLED JUNCTION BOXES ARE FOR CONNECTION BY DIVISION 26. DIVISION 26 IS NOT TO PENETRATE AIR HANDLING UNIT HOUSING. WIRING FROM JUNCTION BOX TO LOAD INSIDE AIR HANDLING

ALL POWER WIRING BETWEEN VARIABLE FREQUENCY DRIVES, MOTOR CONTROLLERS AND MOTORS SHALL BE COMPLETED BY THE ELECTRICAL CONTRACTOR.

INFORMATION SHOWN IS PER UNIT.

REFER TO PLANS, DETAILS & CONTROLS DIAGRAM FOR FURTHER INFORMATION.

AIR HANDLING UNIT SCHEDULE - REPLACEMENT

UNIT INFORMATION	
UNIT NO.	AHU-L-1, 2, 3, 4
OPERATION TYPE	NORMAL
LOCATION	NORTH PENTHOUSE
MANUFACTURER (BASIS OF DESIGN)	TEMTROL
TYPE	WELDED FRAME OR BUILT ON SITE
CONFIGURATION	FANWALL DUAL DUCT
SERVICE	ORANGE AND YELLOW CHASES
SUPPLY FAN DESIGN INFORMATION	
DESIGN SET FAN AIR QUANTITY	79,800
MAX OA	79,800
TOTAL STATIC PRESSURE (IN.W.G.)	5.50
BASIS OF DESIGN	TEMTROL FAN ARRAY 6@ PF11-27
FAN DESCRIPTION	6 @ 27" MAXIMUM DIAMETER
FAN TYPE	PLUG FAN ARRAY (PF)
FAN RPM	1696
BRKE HP	16.9 MAX/FAN
NOMINAL MOTOR HP	20 MAXIMUM / FAN
NOMINAL MOTOR RPM	1750 MAX
VOTALGE/PHASE	480/3
EMERGENCY POWER REQUIRED (YES/NO)	NO
VFD REQUIRED	YES - NEW 125HP
DRIVE ARRANGEMENT TYPE	DIRECT
COOLING COIL DESIGN INFORMATION	
COIL POSITION	PRE COOLING
COIL DESCRIPTION	5@5WC-4-48X84X4-8CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	3LH/3RH
COIL AIRFLOW	79800
MAX FACE VELOCITY	475.0
MINIMUM NUMBER ROWS	4
MAXIMUM NUMBER OF FINS PER INCH	8
MAXIMUM AIR PRESSURE DROP	0.42
ENTERING AIR TEMP (DB) (°F)	98.0
ENTERING AIR TEMP (WB) (°F)	80.0
LEAVING AIR TEMP (DB) (°F)	67.5
LEAVING AIR TEMP (WB) (°F)	65.3
ENTERING WATER TEMP (°F)	50.1
LEAVING WATER TEMP (°F)	62.0
MINIMUM COIL LATENT HEAT (MHB)	1,858,928.0
MINIMUM COIL SENSIBLE HEAT (MBH)	2,504,646.0
MINIMUM COIL TOTAL HEAT (MBH)	4,363,574.0
MAX WATER FLOW (GPM)	731.2
CHILLED WATER TEMP DIFFERENCE (°F)	11.9
MAX WATER PRESSURE DROP (FT OF WATER)	10.11
TUBE MATERIAL / FIN MATERIAL	CU / CU
UV LIGHTS (YES/NO)	YES
COOLING COIL DESIGN INFORMATION	
COIL POSITION	POST COOLING
COIL DESCRIPTION	6@5WC-4-48X84X4-8CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	3LH/3RH
COIL AIRFLOW	79800
MAX FACE VELOCITY	475.0
MINIMUM NUMBER ROWS	4
MAXIMUM NUMBER OF FINS PER INCH	8
MAXIMUM AIR PRESSURE DROP	0.42
ENTERING AIR TEMP (DB) (°F)	67.5
ENTERING AIR TEMP (WB) (°F)	65.3
LEAVING AIR TEMP (DB) (°F)	52.7
LEAVING AIR TEMP (WB) (°F)	52.7
ENTERING WATER TEMP (°F)	42.0
LEAVING WATER TEMP (°F)	50.1
MINIMUM COIL LATENT HEAT (MHB)	1,687,739.0
MINIMUM COIL SENSIBLE HEAT (MBH)	1,285,264.0
MINIMUM COIL TOTAL HEAT (MBH)	2,973,003.0
MAX WATER FLOW (GPM)	731.2
CHILLED WATER TEMP DIFFERENCE (°F)	8.1
MAX WATER PRESSURE DROP (FT OF WATER)	10.36
TUBE MATERIAL / FIN MATERIAL	CU / CU
UV LIGHTS (YES/NO)	YES
HEATING COIL DESIGN INFORMATION	
COIL POSITION	PREHEAT
COIL DESCRIPTION	4@9NS-48X78X1-4CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	4
COIL AIRFLOW IN FULL HEATING	79,800
MAX FACE VELOCITY AT FULL HEATING	767
MINIMUM NUMBER OF ROWS	1
MAXIMUM NUMBER OF FINS PER INCH	6
MAXIMUM AIR PRESSURE DROP AT FULL HEAT	0.18
ENTERING AIR TEMP (DB) (°F)	18
LEAVING AIR TEMP (DB) (°F)	52.5
STEAM PRESSURE	10#
CONDENSATE RATE	3478#/HR
MINIMUM COIL SENSIBLE HEAT (MBH)	3,314,717.0
TUBE MATERIAL / FIN MATERIAL	CU/AL
UV LIGHTS (YES/NO)	NO
HEATING COIL DESIGN INFORMATION	
COIL POSITION	REHEAT
COIL DESCRIPTION	2@9NS-48X84X1-6CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	2
COIL AIRFLOW IN FULL HEATING	40,000
MAX FACE VELOCITY AT FULL COOLING	714
MINIMUM NUMBER OF ROWS	1
MAXIMUM NUMBER OF FINS PER INCH	6
MAXIMUM AIR PRESSURE DROP AT FULL HEAT	0.2
ENTERING AIR TEMP (DB) (°F)	52.5
LEAVING AIR TEMP (DB) (°F)	96.1
STEAM PRESSURE	10#
CONDENSATE RATE	2052#/HR
MINIMUM COIL SENSIBLE HEAT (MBH)	1,955,674.0
TUBE MATERIAL / FIN MATERIAL	CU/CU
UV LIGHTS (YES/NO)	NO
FILTER SECTION	
2" - 30% PLEATED PRE-FILTER	YES
4" - 85% FINAL FILTER	YES

NOTES

UNIT SHALL BE PROVIDED WITH FACTORY INSTALLED JUNCTION BOXES AUXILIARIES, RECEPTACLES, SERVICING LIGHTS, ETC. RE: ELECTRICAL DRAWINGS FOR FURTHER INFORMATION.

FACTORY INSTALLED JUNCTION BOXES ARE FOR CONNECTION BY DIVISION 26. DIVISION 26 IS NOT TO PENETRATE AIR HANDLING UNIT HOUSING. WIRING FROM JUNCTION BOX TO LOAD INSIDE AIR HANDLING UNIT SHALL BE BY THE MANUFACTURER.

ALL POWER WIRING BETWEEN VARIABLE FREQUENCY DRIVES, MOTORCONTROLLERS AND MOTORS SHALL BE COMPLETED BY THE ELECTRICAL CONTRACTOR.

INFORMATION SHOWN IS PER UNIT.

PROVIDE WITH BALANCE STREAM DAMPERS ON FANS

RETURN AIR FAN SCHEDULE

UNIT NO.	LOCATION	SERVICE	TOTAL CFM	TOTAL S.P. IN W.G.	RPM	TYPE	WHEEL DIA. IN.	CLASS	MOTOR BHP	MOTOR HP	MOTOR RPM	MOTOR VOLTS @ 60 HZ	MOTOR PH	MANUFACTURER	MODEL/SERIES	VFD REQUIRED	REMARKS
RF-O1A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-O2A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-O3A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-O4A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-O5A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-O6A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-O7A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-O8A & B	IN-LINE	RETURN AIR	22,500	1.00	846	VANE AXIAL	44.0	-	6.4	7.5	1750	480	3	COOK	44AVAD-28008	YES	1,2
RF-C1	IN-LINE	CHASE RELIEF	4,000	1.00	860	VANE AXIAL	35.0	-	1.48	2	1750	480	3	COOK	35AVAD-19008	NO	1,2
RF-C2	IN-LINE	CHASE RELIEF	4,000	1.00	860	VANE AXIAL	35.0	-	1.48	2	1750	480	3	COOK	35AVAD-19008	NO	1,2
RF-C3	IN-LINE	CHASE RELIEF	4,000	1.00	860	VANE AXIAL	35.0	-	1.48	2	1750	480	3	COOK	35AVAD-19008	NO	1,2
RF-C4	IN-LINE	CHASE RELIEF	4,000	1.00	860	VANE AXIAL	35.0	-	1.48	2	1750	480	3	COOK	35AVAD-19008	NO	1,2
RF-C5	IN-LINE	CHASE RELIEF	4,000	1.00	860	VANE AXIAL	35.0	-	1.48	2	1750	480	3	COOK	35AVAD-19008	NO	1,2
RF-C6	IN-LINE	CHASE RELIEF	4,000	1.00	860	VANE AXIAL	35.0	-	1.48	2	1750	480	3	COOK	35AVAD-19008	NO	1,2

NOTES:
1. PROVIDE UNIT MOUNTED NEMA 1 DISCONNECT.
2. PROVIDE MINIMUM SCCR RATING XX,XXX kAIC

COIL SCHEDULE - CONDENSATE

THE 6TH TOP EXTERIOR PRE-COOLING COIL SHALL SPLIT THE SPACE WITH A CONDENSATE BCOIL AS FOLLOWS:

UNIT NO.	AHU-L-1, 2, 3 & 4
COOLING COIL DESIGN INFORMATION	
COIL POSITION	COOLING - CONDENSATE
COIL DESCRIPTION	1@5WC-8-6X84X6-8CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	2LH/2RH
COIL AIRFLOW	1370
MAX FACE VELOCITY	391
MINIMUM NUMBER ROWS	6
MAXIMUM NUMBER OF FINS PER INCH	8
MAXIMUM AIR PRESSURE DROP	0.42
ENTERING AIR TEMP (DB) (°F)	98.0
ENTERING AIR TEMP (WB) (°F)	80.0
LEAVING AIR TEMP (DB) (°F)	67.4
LEAVING AIR TEMP (WB) (°F)	66.7
ENTERING WATER TEMP (°F)	55.0
LEAVING WATER TEMP (°F)	72.1
MINIMUM COIL LATENT HEAT (MHB)	25,521.0
MINIMUM COIL SENSIBLE HEAT (MBH)	43,076.0
MINIMUM COIL TOTAL HEAT (MBH)	68,597.0
MAX WATER FLOW (GPM)	8.0
CHILLED WATER TEMP DIFFERENCE (°F)	17.1
MAX WATER PRESSURE DROP (FT OF WATER)	6.2
TUBE MATERIAL / FIN MATERIAL	CU / CU
UV LIGHTS (YES/NO)	YES
COOLING COIL DESIGN INFORMATION	
COIL POSITION	COOLING
COIL DESCRIPTION	1@5WC-4-42X84X4-8CU
CASE MATERIAL	16 GA. 304 S.S.
QUANTITY OF COILS	3LH/3RH
COIL AIRFLOW	11,930
MAX FACE VELOCITY	487.0
MINIMUM NUMBER ROWS	4
MINIMUM NUMBER OF FINS PER INCH	8
MAXIMUM AIR PRESSURE DROP	0.42
ENTERING AIR TEMP (DB) (°F)	98.0
ENTERING AIR TEMP (WB) (°F)	80.0
LEAVING AIR TEMP (DB) (°F)	67.8
LEAVING AIR TEMP (WB) (°F)	65.5
ENTERING WATER TEMP (°F)	50.1
LEAVING WATER TEMP (°F)	60.7
MINIMUM COIL LATENT HEAT (MHB)	273,027.0
MINIMUM COIL SENSIBLE HEAT (MBH)	370,848.0
MINIMUM COIL TOTAL HEAT (MBH)	643,875.0
MAX WATER FLOW (GPM)	131.8
CHILLED WATER TEMP DIFFERENCE (°F)	10.6
MAX WATER PRESSURE DROP (FT OF WATER)	10.1
TUBE MATERIAL / FIN MATERIAL	CU / CU
UV LIGHTS (YES/NO)	YES

PUMP SCHEDULE - CONDENSATE

UNIT NO.	LOCATION	SERVICE	TYPE	GPM	FT. HEAD H_2O	SHUT OFF HEAD FT. H_2O	DESIGN PRESSURE PSI	MOTOR BHP	MOTOR HP	MOTOR RPM	MOTOR VOLTS @ 60 HZ	MOTOR PH	REMARKS
CP-L1	CONDENSATE RECEIVER	CONDENSATE	SUBMERSIBLE	8.5	20.0	22.0	150	4.0	1/6	3450	120	1	SIMILAR TO FLINT & WALLING ECP062S
CP-L2	CONDENSATE RECEIVER	CONDENSATE	SUBMERSIBLE	8.5	20.0	22.0	150	4.0	1/6	3450	120	1	SIMILAR TO FLINT & WALLING ECP062S
CP-L3	CONDENSATE RECEIVER	CONDENSATE	SUBMERSIBLE	8.5	20.0	22.0	150	4.0	1/6	3450	120	1	SIMILAR TO FLINT & WALLING ECP062S
CP-L4	CONDENSATE RECEIVER	CONDENSATE	SUBMERSIBLE	8.5	20.0	22.0	150	4.0	1/6	3450	120	1	SIMILAR TO FLINT & WALLING ECP062S

ISSUE FOR:			
Area	Rev.	Date	Description
		04/13/18	CONSTRUCTION

E & C
ENGINEERS & CONSULTANTS, INC.
1010 LAMAR, SUITE 650
HOUSTON, TEXAS 77002
TEL 713/580-8800
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STATE OF TEXAS
HEATHER CAMDEN
86883
LICENSED
PROFESSIONAL ENGINEER

THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY:
Digitally signed by Heather Camden
Date: 2018.04.12 15:41:53-05'00'
E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL SCHEDULES

DRAWING NO.
M800

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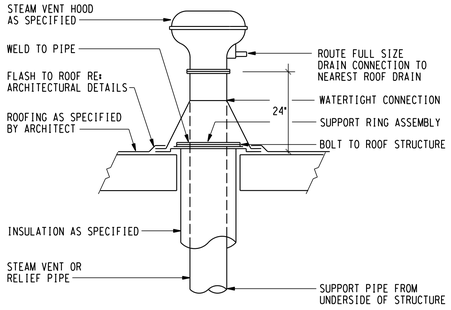
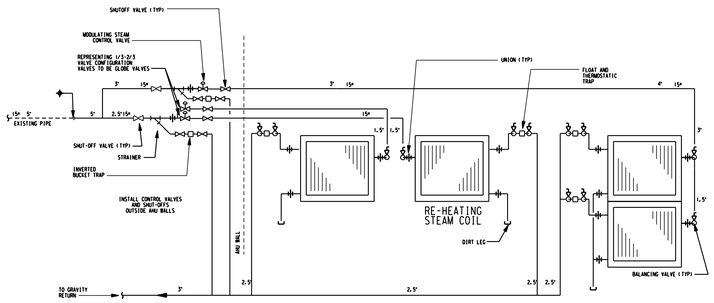


10 TYPICAL STEAM VENT THRU ROOF ASSEMBLY

NOT TO SCALE

PIPING COMING TO THE EXISTING UNIT IS 5'.



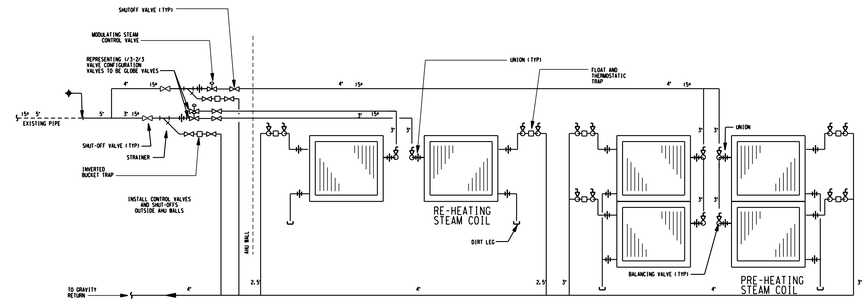
NOTES:

1. INSULATE ALL PIPING, VALVES, FITTINGS AND ACCESSORIES. RE: SPECIFICATIONS.

8 TYPICAL OFFICE AIR HANDLING UNIT STEAM COIL PIPING

NOT TO SCALE

PIPING COMING TO THE EXISTING UNIT IS 5'.

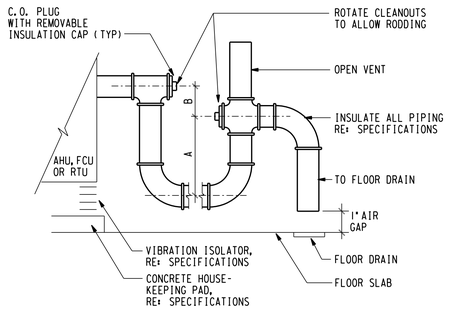


NOTES:

1. INSULATE ALL PIPING, VALVES, FITTINGS AND ACCESSORIES. RE: SPECIFICATIONS.

3 TYPICAL LAB AIR HANDLING UNIT STEAM COIL PIPING

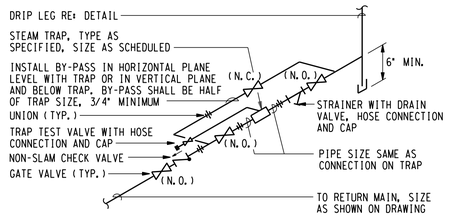
NOT TO SCALE



A - MINIMUM = B/2+1/2"
B - MINIMUM = UNIT FAN DISCHARGE PRESSURE +2"

9 TYPICAL CONDENSATE DRAIN PIPING

NOT TO SCALE

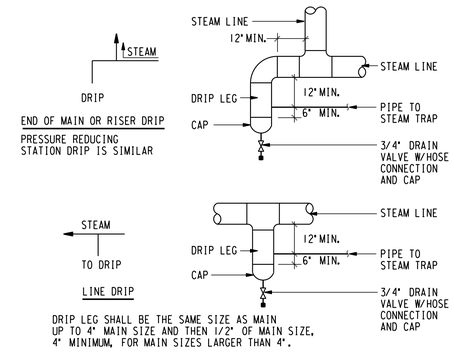


NOTES:

1. BY-PASS IS NOT REQUIRED ON THE TRAP PROVIDED FOR THE DRIPPING OF LOW PRESSURE SUPPLY MAINS (15 PSIG OR LESS).
2. CHECK VALVE IS NOT REQUIRED FOR LOW PRESSURE STEAM SYSTEM WITH GRAVITY RETURN.

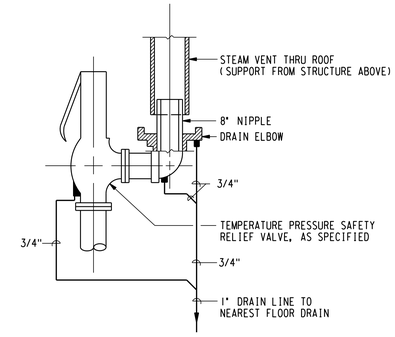
7 TYPICAL STEAM DRIP TRAP PIPING

NOT TO SCALE



5 TYPICAL STEAM DRIP TRAP POCKETS

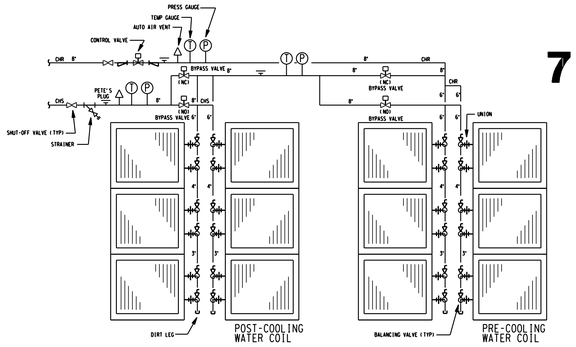
NOT TO SCALE



2 TYPICAL STEAM SAFETY RELIEF VALVE

NOT TO SCALE

PIPING COMING TO THE EXISTING UNIT IS 10'. ANY PIPE THAT IS TO BE REUSED CAN BE OF A LARGER SIZE THAN NOTED BELOW, BUT NOT SMALLER.

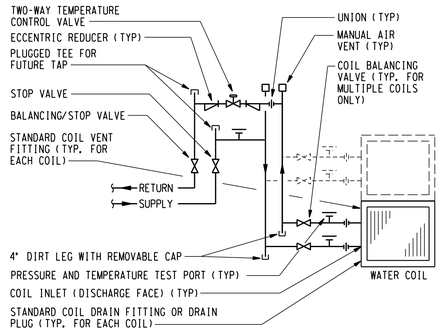


NOTES:

1. INSULATE ALL PIPING, VALVES, FITTINGS AND ACCESSORIES. RE: SPECIFICATIONS.
2. INSTALL TEST PORTS IN EASILY ACCESSIBLE LOCATIONS WITH MINIMUM OF 12" CLEARANCE ABOVE AND IN FRONT OF PORTS.

TYPICAL AIR HANDLING UNIT COIL PIPING

NOT TO SCALE

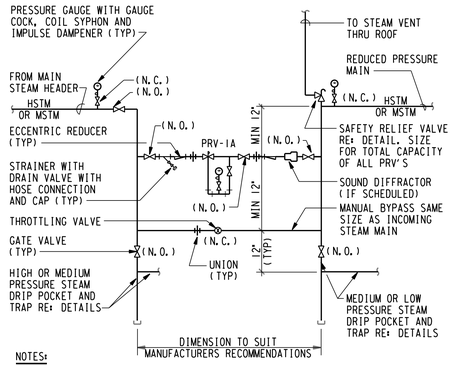


NOTES:

1. INSULATE ALL PIPING, VALVES, FITTINGS AND ACCESSORIES. RE: SPECIFICATIONS.
2. INSTALL TEST PORTS IN EASILY ACCESSIBLE LOCATIONS WITH MINIMUM OF 12" CLEARANCE ABOVE AND IN FRONT OF PORTS.

4 TYPICAL AIR HANDLING UNIT COIL PIPING

NOT TO SCALE



NOTES:

1. SIZE PRV-1A SIZED FOR 100% OF REDUCED PRESSURE STEAM LOAD.
2. HIGH PRESSURE TO MEDIUM PRESSURE OR MEDIUM PRESSURE TO LOW PRESSURE. DO NOT USE FOR HIGH PRESSURE TO LOW PRESSURE.

1 TYPICAL SINGLE STAGE STEAM PRESSURE REDUCING STATION

NOT TO SCALE

06 AIR HANDLING UNIT WITH SERIES COILS CHILLED WATER COIL PIPING DETAIL (REPLACEMENT UNIT)

NOT TO SCALE

ISSUE FOR:			
Area	Rev.	Date	Description
		04/13/18	CONSTRUCTION

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STATE OF TEXAS — HEATHER CAMDEN — 86883 — LICENSED — PROFESSIONAL ENGINEER

THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY: Digitally signed by Heather Camden Date: 2018.04.12 15:41:53-05'00'
E&C Engineers & Consultants Inc. Texas Firm Registration No: F-003968

Date 04/13/2018
Drawn By RWC
Checked By REG

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth — The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE: **MECHANICAL DETAILS**

DRAWING NO. **M900**

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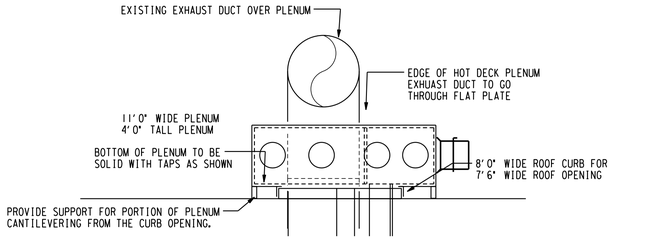
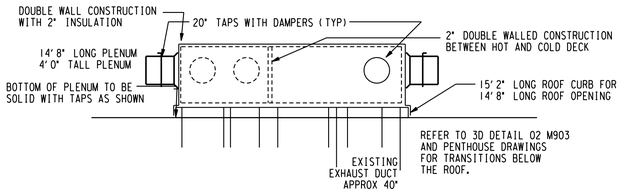
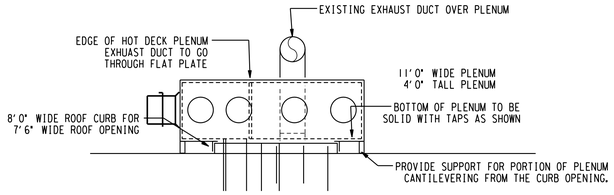
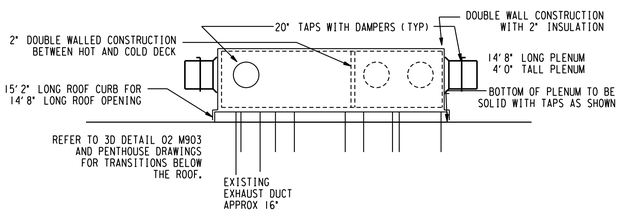




10 AHU-L4 RISER PLENUM
NOT TO SCALE





9 AHU-L3 RISER PLENUM
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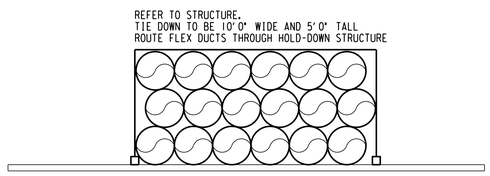

8 TYPICAL HOLD-DOWN LAY-OUT - RE: STRUCTURE
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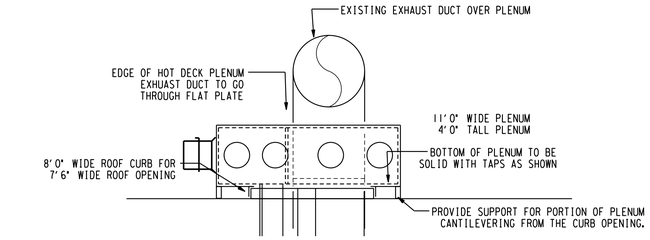

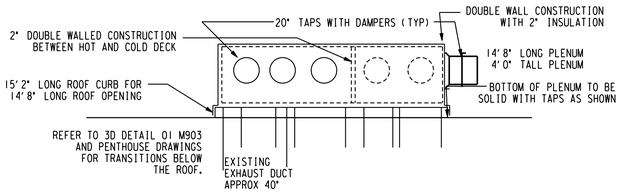

7 AHU-L2 RISER PLENUM
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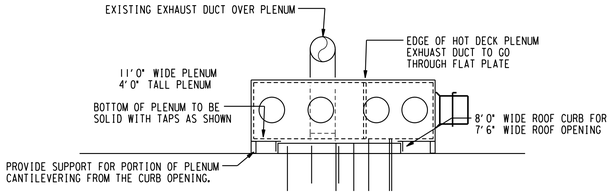

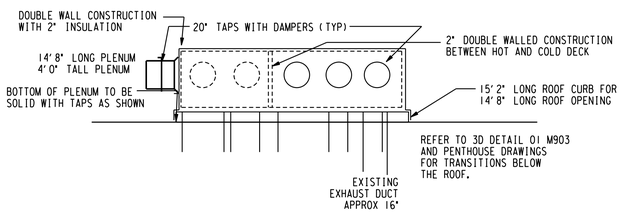

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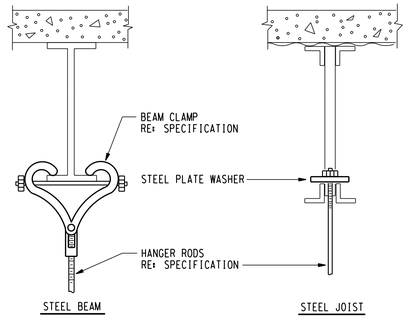
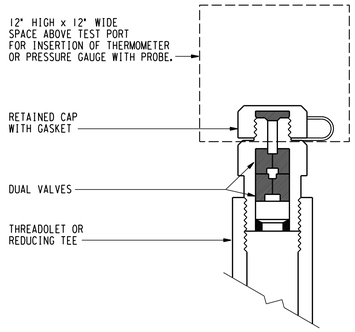


5 TYPICAL PIPE AND DUCT SUPPORT ATTACHMENT
NOT TO SCALE



4 TYPICAL PRESSURE/TEMPERATURE TEST PORT INSTALLATION
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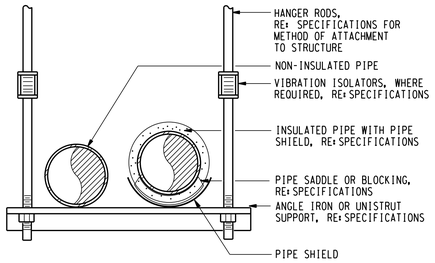
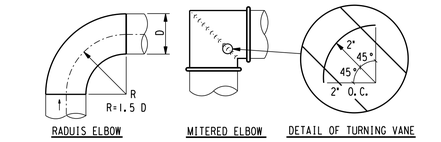
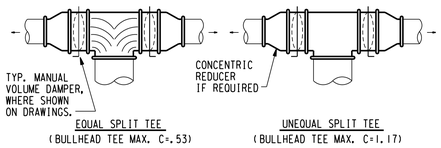
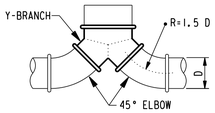


3 TYPICAL TRAPEZE TYPE MULTIPLE PIPE HANGER
NOT TO SCALE





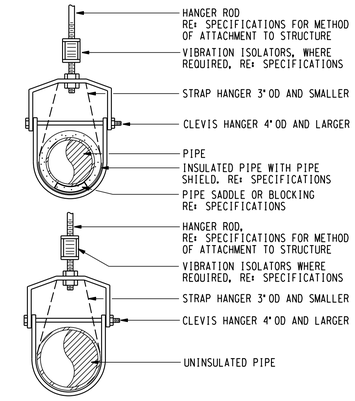


EQUAL SPLIT TEE
(Y-2PLUS 45° ELBOWS MAX. C=.22)
(FOR UP STREAM VELOCITY ABOVE 2500 FPM)

EXPANDED DUCT TAP
(CONTOURED LOLOSS TEE TAP)
(FOR VELOCITY BELOW 1500 FPM)

EXPANDED DUCT TAP
(SADDLE CONICAL LATERAL TAP)
(FOR VELOCITY ABOVE 1500 FPM)

2 TYPICAL ROUND/OVAL DUCT FITTINGS
NOT TO SCALE



1 TYPICAL SINGLE PIPE HANGER
NOT TO SCALE

ISSUE FOR:			
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E&C Engineers & Consultants Inc. Texas Firm Registration No: F-003968

Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

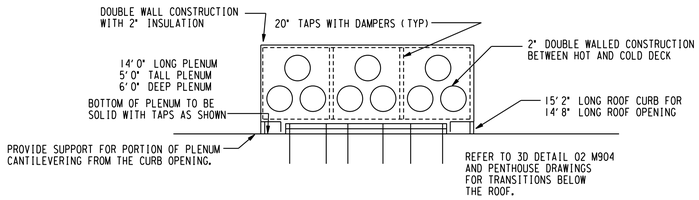
UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

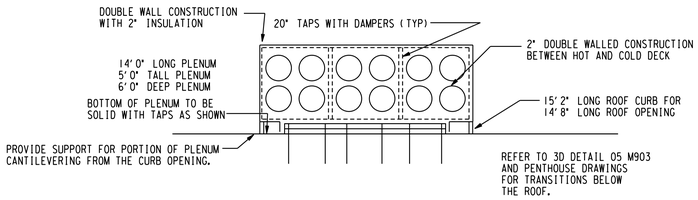
DRAWING TITLE
MECHANICAL DETAILS

DRAWING NO.
M901

I:\3300\3301\m\Provider Penthouse\3302 M02.dgn
4/15/2018 11:02:15 PM



6 AHU-06 RISER PLENUM
NOT TO SCALE



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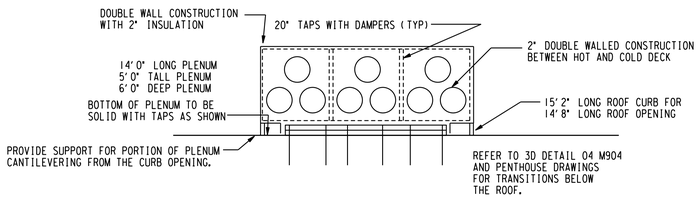

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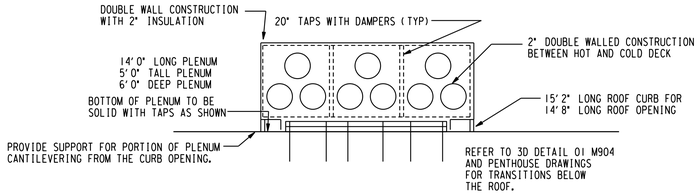

5 AHU-05 RISER PLENUM
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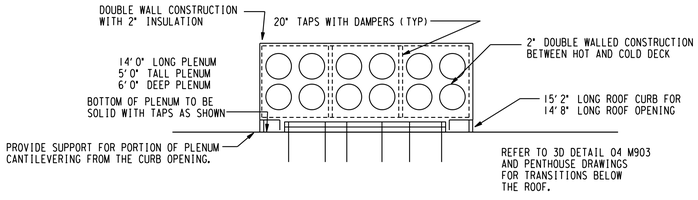

2 AHU-02 RISER PLENUM
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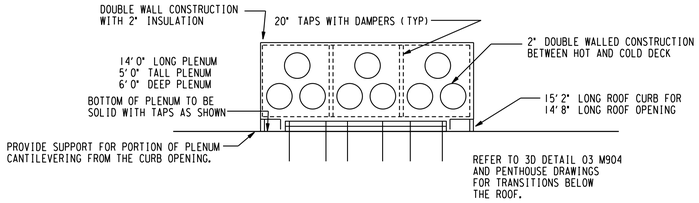

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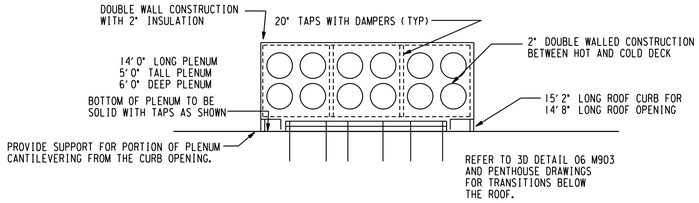

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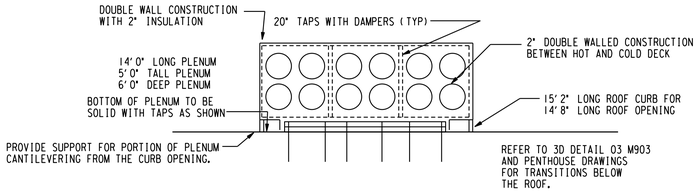

1 AHU-01 RISER PLENUM
NOT TO SCALE

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E & C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

Date 04/13/2018
Drawn By MHMc
Checked By HEC

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

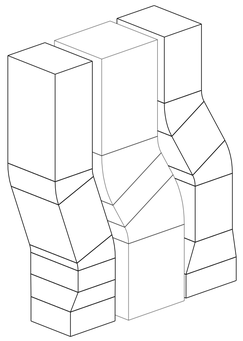
UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

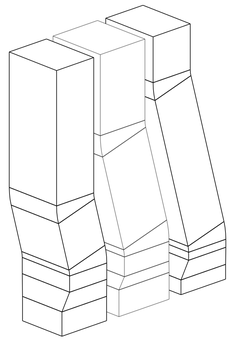
DRAWING TITLE
MECHANICAL DETAILS

DRAWING NO.
M902

I:\3302\3302\on\Openplan Penthouse\3302_M03.dgn
4/12/2018 11:03:02 PM



05 ISOMETRIC OF CHASE CONNECTIONS AHU-03
NOT TO SCALE



03 ISOMETRIC OF CHASE CONNECTIONS AHU-01
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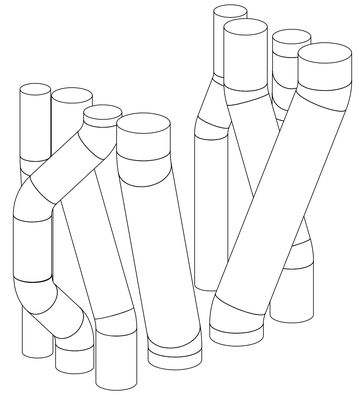

01 ISOMETRIC OF CHASE CONNECTIONS AHU-L1&2
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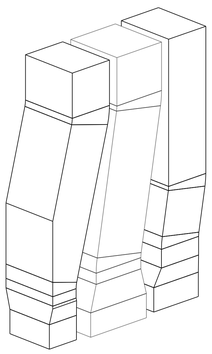
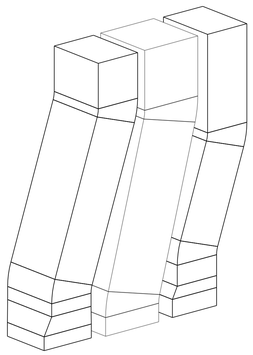
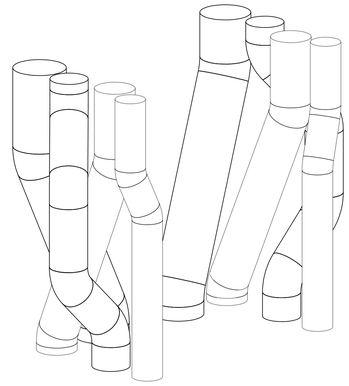


06 ISOMETRIC OF CHASE CONNECTIONS AHU-04
NOT TO SCALE



04 ISOMETRIC OF CHASE CONNECTIONS AHU-02
NOT TO SCALE



02 ISOMETRIC OF CHASE CONNECTIONS AHU-L3&4
NOT TO SCALE

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Date 04/13/2018
Drawn By MHMc
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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL DETAILS

DRAWING NO.
M903

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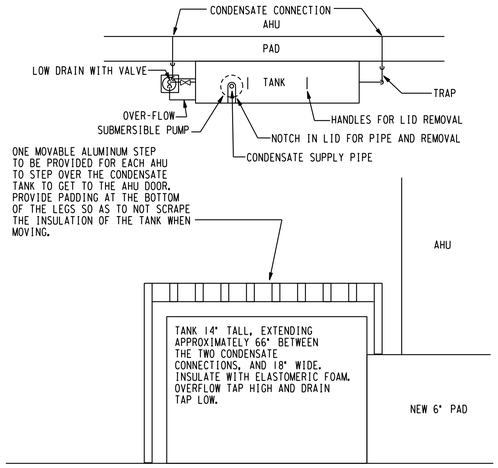
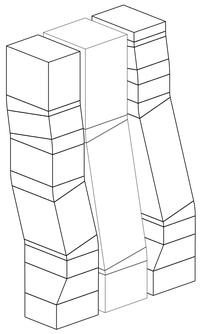
4/13/2018 11:03:44 PM



05 DETAIL OF CONDENSATE TANK WITH MOVABLE STEP
NOT TO SCALE



03 ISOMETRIC OF CHASE CONNECTIONS AHU-07
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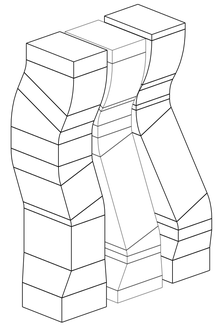

01 ISOMETRIC OF CHASE CONNECTIONS AHU-05
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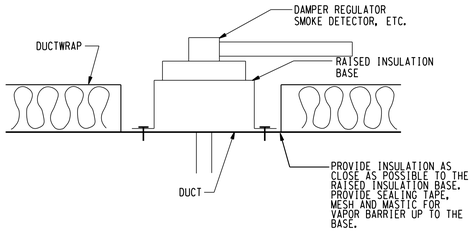
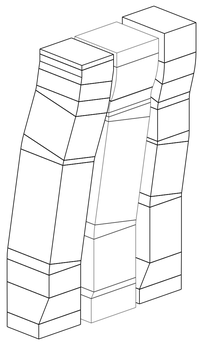
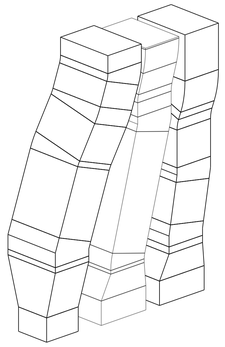


06 DETAIL OF DUCT MOUNTED EQUIPMENT INSTALLATION
NOT TO SCALE



04 ISOMETRIC OF CHASE CONNECTIONS AHU-08
NOT TO SCALE



02 ISOMETRIC OF CHASE CONNECTIONS AHU-06
NOT TO SCALE

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STATE OF TEXAS
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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL DETAILS

DRAWING NO.
M904

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AIR HANDLING UNIT

A. This unit shall be a medium pressure, dual duct, blow-through unit serving multiple dual duct boxes. The unit shall consist of a mixing box, 30%/85% filter bank, a steam preheat coil, fan array section, pre and post cooling coils and a dual duct section with steam heating coils.

B. When the VFD - H-O-A switch is in automatic, the BAS system shall start and stop the supply fan by way of a signal to the VFD control input port. When the switch is in hand, the supply fan shall start and run at the set speed. When in the bypass mode the fan shall start and run at full speed.

C. For the supply fans to start in either hand or automatic, the following permissives shall be satisfied:

1. the smoke detector in the unit discharge.
2. supply air duct high pressure switch is closed indicating a safe operating condition.
3. the door switch is closed.

D. When the supply fan array is off, the heating coils and chilled water valves shall be closed to the coils, except in freeze protection mode. In freeze protection mode, the preheat coil valves shall be open when the outdoor temperature is under 36 degrees.

E. Upon a signal to start the fan array, the fan array shall be energized and ramp up to control speed through the VFD to maintain the riser pressure requiring the highest speed to achieve the static pressure setpoint (Owner adjustable setpoint).

F. When the supply fan array is operating, the preheating and chilled water valve shall modulate to maintain the desired leaving air conditions. The discharge conditions for the cold deck shall be set for a dewpoint no greater than 53 degrees and dry bulb no less than 51 degrees. The preheat and cooling coil control valves shall not be open at the same time.

1. When inlet air temperature entering the AHU is below 65 degrees F (owner adjustable), the normally-open two-position valve located in the return piping for the pre cooling coil shall close, while the normally-closed bypass two-position valve shall open allowing chilled water to flow through the post-cooling coil only. Once the outside air temperature rises above the setpoint, the valves shall actuate to normal positions.

G. The discharge conditions for the hot deck shall be set for a dry bulb no greater than 97 degrees.

H. Condensate pump controls:

1. A condensate pump shall operate to flow condensate through a coil. The trap shall be sized to keep the coil wet. When the condensate collection basin float switch rises to the "pump on" setpoint, the condensate pump shall turn on to flow condensate through the coil.
2. When the basin float lowers below the shut-off setpoint, the pump shall be de-energized.
3. If at any time the float rises above a high-limit point, the two-position drain valve shall open to dump to drain until the float lowers back below the "pump on" setpoint.
4. If the temperature of the condensate rises above 75 degrees, the overflow valve shall open and the condensate shall dump to drain. Once the float is to the "pump off" low limit, the valve shall close and the basin will begin to fill again.

I. A current sensing relay shall independently indicate status of each of the supply fans. Status shall be input to the BAS system and to the fire alarm system.

J. The filter bank shall have an adjustable differential pressure switch to indicate high differential pressure across the filters. The switch shall be an alarm input to the BAS system.

K. The supply air duct shall have a pressure sensor to indicate duct static pressure at the discharge of the unit on both the hot and cold decks. The pressure sensor shall provide an input to the BAS system.

L. The supply air duct shall have an adjustable pressure switch to indicate high pressure downstream of the fan and a low pressure switch upstream of the fan. The switches shall be an alarm input to the BAS system and shall be an interlock for the supply air fan.

M. There shall be a discharge smoke detector interlocked with the fire alarm system to shut the system down in the event of smoke in the fan discharge.

N. There shall be a low temperature limit switch that shall be before the inlet of the cooling coil. Upon a signal from the switch that the temperature is below 35 degrees, the outside air damper shall shut and an alarm shall be sent to the BAS. If the temperature remains below the limit of 35 degrees for more than 1 minute after the outside air damper is shut, the fan shall be de-energized and the cooling coil shall open fully to circulate water to avoid freezing the coil.

O. There shall be a door switch on the fan section. When the door switch is open, the fan shall be de-energized for safety.

P. There shall be a door switch on the cooling coil section. When the door switch is open, the UV lights shall be de-energized for safety. Otherwise, the UV lights shall be on if the AHU is operational.

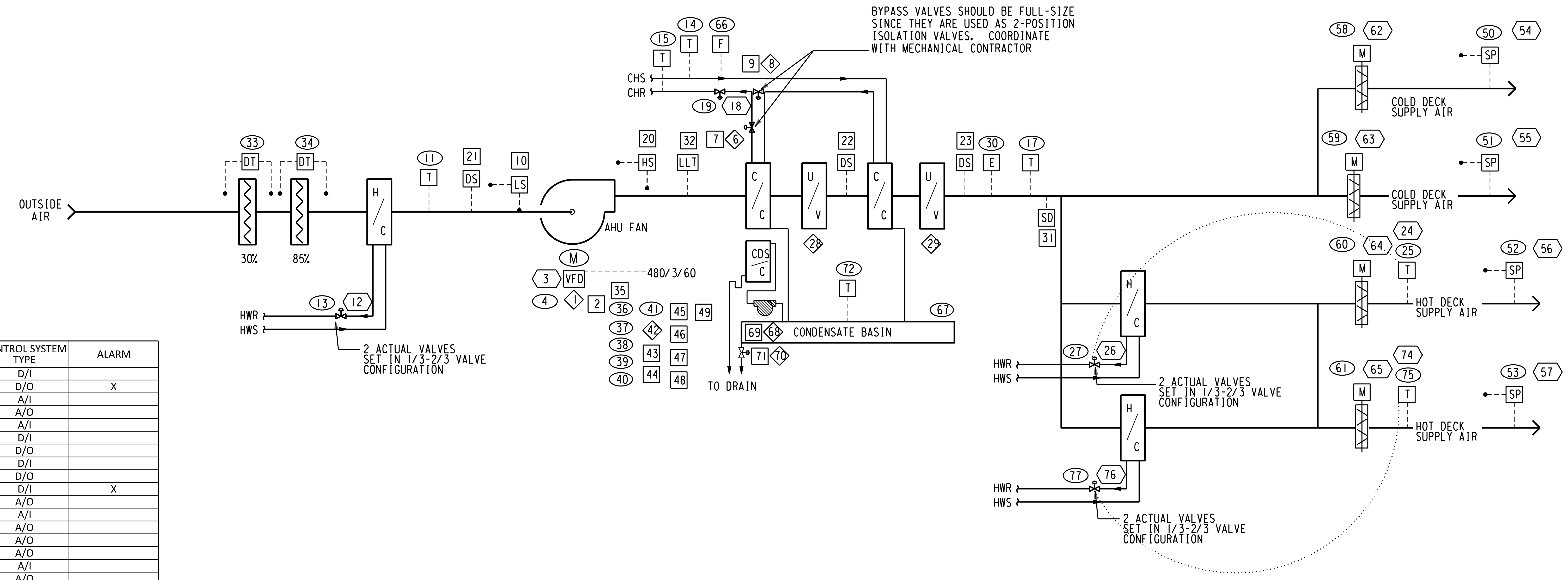
Q. There shall be a contractor-provided Nutech venture flowmeter installed in the chilled water supply or return line with high and low pressure points (contractor option based on ease of installation). Controls contractor to connect to the ports and provide flow to the BAS.

If Alternate A1 is selected, the risers will be set with a minimum and maximum SP setpoint. Once the worst case riser is satisfied to the minimum SP setpoint, the dampers at the unit discharge will operate to maintain static pressure between the minimum and maximum for that riser.

NAE 8

POINT NO.	POINT	DESCRIPTION	UNIT OF MEASURE	CONTROL SYSTEM TYPE	ALARM
1	FAN_C	FAN ARRAY COMMAND	ON|OFF	D/I	
2	FAN_S	FAN ARRAY STATUS	ON|OFF	D/O	X
3	VFD_C	VFD COMMAND	%	A/I	
4	VFD_FB	VFD FEEDBACK	%	A/O	
5	OABP_SP	OA TEMP COOLING BYPASS SETPOINT	°F	A/I	
6	BP_V1_C	BYPASS VALVE 1 CONTROL (NO)	OPEN/CLOSE	D/I	
7	BP_V1_FB	BYPASS VALVE 1 FEEDBACK (NO)	OPEN/CLOSE	D/O	
8	BP_V2_C	BYPASS VALVE 2 CONTROL (NC)	OPEN/CLOSE	D/I	
9	BP_V2_FB	BYPASS VALVE 2 FEEDBACK (NC)	OPEN/CLOSE	D/O	
10	LS_A	LOW STATIC ALARM	NORMAL/ALARM	D/I	X
11	PH_T	PREHEAT TEMPERATURE - 4 AVERAGING	°F	A/O	
12	PH_V_C	PREHEAT VALVE COMMAND	%	A/I	
13	PH_V_FB	PREHEAT VALVE FEEDBACK	%	A/O	
14	CHW_S_T	CHILLED WATER SUPPLY TEMP	°F	A/O	
15	CHW_R_T	CHILLED WATER RETURN TEMP	°F	A/O	
16	CD1_T_SP	COLD DECK 1 TEMP SETPOINT	°F	A/I	
17	CD1_T	COLD DECK 1 TEMPERATURE	°F	A/O	
18	CHW_V1_C	CHILLED WATER VALVE 1 CMD	%	A/I	
19	CHW_V1_F	CHILLED WATER VALVE 1 FB	%	A/O	
20	HS_A	HIGH STATIC ALARM	NORMAL/ALARM	D/O	X
21	DS1	FAN DOOR SWITCH	OPEN/CLOSE	D/O	
22	DS2	UV LIGHT DOOR SWITCH	OPEN/CLOSE	D/O	
23	DS3	UV LIGHT DOOR SWITCH	OPEN/CLOSE	D/O	
24	HD1_T_SP	HOT DECK 1 TEMP SETPOINT	°F	A/I	
25	HD1_T	HOT DECK 1 TEMPERATURE	°F	A/O	
26	HTG_V1_C	REHEAT VALVE 1 CMD	%	A/I	
27	HTG_V1_FB	REHEAT VALVE 1 FB	%	A/O	
28	UV1	UV LIGHTS ON/OFF	ON|OFF	D/O	
29	UV2	UV LIGHTS ON/OFF	ON|OFF	D/O	
30	LA_DP	LEAVING AIR DEWPOINT	°F	A/I	X
31	LA_SD	LEAVING AIR SMOKE DETECTOR	NORMAL|ALARM	D/O	X
32	LL_A	LOW LIMIT ALARM - 2-20' AVERAGING	NORMAL|ALARM	D/O	X
33	PRE_FIL_DP	PREFILTER DP	IWC	A/O	X
34	FIN_FIL_DP	FINAL FILTER DP	IWC	A/O	X
35	VFD_S	VFD STATUS	ON|OFF	D/O	
36	VFD_HTZ	VFD HERTZ	Hz	A/O	
37	VFD_AMP	VFD AMPS	A	A/O	
38	VFD_RPM	VFD RPM	RPM	A/O	
39	VFD_PWR	VFD POWER	kW	A/O	
40	KWH	VFD KILOWATT HOURS	kWh	A/O	
41	VFD_RT	VFD RUNTIME	hours	A/O	
42	VFD_RT_RS	VFD RUNTIME RESET	OFF|RESET	D/I	
43	VFD_FS	VFD FAULT STATUS	OF|FAULT	D/O	X
44	FAN_S1	FAN 1 STATUS	NORMAL|ALARM	D/O	X
45	FAN_S2	FAN 2 STATUS	NORMAL|ALARM	D/O	X
46	FAN_S3	FAN 3 STATUS	NORMAL|ALARM	D/O	X
47	FAN_S4	FAN 4 STATUS	NORMAL|ALARM	D/O	X
48	FAN_S5	FAN 5 STATUS	NORMAL|ALARM	D/O	X
49	FAN_S6	FAN 6 STATUS	NORMAL|ALARM	D/O	X
50	CD1_DP_SP	COLD DECK 1 STATIC PRESSURE SETPOINT	IWC	A/I	
51	CD2_DP_SP	COLD DECK 2 STATIC PRESSURE SETPOINT	IWC	A/I	
52	HD1_DP_SP	HOT DECK 1 STATIC PRESSURE SETPOINT	IWC	A/I	
53	HD2_DP_SP	HOT DECK 2 STATIC PRESSURE SETPOINT	IWC	A/I	
54	CD1_DP	COLD DECK 1 STATIC PRESSURE	IWC	A/O	X
55	CD2_DP	COLD DECK 2 STATIC PRESSURE	IWC	A/O	X
56	HD1_DP	HOT DECK 1 STATIC PRESSURE	IWC	A/O	X
57	HD2_DP	HOT DECK 2 STATIC PRESSURE	IWC	A/O	X
58	CD1_D_C	COLD DECK 1 DAMPER CONTROL	%	A/I	
59	CD2_D_C	COLD DECK 2 DAMPER CONTROL	%	A/I	
60	HD1_D_C	HOT DECK 1 DAMPER CONTROL	%	A/I	
61	HD2_D_C	HOT DECK 2 DAMPER CONTROL	%	A/I	
62	CD1_D_FB	COLD DECK 1 DAMPER FEEDBACK	%	A/O	
63	CD2_D_FB	COLD DECK 2 DAMPER FEEDBACK	%	A/O	
64	HD1_D_FB	HOT DECK 1 DAMPER FEEDBACK	%	A/O	
65	HD2_D_FB	HOT DECK 2 DAMPER FEEDBACK	%	A/O	
66	CHW_FL	CHILLED WATER FLOW (NUTECH VENTURI PROVIDED BY THE MECHANICAL CONTRACTOR)	GPM	A/I	
67	CDS_FLT	FLOAT POSITION	OFF/ON/OVERFLOW	A/I	X
68	CDS_P_C	PUMP CONTROL	ON/OFF	A/I	
69	CDS_P_FB	PUMP FEEDBACK	ON/OFF	A/O	
70	CDS_V_C	OVERFLOW - DUMP CONTROL	OPEN/CLOSE	D/I	X
71	CDS_V_FB	OVERFLOW - DUMP FEEDBACK	OPEN/CLOSE	D/O	
72	CDS_T	CONDENSATE TEMPERATURE	°F	A/O	
73	LEAK	FUTURE LEAK DETECTION ALARM POINT	NORMAL|ALARM	D/I	X
74	HD2_T_SP	HOT DECK 2 TEMP SETPOINT	°F	A/I	
75	HD2_T	HOT DECK 2 TEMPERATURE	°F	A/O	
76	HTG_V2_C	REHEAT VALVE 2 CMD	%	A/I	
77	HTG_V2_FB	REHEAT VALVE 2 FB	%	A/O	

POINTS 51-53 AND 58-65 SHALL BE PART OF ALTERNATE PRICING A1.
VERIFY NAMING ON ALL POINTS WITH UTHSC-H PRIOR TO PROGRAMMING.



01 AHU CONTROL DIAGRAM AHU-L7 & L8

NOT TO SCALE

GENERAL NOTES:

1 ALL SET POINTS SHALL BE REPORTED AS DISPLAYED.
2 ALL ALARMS SHALL BE REPORTED AND DISPLAYED.
3 ALL ALARM SETTINGS SHALL BE DISPLAYED.
4 REFER TO PIPING DIAGRAMS FOR ACTUAL PIPING DETAILS.
5 ALL CONTROLS EQUIPMENT REQUIRED TO PROVIDE THE SEQUENCE OF OPERATTION IS REQUIRED TO BE PROVIDED BY THE CONTRACTOR EVEN IF NOT SPECIFICALLY SHOWN ON THE DRAWING OR POINTS LIST.

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ISSUE FOR:			
Area	Rev.	Date	Description
		04/13/18	CONSTRUCTION

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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas
Health Science Center at Houston

MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING TITLE
MECHANICAL
CONTROL DIAGRAMS

DRAWING NO.
M990

AIR HANDLING UNIT

A. This unit shall be a medium pressure, dual duct, blow-through unit serving multiple dual duct boxes. The unit shall consist of a economizer/mixing box, 30%/85% filter bank, a steam preheat coil, fan array section, pre and post cooling coils and a dual duct section with steam heating coils.

B. When the VFD - H-O-A switch is in automatic, the BAS system shall start and stop the supply fan by way of a signal to the VFD control input port. When the switch is in hand, the supply fan shall start and run at the set speed. When in the bypass mode the fan shall start and run at full speed.

C. For the supply fans to start in either hand or automatic, the following permissives shall be satisfied:

1. the smoke detector in the unit discharge.
2. supply air duct high pressure switch is closed indicating a safe operating condition.
3.the door switches are closed.
4. the unit RA and OA dampers are open per control sequence.

D. When the supply fan array is off, the heating coils and chilled water valves shall be closed to the coils, except in freeze protection mode. In freeze protection mode, the preheat coil valves shall be open if the low limit switch shows a temperature under 36 degrees. When the supply fan array is off, all outside air and return air dampers shall be shut and the return/relief fans shall be de-energized.

E. Upon a signal to start the fan array, the fan array shall be energized and ramp up to control speed through the VFD to maintain the riser pressure requiring the highest speed to achieve the static pressure setpoint (Owner adjustable setpoint).

F. Economizer Dampers:

1. Normal Operation:

i. When the supply fan is in operation, the outside air and return air dampers along with the return air fans shall modulate to maintain the required outside air flow per the schedule. The return air damper shall be 100% open and the VFDs for the fans shall modulate in parallel to maintain the proper return air volume (total flow-outside air) while the outside air damper modulates to maintain the proper outside air flow per the schedule.

ii.If the outside air damper is 100% open and the VFDs are at minimum flow, the return air damper shall modulate to close to provide the additional static needed to reduce the return air flow. If the damper modulates to 15% open or less, the fan shall be de-energized, and the AHU fan shall ramp up to achieve the required static while the outside air damper modulates to meet the outside air. If in this mode, the outside air cannot meet the flow at 100% open, the return air damper shall again begin to close to meet setpoint. When the return air damper is 100% open and the outside air is 50% or more closed, the return fans shall be re-energized to operate as noted.

2. Economizer Mode:

i. When the supply fan is in operation and the outside air enthalpy is less than 28 Btu/lb and the dry bulb is greater than 50 degrees, the system shall enter into economizer mode.

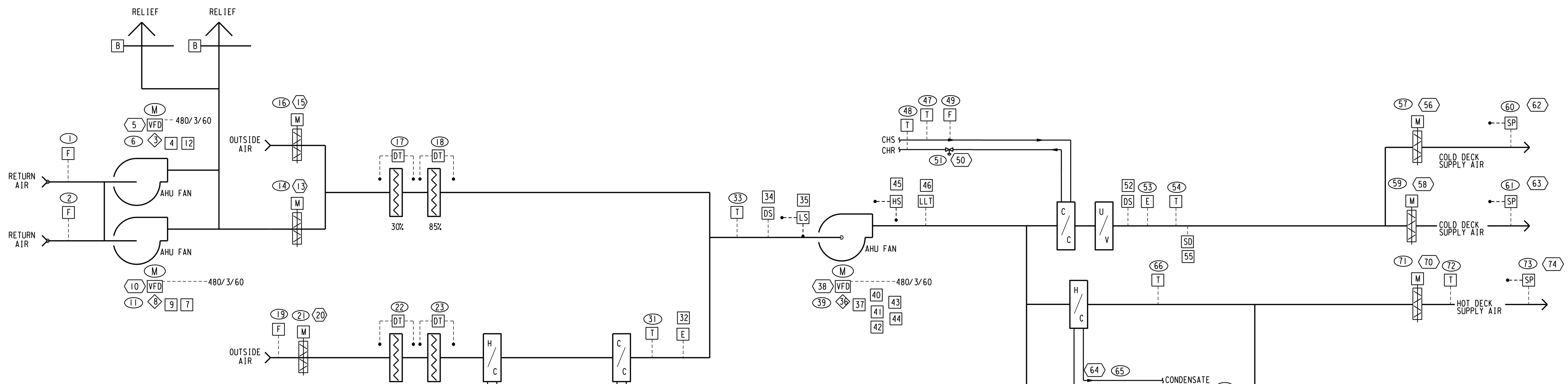
ii.The outside air damper shall fully close and the precooling and preheating coil shall be off.

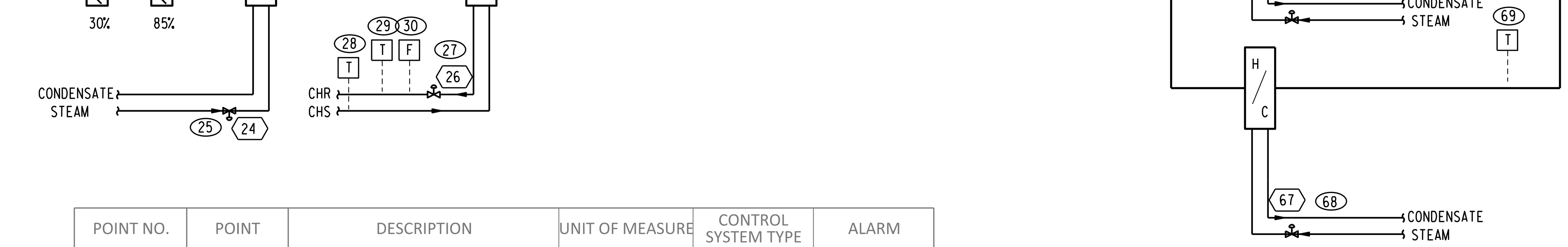
iii. The AHU return air damper shall fully close.

iv. The outside air economizer damper shall fully open and the AHU shall operate as designed.

v.The relief damper shall open and the return air fans shall modulate in parallel to control the total cfm of relief to the equivalent of the required relief air (total AHU cfm - outside air design cfm per schedule). If the return air fans are at minimum speed on the VFD and less return air is called for, the relief damper shall begin to close to create the additional static pressure to reduce the total flow. If the damper is 15% open and the relief air flow requirement is still less than the flow, the fan shall be de-energized and the relief air damper shall modulate to maintain the required flow. The fan shall re-energize when the damper is fully open and the relief air flow is 1,000 cfm less than the required flow.

vi. When the enthalpy of the outside air rises above 28 Btu/lb or the outside air temperature falls below 50 degrees, the unit shall return to normal mode.





G. Pretreat section:

1. When the supply fan array is operating and the unit is in normal mode, the preheating and precooling chilled water valve shall modulate to maintain the desired leaving air conditions of 52.5 degrees. The preheat and cooling coil control valves shall not be open at the same time.

2. When the supply fan array is de-energized or the unit is in economizer mode, the pretreat section with preheat coil and precooling coil, shall have the valves closed.

H. Dual Deck Section:

3. When the supply fan array is operating and the unit is in normal or economizer mode, the cooling coil shall modulate to maintain a leaving air temperature of 51.5 degrees and the steam heating shall modulate to maintain a linear hot deck temperature reset of 95 degrees when the outdoor temperature is 35 degrees or less to a temperature of 80 degrees when the temperature is 85 degrees or greater.

I. All temperature setpoints shall be owner adjustable.

J. A current sensing relay shall independently indicate status of each of the supply fans, or if the AHU manufacturer provides a control panel that is bacnet compatible, the BAS shall provide the status of each fan through the AHU control panel. Status shall be input to the BAS system and to the fire alarm system.

K. The filter bank shall have a differential pressure sensor to indicate high differential pressure across the filters. The switch shall be an alarm input to the BAS system.

L. The supply air duct shall have a pressure sensor to indicate duct static pressure at the discharge of the unit on both the hot and cold decks. The pressure sensor shall provide an input to the BAS system.

M. The supply air duct shall have an adjustable pressure switch to indicate high pressure downstream of the fan and a low pressure switch upstream of the fan. The switches shall be an alarm input to the BAS system and shall be an interlock for the supply air fan.

N. There shall be a discharge smoke detector interlocked with the fire alarm system to shut the system down in the event of smoke in the fan discharge.

O. There shall be a low temperature limit switch that shall be before the inlet of each cooling coil. Upon a signal from the switch that the temperature is below 35 degrees, the outside air damper and outside air economizer damper shall shut and an alarm shall be sent to the BAS. If the temperature remains below the limit of 35 degrees for more than 1 minute after the outside air damper is shut, the fan shall be de-energized and the cooling coil shall open fully to circulate water to avoid freezing the coil.

P. There shall be a door switch on the fan section. When the door switch is open, the fan shall be de-energized for safety.

Q. There shall be a door switch on the cooling coil section. When the door switch is open, the UV lights shall be de-energized for safety. Otherwise, the UV lights shall be on if the AHU is operational. A toggle switch shall also be provided.

R. There shall be a contractor-provided Nutech venturi flowmeter installed in the chilled water supply or return line with high and low-pressure points (contractor option based on ease of installation). Controls contractor to connect to the ports and provide flow to the BAS.

S. If Alternate A1 is selected, the risers will be set with a minimum and maximum SP setpoint. Once the worst-case riser is satisfied to the minimum SP setpoint, the dampers at the unit discharge will operate to maintain static pressure between the minimum and maximum for that riser.

POINT NO.	POINT	DESCRIPTION	UNIT OF MEASURE	CONTROL SYSTEM TYPE	ALARM
1,2	RAF	RETURN AIR FLOW	CFM	A/I	
3,8	FAN_C	RETURN AIR FAN COMMAND	ON|OFF	D/O	
4,9	FAN_S	RETURN AIR FAN STATUS	ON|OFF	D/I	X
5,10	VFD_C	VFD COMMAND	%	A/O	
6,11	VFD_FB	VFD FEEDBACK	%	A/I	
7,12	VFD_AL	VFD GENERAL ALARM	NORMAL/ALARM	D/I	X
13	RA_D_C	RA DAMPER COMMAND	%	A/O	
14	RA_D_FB	RA DAMPER FEEDBACK	%	A/I	
15	OAE_D_C	OA ECONOMIZER DAMPER CONTROL	%	A/O	
16	OAE_D_FB	OA ECONOMIZER DAMPER FEEDBAC	%	A/I	
17	PRE_RAFIL_D	RETURN AIR PREFILTER DP	"WC	A/I	X
18	FIN_RAFIL_D	RETURN AIR FINAL FILTER DP	"WC	A/I	X
19	OA_D_C	OUTSIDE AIR DAMPER COMMAND	%	A/O	
20	OA_D_FB	OUTSIDE AIR DAMPER FEEDBACK	%	A/I	
21	OA_F	OUTSIDE AIR FLOW	CFM	A/I	
22	PRE_OAFIL_D	OUTSIDE AIR PREFILTER DP	"WC	A/I	X
23	FIN_OAFIL_D	OUTSIDE AIR FINAL FILTER DP	"WC	A/I	X
24	PH_V_C	PREHEAT VALVE COMMAND (1/3-2/3)	%	A-O	
25	PH_V_FB	PREHEAT VALVE FEEDBACK	%	A/I	
26	CC_V_C	OA COOLING VALVE COMMAND	%	A/O	
27	CC_V_FB	OA COOLING VALVE FEEDBACK	%	A/I	X
28	CHW_S_T	CHILLED WATER SUPPLY TEMP	°F	A/I	
29	CHW_R_T	CHILLED WATER RETURN TEMP	°F	A/I	
30	CHW_FL	CHILLED WATER FLOW	%	A/I	
31	OA_CON_T	CONDITIONED OA TEMP	°F	A/I	
32	OA_COND_E	CONDITIONED OA DEWPOINT	°F	A/I	
33	MA_T	MIXED AIR TEMP	°F	A/I	
34	DS1	FAN DOOR SWITCH	OPEN/CLOSE	D/O	
35	PRES_LL	LOW PRESSURE ALARM	NORMAL/ALARM	D/I	X
36	FAN_C	FAN ARRAY COMMAND	ON|OFF	D/O	
37	FAN_S	FAN ARRAY STATUS	ON|OFF	D/I	X
38	VFD_C	FAN ARRAY VFD COMMAND	%	A/O	
39	VFD_FB	FAN ARRAY VFD FEEDBACK	%	A/I	
40	VFD_AL	FAN ARRAY VFD GENERAL ALARM	NORMAL/ALARM	D/I	X
41, 42, 43, 44	FAS	FAN STATUS IN ARRAY	NORMAL/ALARM	D/I	X
45	SP_HL	HIGH STATIC LIMIT SWITCH	NORMAL/ALARM	D/I	X
46	LLT	LOW TEMP SWITCH	NORMAL/ALARM	D/I	X
47	CHW_S_T	CHILLED WATER SUPPLY TEMP	°F	A/I	
48	CHW_R_T	CHILLED WATER RETURN TEMP	°F	A/I	
49	CHW_FL	CHILLED WATER FLOW	%	A/I	
50	CC_V_C	COLD DECK VALVE COMMAND	%	A/O	
51	CC_V_FB	COLD DECK VALVE FEEDBACK	%	A/I	X
52	DS2	COIL DOOR SWITCH	OPEN/CLOSE	D/O	
53	CD_E	COLD DECK DEWPOINT	°F	A/I	
54	CD_T	COLD DECK TEMPERATURE	°F	A/I	
55	SA	SMOKE ALARM	NORMAL/ALARM	D/I	X
56/58	CD_D_C	COLD DECK DAMPER CONTROL	%	A/O	
57/59	CD_D_FB	COLD DECK DAMPER FEEDBACK	%	A/I	
60/61	CD1_P	COLD DECK PRESSURE	"WC	A/O	
62/63	CD1_P_SP	COLD DECK PRESSURE SETPOINT	"WC	A/I	
64/67	HD_C	HOT DECK VALVE CONTROL (1/3-2/3)	%	A/O	
65/68	HD_FB	HOT DECK VALVE FEEDBACK	%	A/I	
66/69	HD_T	HOT DECK DISCHARGE TEMP	°F	A/I	
70	HD_D_C	HOT DECK DAMPER CONTROL	%	D/O	
71	HD_D_FB	HOT DECK DAMPER FEEDBACK	%	A/I	
72	HD_T	HOT DECK TEMP	°F	A/I	
73	HD_P	HOT DECK PRESSURE	"WC	A/I	
74	HD_P_SP	HOT DECK PRESSURE DETPOINT	"WC	A/O	

POINTS 60-63, 70-71 AND 73-74 SHALL BE PART OF ALTERNATE PRICING A1.
VERIFY NAMING ON ALL POINTS WITH UTHSC-H PRIOR TO PROGRAMMING.

GENERAL NOTES:

1 ALL SET POINTS SHALL BE REPORTED AS DISPLAYED.
2 ALL ALARMS SHALL BE REPORTED AND DISPLAYED.
3 ALL ALARM SETTINGS SHALL BE DISPLAYED.
4 REFER TO PIPING DIAGRAMS FOR ACTUAL PIPING DETAILS.
5 ALL CONTROLS EQUIPMENT REQUIRED TO PROVIDE THE SEQUENCE OF OPERATTION IS REQUIRED TO BE PROVIDED BY THE CONTRACTOR EVEN IF NOT SPECIFICALLY SHOWN ON THE DRAWING OR POINTS LIST.

01 AHU CONTROL DIAGRAM AHU-01, 2, 3, 4, 5, 6, 7, & 8
NOT TO SCALE

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ISSUE FOR:			
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UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas
Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
MECHANICAL CONTROL DIAGRAMS

DRAWING NO.
M991

ABBREVIATIONS

A	AMPS, AIR (COMPRESSED)
AAP	AREA ALARM PANEL
ABV	ABOVE
AC	ALTERNATING CURRENT, AIR COMPRESSOR
A/C	AIR CONDITIONING
ACC	AIR COOLED CHILLER
ACCU	AIR COOLED CONDENSING UNIT
AD	ACCESS DOOR, AIR DRYER
ADJ	ADJUSTABLE
AF	AIR FILTER
AFC	ABOVE FINISHED CEILING
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHU	AIR HANDLING UNIT
AIC	AMPERES INTERRUPTING CAPACITY
AL	ALUMINUM
ALT	ALTERNATE
AMB	AMBIENT
ANOD	ANODIZED
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
AP	ACCESS PANEL, ALARM PANEL
APD	AIR PRESSURE DROP
ARCH	ARCHITECT, ARCHITECTURAL
ARI	AMERICAN REFRIGERATION INSTITUTE
AS	AIR SEPARATOR
ASHRAE	AMERICAN SOCIETY OF HEATING AND REFRIGERATION AND AIR CONDITIONING ENGINEERS
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
ATP	AUTOMATIC TRAP PRIMER
ATS	AUTOMATIC TRANSFER SWITCH
ATT(S)	ATTENUATOR(S)
AUTO	AUTOMATIC
AUX	AUXILIARY
AV	AREA VALVE, ACID VENT
AVG	AVERAGE
AVTR	ACID VENT THRU ROOF
AW	ACID WASTE
AWS	AMERICAN WELDING SOCIETY
AWWA	AMERICAN WATER WORKS ASSOCIATION
BC	BELOW COUNTER
BFD	BOILER FEED DEAREATOR
BFP	BOILER FEED PUMP, BACKFLOW PREVENTER
BFV	BOILER FEED VALVE
BFW	BOILER FEED WATER
BH	BOX HYDRANT
BLDG	BUILDING
BM	BEAM, BENCH MARK
BOB	BOTTOM OF BEAM
BOF	BOTTOM OF FOOTING
BOH	BOTTOM OF HUB
BOP	BOTTOM OF PIPE
BOS	BOTTOM OF STRUCTURE
BOT	BOTTOM
BKT	BRACKET
BS	BLACK STEEL
BSMT	BASEMENT
BT	BATH TUB, BREAK TANK
BV	BUTTERFLY VALVE, BALL VALVE, BALANCING VALVE
BWV	BACKWATER VALVE
C	CELSIUS, CONDUIT
CA	CONTROL AIR, COMPRESSED AIR
CAB	CABINET
CB	CATCH BASIN
CC	CENTER TO CENTER
CD	CEILING DIFFUSER
CDP	CONDENSER WATER PUMP
CDR	CONDENSER WATER RETURN
CDS	CONDENSER WATER SUPPLY
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CG	CEILING GRILL
CH	CHILLER
CHP	CHILLED WATER PUMP
CHS	CHILLED WATER SUPPLY
CHV	CHECK VALVE
CI	CAST IRON
CIP	CAST IN PLACE
CIRC	CIRCULATING
CL.	CENTER LINE
CLG	CEILING
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
CHR	CHILLED WATER RETURN
COL	COLUMN
COMB	COMBINATION
COMP	COMPRESSOR
CONC	CONCRETE, CONCENTRIC
COND	CONDENSER, CONDENSATE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS, CONTROLLER, CONTINUATION
CONTR	CONTRACTOR
CONV	CONVERTER
CORR	CORRIDOR
CO2	CARBON DIOXIDE
CPI	CAST IRON PIPE INSTITUTE
CPVC	CHLORINATED POLYVINYL CHLORIDE
CPUC	CPU CHILLER
CR	CONSTANT VOLUME REHEAT, CONDENSATE RETURN
CRAC	COMPUTER ROOM A/C UNIT
CRT	CATHODE RAY TUBE
CRU	CONDENSATE RETURN UNIT
CSS	CLINICAL SERVICE SINK
CT	COOLING TOWER
CTR	CENTER
CU	COPPER
CU FT	CUBIC FEET
Cv	CAPACITY INDEX
CV	CONTROL VALVE, CHECK VALVE
CW	COLD WATER
CVRH	CONSTANT VOLUME REHEAT
D	DEPTH, DRAIN
Db	DECIBEL
DB	DRY BULB
DBL	DOUBLE
DC	DIRECT CURRENT, DOUBLE DUCT CONSTANT VOLUME
DD	DECK DRAIN, DOUBLE DUCT
DDC	DIRECT DIGITAL CONTROL
DEG	DEGREE
DEP	DEIONIZED WATER PUMP
DEPT	DEPARTMENT
DESIG	DESIGNATION
DET	DETAIL
DF	DRINKING FOUNTAIN
DI	DUCTILE IRON, DRAIN INLET, DEIONIZED WATER
DIA	DIAMETER
DIFF	DIFFUSER
DIM	DIMENSION
DIR	DEIONIZED WATER RETURN
DIS	DEIONIZED WATER SUPPLY
DISC	DISCONNECT
DIST	DISTRIBUTION
DIV	DIVISION
DL	DOOR LOUVER
DMH	DRAIN MANHOLE
DN	DOWN
DP	DIFFERENTIAL PRESSURE
DPR	DAMPER
DS	DOUBLE SUCTION, DOWN SPOUT
DV	DOUBLE DUCT VAV
DW	DISHWASHER, DISTILLED WATER
DWC	DRINKING WATER COOLER
DWG	DRAWING
DWH	DOMESTIC WATER HEATER
DWP	DOMESTIC WATER PUMP
DWR	DRINKING WATER RETURN
DWS	DRINKING WATER SUPPLY
DX	DIRECT EXPANSION
DXFC	DIRECT EXPANSION FAN COIL UNIT
E	EAST
(E)	EXISTING
EA	EACH
EAT	ENTERING AIR TEMPERATURE
EC	ELECTRICAL CONTRACTOR
ECC	ECCENTRIC
EDB	ENTERING DRY BULB
EF	EXHAUST FAN
EJ	EXPANSION JOINT
EL	ELEVATION, EXPANSION LOOP
ELEC	ELECTRIC, ELECTRICAL
ELEV	ELEVATOR
EMER	EMERGENCY
ENCL	ENCLOSURE
ENGR	ENGINEER
EPA	ENVIRONMENTAL PROTECTION AGENCY
EQ	EQUAL
EQUIP	EQUIPMENT
EQUIV	EQUIVALENT
ES	END SUCTION
ET	EXPANSION TANK
ETR	EXISTING TO REMAIN
EVAC	EVACUATION PUMP
EUH	ELECTRIC UNIT HEATER
EVAP	EVAPORATOR
EW	EACH WAY
EWB	ENTERING WET BULB
EWC	ELECTRIC WATER COOLER
EWT	ENTERING WATER TEMPERATURE
EX	EXPLOSION PROOF
EXCV	EXCAVATE, EXCAVATION
EXH	EXHAUST
EXIST	EXISTING
EXP	EXPANSION
EXPD	EXPOSED
EXT	EXTERNAL
F	FAHRENHEIT, FAN, FIRE, FEMALE
F to F	FACE TO FACE
F & E	FURNITURE & EQUIPMENT
FA	FIRE ALARM
FAB(D)	FABRICATE(D)
FACP	FIRE ALARM CONTROL PANEL
FBO	FURNISHED BY OTHERS
FCO	FLOOR CLEAN OUT
FCS	FLOOR CONTROL STATION
FCU	FAN COIL UNIT
FCVA	FLOOR CONTROL VALVE ASSEMBLY
FD	FIRE DAMPER, FLOOR DRAIN
FDC	FIRE DEPARTMENT CONNECTION
FDN	FOUNDATION
FDS	FIRE DEPARTMENT SIAMESE
FDV	FIRE DEPARTMENT VALVE
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FF	FINAL FILTER, FINISHED FLOOR
FFE	FINISHED FLOOR ELEVATION
FG	FINISHED GRADE
FH	FIRE HYDRANT
FHC	FIRE HOSE CABINET
FHR	FIRE HOSE RACK
FHV	FIRE HOSE VALVE
FIN	FINISH
FIXT	FIXTURE
FL	FLOW LINE
FLA	FULL LOAD AMPERES
FLEX	FLEXIBLE
FLR	FLOOR
FM	FACTORY MUTUAL
FO	FUEL OIL
FOP	FUEL OIL PUMP
FOR	FUEL OIL RETURN
FOS	FUEL OIL SUPPLY
FOV	FUEL OIL VALVE
FP	FAN POWERED MIXING BOX, FIRE PUMP
FPC	FIRE PUMP CONTROLLER
FPT	FEMALE PIPE THREAD
FR	FLOOR REGISTER
FRM	FRAME
FRZR	FREEZER
FS	FUSED SWITCH, FLOW SWITCH, FIRE SPRINKLER, FLOOR SINK
FSCP	FIRE SUPPRESSION CONTROL PANEL
FT	FOOT, FEET
FTG	FOOTING
FTR	FINNED TUBE RADIATION
FURN	FURNITURE
FURND	FURNISHED
FUT	FUTURE
FVC	FIRE VALVE CABINET
FVNR	FULL-VOLTAGE, NON-REVERSING
FVR	FULL-VOLTAGE, REVERSING
G	GAS
GA	GAGE
GAL	GALLON
GALV	GALVANIZED
GB	GRADE BEAM
GC	GENERAL CONTRACTOR
GCO	GRADE CLEAN OUT
GEN	GENERATOR
GKT	GASKET
GL	GLASS
GLV	GLOBE VALVE
GND	GROUND
GOVT	GOVERNMENT
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GR	GRILLE
GRD	GRADE
GRV	GRAVITY ROOF VENT
GSH	GRAND SENSIBLE HEAT
GTH	GRAND TOTAL HEAT
GV	GATE VALVE
GW	GREASE WASTE
H	HIGH, HEIGHT, HUMIDIFIER
H-O-A	HAND-OFF-AUTOMATIC
H STAT	HUMIDISTAT/SENSOR
HB	HOSE BIBB
HC	HEATING COIL
HD	HEAD, HUB DRAIN, HEAT DETECTOR
HE	HEAT EXCHANGER
HGR	HANGER
HKP	HOUSEKEEPING PAD
HND D	HAND DRYER
HORIZ	HORIZONTAL
HP	HORSEPOWER, HIGH PRESSURE
HPT	HIGH POINT
HR	HOUR, HOT WATER RETURN
HS	HOT WATER SUPPLY
HSC	HORIZONTAL SPLIT CASE
HSTM	HIGH PRESSURE STEAM
HSZBT	HORIZONTAL, SINGLE-ZONE, BLOW-THRU
HSZDT	HORIZONTAL, SINGLE-ZONE, DRAW-THRU
HT	HEIGHT
HTG	HEATING
HTR	HEATER
HUH	HOT WATER/GAS UNIT HEATER
HVAC	HEATING, VENTILATING & AIR CONDITIONING
HVU	HEATING AND VENTILATING UNIT
HW	HOT WATER
HWB	HOT WATER BOILER
HWC	HOT WATER CIRCULATOR
HWP	HEATING WATER PUMP
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
HZ	HERTZ
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IG	IRRIGATION
IF	INTERMITTENT FAN VAV
IN	INCH
INCAND	INCANDESCENT
INC	INCLUDE, INCLUSIVE
INSUL	INSULATE, INSULATION
INT	INTERNAL, INTERIOR
INV	INVERT
IPS	IRON PIPE SIZE
JAN	JANITOR
JB	JUNCTION BOX
JP	JOCKEY PUMP
JPC	JOCKEY PUMP CONTROLLER
JS	JANITOR SINK
JST	JOIST
JT	JOINT
KEC	KITCHEN EQUIPMENT CONTRACTOR
KIT	KITCHEN
KO	KNOCKOUT
KVA	KILOVOLT-AMPS
KW	KILOWATTS
KWH	KILOWATT-HOUR
L	LENGTH, LONG, LAVATORY
LA	LAB AIR
LAC	LAB AIR COMPRESSOR
LAB	LABORATORY
LAV	LAVATORY
LAT	LEAVING AIR TEMPERATURES, LATENT
LB(S)	POUND(S)
LCD	LIQUID CRYSTAL DISPLAY
LD	LINEAR DIFFUSER
LDB	LEAVING DRY BULB
LED	LIGHT EMITTING DIODE
LF	LINEAR FEET
LG	LAB GAS OUTLET
LH	LEFT HAND
LOC	LOCATION, LIMIT OF CONSTRUCTION
LP	LOW PRESSURE
LPT	LOW POINT
LRA	LOCKED ROTOR AMPS
LSTM	LOW PRESSURE STEAM
LTG	LIGHTING
LV	LAB VACUUM
LVL	LEVEL
LVP	LABORATORY VACUUM PUMP
LW	LAUNDRY LINT WASTE
LWB	LEAVING WET BULB
LWCO	LOW WATER CUT OFF
LWT	LEAVING WATER TEMPERATURE
M	METER, MALE, MEN
MA	MEDICAL AIR
MAC	MEDICAL AIR COMPRESSOR
MAP	MASTER ALARM PANEL
MAX	MAXIMUM
MBH	THOUSANDS OF BTU'S
MC	MECHANICAL CONTRACTOR
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MED	MEDIUM
MEMB	MEMBRANE
M/E/P	MECHANICAL/ ELECTRICAL/ PLUMBING
MEZZ	MEZZANINE
MFGR	MANUFACTURER
MG	MEDICAL GAS OUTLET
MH	MANHOLE
MI	MALLEABLE IRON
MIN	MINIMUM
MISC	MISCELLANEOUS
ML	MATCH LINE
MON	MONITOR SWITCH
MP	MEDIUM PRESSURE
MPT	MALE PIPE THREAD
MS	MONITOR SWITCH
MSB	MAIN SWITCHBOARD
MSGR	MAIN SWITCHGEAR
MSTM	MEDIUM PRESSURE STEAM
MTD	MOUNTED
MTG	MOUNTING
MU	MAKE-UP
MV	MEDICAL VACUUM
MVA	MEGA VOLT-AMPS
MVD	MANUAL VOLUME DAMPER
MVP	MEDICAL VACUUM PUMP
MZU	MULTI-ZONE UNIT
N	NORTH, NITROGEN
(N)	NEW
NA	NOT ACCEPTABLE
NAT	NATURAL
NC	NOISE CRITERIA
N.C.	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NF	NON-FUSED
NFS	NON-FUSED SWITCH
NIC	NOT IN CONTRACT
NO	NUMBER
N.O.	NORMALLY OPEN
NOM	NOMINAL
NTS	NOT TO SCALE
O	OXYGEN
OA	OUTSIDE AIR
OAF	OUTSIDE AIR FAN
OBD	OPPOSED BLADE DAMPER
OC	ON CENTER
OCEW	ON CENTER EACH WAY
OD	OUTSIDE DIAMETER
OFF	OFFICE
OH	OVERHEAD
OPH	OPPOSITE HAND
OPNG	OPENING
OPP	OPPOSITE
OS&Y	OUTSIDE STEM & YOLK
OZ	OUNCE
P	PUMP, POLE, PLUMBING EQUIPMENT
PB	PUSH-BUTTON
PC	PLUMBING CONTRACTOR, PERSONAL COMPUTER
PCR	PUMPED CONDENSATE RETURN
PCHP	PRIMARY CHILLED WATER PUMP
PCHR	PRIMARY CHILLED WATER RETURN
PCHS	PRIMARY CHILLED WATER SUPPLY
PCW	PUMPED COLD WATER
PD	PRESSURE DROP
PEND	PENDANT
PERF	PERFORATED
PH	PHASE
PHWP	PRIMARY HEATING WATER PUMP
PHWR	PRIMARY HEATING WATER RETURN
PHWS	PRIMARY HEATING WATER SUPPLY
PIV	POST INDICATOR VALVE
PKG	PACKAGE, PARKING
PL	PILOT LIGHT
PLUMB	PLUMBING
PNEU	PNEUMATIC
PNL	PANEL
PNTH	PENTHOUSE
PP	POLY PROPYLENE
PPM	PARTS PER MILLION
PR	PAIR, PRINTER
PRES	PRESSURE
PRI	PRIMARY
PROJ	PROJECT
PROP	PROPERTY
PRS	PRESSURE REDUCING STATION
PRV	PRESSURE REDUCING VALVE
PS	PRESSURE SWITCH
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAUGE
PT	PLUMBING TRIM
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVDF	POLYVINYLIDENE FLUORIDE
PVMT	PAVEMENT
PW	PROCESS WASTE
PWR	POWER
QTY	QUANTITY
R	RISER
(R)	RELOCATE
R&D	REMOVE & DISPOSE
RA	RETURN AIR
RAD	REFRIGERATED AIR DRYER
RAF	RETURN AIR FAN
RAG	RETURN AIR GRILLE
RCP	REFLECTED CEILING PLAN
RD	ROOF DRAIN
RE:	REFERENCE, REFER
REC	RECESSED
RECIRC	RECIRCULATE, RECIRCULATING
RECPT	RECEPTACLE
RED	REDUCER
REFR	REFRIGERATOR
REG	REGISTER
REINF	REINFORCED, REINFORCING
REQD	REQUIRED
REV	REVISION, REVISED
RH	RELATIVE HUMIDITY
RHG	REFRIGERANT HOT GAS
RIC	ROUGH-IN AND CONNECT
RIO	ROUGH-IN ONLY
RKVA	RUNNING KVA
RKW	RUNNING KW
RL	REFRIGERANT LIQUID
RLA	RUNNING LOAD AMPS
RM	REFRIGERATION MACHINE, ROOM
RND, φ	ROUND
RO	ROUGH OPENING, REVERSE OSMOSIS
ROW	RIGHT OF WAY
RPM	REVOLUTIONS PER MINUTE
RS	REFRIGERANT SUCTION
RTAH	ROOFTOP AIR HANDLING UNIT
RTU	ROOFTOP UNIT
RV	RELIEF VALVE
RVS	REVERSE
S	SOUTH, SUPPLY, SINK
SA	SUPPLY AIR, SHOP AIR, SOUND ATTENUATOR
SAD	SUPPLY AIR DIFFUSER
SAF	SUPPLY AIR FAN
SC	STEAM CONVERTER
SCHED	SCHEDULE(D)
SCHP	SECONDARY CHILLED WATER PUMP
SCR	SILICON CONTROLLED RECTIFIER
SCW	SOFTENED COLD WATER
SD	SMOKE DETECTOR
SE	SEWAGE EJECTOR
SEC	SECONDARY
SECT	SECTION
SENS	SENSIBLE
SERV	SERVICE
SF	SQUARE FEET
SH	SHOWER
SHR	SHOWER
SHT	SHEET
SHWP	SECONDARY HEATING WATER PUMP
SHWR	SECONDARY HEATING WATER RETURN
SHWS	SECONDARY HEATING WATER SUPPLY
SIM	SIMILAR
SK	SINK
SL	SLOPE
SKVA	STARTING KVA
SKW	STARTING KW
SP	STATIC PRESSURE, SUMP PUMP
SPEC	SPECIFICATION, SPECIFIED
SPF	STAIR PRESSURIZATION FAN
SPKLK	SPRINKLER
SQ	SQUARE
SQ IN	SQUARE INCHES
SRF	SMOKE REMOVAL FAN
SS	STOP-START PUSH-BUTTON, STAINLESS STEEL
SSSC	SOLID STATE SPEED CONTROL
SSD	SUBSURFACE DRAIN
SST	STAINLESS STEEL
ST	SOUND TRAP, STEAM TRAP, SURGE TANK
STA	STATION
STAP	SURGE TANK ALARM PANEL
STB	STEAM BOILER
STC	SOUND TRANSMISSION CLASS
STD	STANDARD
STL	STEEL
STM	STEAM
STOR	STORAGE
STR	STRAINER
STRUC	STRUCTURE, STRUCTURAL
SURF	SURFACE
SUSP	SUSPENDED
SV	SANITARY VENT
SW	SWITCH, SOFTENED WATER
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SWR	SIDE WALL REGISTER
SYM	SYMMETRICAL
SYS	SYSTEM
T&P	TEMPERATURE & PRESSURE
T STAT	THERMOSTAT/SENSOR
TC	TEMPERATURE CONTROL
TCC	TEMPERATURE CONTROL COMPRESSOR
TD	TRENCH DRAIN
TDH	TOTAL DYNAMIC HEAD
TF	TRANSFER FAN
TEMP	TEMPORARY
TH BLK	THRUST BLOCK
THK	THICK
TK	TANK
TOC	TOP OF CURB
TOF	TOP OF FOOTING
TOIL	TOILET
TOS	TOP OF SLAB
TOT	TOTAL
TP	TRAP PRIMER, TOTAL PRESSURE
TR	TRENCH
TRD	THREAD, THREADED
TS	TAMPER SWITCH
TU	TERMINAL UNIT
TW	TREATED WATER, TEMPERED WATER
TXV	THERMAL EXPANSION VALVE
TYP	TYPICAL
2S-1W	TWO-SPEED, ONE WINDING
2S-2W	TWO-SPEED, TWO WINDING
U/F	UNDERFLOOR
U/S	UNDERSLAB
UG	UNDERGROUND
UH	UNIT HEATER
UL	UNDERWRITER'S LABORATORIES, INC.
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SUPPLY
V	VOLT, VENT
V/D	VOICE/DATA
VA	VOLT-AMPERE, VARIABLE
VAC	VACUUM, VOLTS AC
VAV	VARIABLE AIR VOLUME
VB	VACUUM BREAKER
VD	VOLUME DAMPER
VEL	VELOCITY
VERT	VERTICAL
VEST	VESTIBULE
VFD	VARIABLE FREQUENCY DRIVE
VOL	VOLUME
VP	VACUUM PUMP
VR	VARIABLE AIR VOLUME REHEAT
VSZBT	VERTICAL SINGLE ZONE BLOW THRU
VSZDT	VERTICAL SINGLE ZONE DRAW THRU
W	WATT, WIDTH, WASTE, WEST, WIRE, WOMEN
W/	WITH
W/O	WITHOUT
WB	WET BULB
WC	WATER CLOSET
WCO	WALL CLEANOUT
WH	WATER HEATER, WALL HYDRANT
WM	WATER METER
WP	WEATHERPROOF
WPD	WATER PRESSURE DROP
WS	WATER SOFTENER
WT	WATERTIGHT, WEIGHT
WWF	WELDED WIRE FABRIC
XFMR	TRANSFORMER
XP	EXPLOSION PROOF
Z	ZONE
ZV	ZONE VALVE

ELECTRICAL SYMBOLS
(ALL SYMBOLS SHOWN ARE NOT NECESSARILY USED ON THE DRAWINGS)

ONE LINE/RISER DIAGRAMS

- TRANSFORMER, TYPE AND RATINGS AS NOTED
- 800A/3P — SWITCH, RATING AS SHOWN
- 400A — FUSE, RATING AS SHOWN
- 225A/3P — CIRCUIT BREAKER, RATINGS AS SHOWN, 3 POLE UNLESS NOTED OTHERWISE
- 2000A/3P — DRAWOUT CIRCUIT BREAKER, RATINGS AS SHOWN, 3 POLE UNLESS NOTED OTHERWISE
- ST — SHUNT TRIP
- GFR — GROUND FAULT RELAY
- K — KIRK-KEY INTERLOCK
- A 0-2000 — AMMETER, RANGE AS SHOWN
- AS — AMMETER SWITCH
- V 0-600 — VOLTMETER, RANGE AS SHOWN
- VS — VOLTMETER SWITCH
- M — FULL FUNCTION METER
- 1200/5 — CURRENT TRANSFORMER, RATED AS SHOWN
- 12.47KV/120V — POTENTIAL TRANSFORMER, RATING AS SHOWN
- GROUND CONNECTION
- LIGHTNING ARRESTOR
- G — GENERATOR SET
- AUTOMATIC TRANSFER SWITCH
- HOA OR SS AS NOTED

FIRE ALARM

- FACP FACP — FIRE ALARM CONTROL PANEL (FLUSH/SURFACE)
- FAAP FAAP — FIRE ALARM REMOTE ANNUNCIATOR (FLUSH/SURFACE)
- AV — FIRE ALARM AUDIO VISUAL SIGNAL, WALL MOUNTED
- V — FIRE ALARM VISUAL SIGNAL, WALL MOUNTED
- A — FIRE ALARM AUDIO SIGNAL, WALL MOUNTED
- A — FIRE ALARM CEILING SPEAKER
- H — HEAT DETECTOR
- S — AREA SMOKE DETECTOR
- S L — AREA SMOKE DETECTOR WITH LOCAL ALARM
- D RA — DUCT SMOKE DETECTOR. "RA" DENOTES RETURN AIR, "SA" DENOTES SUPPLE AIR
- RI — SMOKE DETECTOR REMOTE INDICATOR STATION
- J — FIREFIGHTER'S COMMUNICATION JACK
- H — STAIRWAY EMERGENCY TELEPHONE
- ES — ELEVATOR LOBBY EMERGENCY SIGN
- F — FIRE ALARM MANUAL PULL STATION
- FJ — FIRE ALARM MANUAL PULL STATION WITH FIREMAN'S JACK
- WF — SPRINKLER WATER FLOW SWITCH
- VS — VALVE SUPERVISORY SWITCH
- DH — MAGNETIC DOOR HOLDER
- ELECTRIC DOOR LOCK
- R — FIRE ALARM RELAY
- HCP — HALON CONTROL PANEL

COMMUNICATIONS

- NEW VOICE WALL OUTLET. "W" DENOTES WALL PHONE HEIGHT, "P" DENOTES PAY PHONE, DOT INDICATES ABOVE COUNTER
- E — EXISTING VOICE WALL OUTLET TO REMAIN
- R — EXISTING VOICE WALL OUTLET TO BE REMOVED
- NEW DATA WALL OUTLET
- R — RELOCATED EXISTING DATA WALL OUTLET
- EXISTING DATA WALL OUTLET TO REMAIN
- R — EXISTING DATA WALL OUTLET TO BE REMOVED AND REUSED AS APPLICABLE
- COMBINATION VOICE/DATA WALL OUTLET
- ICM — INTERCOM MASTER STATION
- ICS — INTERCOM STAFF STATION
- ICP — INTERCOM EQUIPMENT PANEL
- S — CEILING MOUNTED SPEAKER
- S — PAGING HORN
- M — PAGING SYSTEM MICROPHONE
- PATC — PAGING SYSTEM TERMINAL CABINET

LIGHTING/SWITCHES

- A B — NEW INCANDESCENT OR HID LIGHTING FIXTURE, LETTER DENOTES TYPE, H PREFIX DENOTES HID
- RELOCATED EXISTING INCANDESCENT OR HID LIGHTING FIXTURE, LETTER DENOTES TYPE WHERE APPLICABLE
- EXISTING INCANDESCENT OR HID LIGHTING FIXTURE TO REMAIN
- EXISTING INCANDESCENT OR HID LIGHTING FIXTURE TO BE REMOVED AND REUSED AS APPLICABLE
- X — NEW EXIT SIGN, ARROWS AS INDICATED, LETTER DENOTES TYPE
- R — RELOCATED EXISTING EXIT SIGN, ARROWS AS INDICATED
- EXISTING EXIT SIGN TO REMAIN, ARROWS AS INDICATED
- R — EXISTING EXIT SIGN TO BR REMOVED AND REUSED AS APPLICABLE
- FB — NEW FLUORESCENT LIGHTING FIXTURE, LETTER DENOTES TYPE, F PREFIX DENOTES FLUORESCENT
- R FB — RELOCATED EXISTING FLUORESCENT LIGHT FIXTURE, LETTER DENOTES TYPE WHERE APPLICABLE
- FB — EXISTING FLUORESCENT LIGHT FIXTURE TO REMAIN
- R FB — EXISTING FLUORESCENT LIGHT FIXTURE TO BE REMOVED AND REUSED AS APPLICABLE
- LIGHT FIXTURE ON EMERGENCY CIRCUIT
- $ — NEW SWITCH, SPST, 20A, 120/277V
- $R — RELOCATED EXISTING SWITCH
- $ — EXISTING SWITCH TO REMAIN
- $R — EXISTING SWITCH TO BE REMOVED AND REUSED AS APPLICABLE
- $3 — SWITCH, 20A, 120/277V, "2" DENOTES DPST, "3" DENOTES THREE-WAY, "4" DENOTES FOUR-WAY
- $L — SWITCH, SPDT, CENTER OFF, MOMENTARY CONTACT, "L" DENOTES TOGGLE, "LR" DENOTES ROCKER
- $K — SWITCH, SPST, 20A, 120/277V, "K" DENOTES KEY SWITCH, "P" DENOTES PILOT LIGHT, "T" DENOTES SPRING WOUND TIMER, "M" DENOTES MOTION DETECTOR
- DIMMER CONTROL SWITCH, 1000 WATT UNLESS OTHERWISE NOTED

RECEPTACLES/OUTLETS

- SIMPLEX WALL RECEPTACLE, NEMA 5-20R, 20A, 125V
- NEW DUPLEX WALL RECEPTACLE, NEMA 5-15R, 15A, 125V OR NEMA 5-20R, 20A, 125V, RE: SPECIFICATIONS, DOT INDICATES ABOVE COUNTER
- R — RELOCATED EXISTING DUPLEX RECEPTACLE
- EXISTING DUPLEX RECEPTACLE TO REMAIN
- R — EXISTING DUPLEX RECEPTACLE TO BE REMOVED AND REUSED AS APPLICABLE
- DUPLEX WALL RECEPTACLE ON EMERGENCY CIRCUIT, RED COLOR
- DUPLEX WALL RECEPTACLE ON A CIRCUIT DEDICATED TO DATA PROCESSING, GRAY COLOR, PROVIDE ISOLATED GROUND TYPE RECEPTACLES WHERE NOTED WITH IG.
- WP — DUPLEX WALL RECEPTACLE, "WP" DENOTES WEATHERPROOF, "TP" DENOTES SAFETY TYPE.
- FOURPLEX WALL RECEPTACLE, NEMA 5-15R, 15A, 125V OR NEMA 5-20R, 20A, 125V, RE: SPECIFICATIONS.
- C — CLOCK OUTLET, NEMA 15-20R SIMPLEX, RE: SPECS
- SPECIAL RECEPTACLE, NEMA CONFIGURATION AS NOTED
- PA — FLOOR OUTLET, "P" DENOTES POKE-THRU, "F" DENOTES FLUSH, "A" DENOTES TYPE WHERE APPLICABLE.
- MULTI-OUTLET SURFACE RACEWAY
- J — JUNCTION BOX
- DIRECT CONNECTION TO EQUIPMENT
- P — PULL BOX (OVER 4" SQUARE)
- L — TENANT LIGHTING JUNCTION BOX
- P — TENANT POWER JUNCTION BOX

ELECTRICAL EQUIPMENT/CIRCUITING

- DISTRIBUTION PANEL
- SWITCHBOARD OR MOTOR CONTROL CENTER
- NEW PANELBOARD (FLUSH/SURFACE MOUNT)
- EXISTING PANELBOARD
- DRY-TYPE TRANSFORMER
- ATS — AUTOMATIC TRANSFER SWITCH
- PLYWOOD TERMINAL BOARD, TYPE AS NOTED, 4' X 8' X 3/4", UNLESS NOTED OTHERWISE
- TERMINAL CABINET (FLUSH/SURFACE MOUNT), TYPE AS NOTED, 24"x48"x3 1/2", UNLESS NOTED OTHERWISE.
- BAT — BATTERY/INVERTER UNIT
- CIRCUIT CONCEALED IN WALL OR CEILING
- CONDUIT CAST IN CONCRETE OR BELOW SLAB
- EXPOSED CONDUIT
- CONDUIT TURNED UP
- CONDUIT TURNED DOWN
- HASH MARKS INDICATE NUMBER OF CONDUCTORS PHASE/NEUTRAL/SWITCH LEG/GROUND LEFT TO RIGHT. NO HASH MARKS INDICATES 2#12, UNLESS OTHERWISE NOTED.
- ILA-2, 4 — HOMERUN TO PANEL WITH CIRCUIT NUMBER(S) AS INDICATED.
- ILA-6 — PARTIAL CIRCUIT HOMERUN TO PANEL
- T — COMMUNICATIONS CONDUIT OR CABLE. "V" DENOTES VOICE, "D" DENOTES DATA, "I" DENOTES INTERCOM, "PA" DENOTES PAGING, "S" DENOTES SECURITY, "FA" DENOTES FIRE ALARM
- SINGLE OR THREE PHASE MOTOR
- ELECTRIC DUCT HEATER
- DISCONNECT (SAFETY) SWITCH "200/3/150" DENOTES AMPERES/POLE/FUSE, "NF" DENOTES NON-FUSED
- ENCLOSED CIRCUIT BREAKER
- MOTOR STARTER
- MOTOR STARTER FURNISHED WITH EQUIPMENT
- COMBINATION DISCONNECT (SAFETY) SWITCH AND MOTOR STARTER, "30/3/15/#0" DENOTES AMPERES/POLES/FUSE/STARTER SIZE, "NF" DENOTES NON-FUSED.
- COMBINATION DISCONNECT (SAFETY) SWITCH AND MOTOR STARTER FURNISHED WITH EQUIPMENT
- MS — MANUAL MOTOR STARTING WITH THERMAL OVERLOAD
- T — MOTOR-RATED TOGGLE SWITCH
- C — LIGHTING CONTACTOR
- TS — TIME SWITCH
- PC — PHOTOCELL
- PUSH BUTTON
- DC — DOOR CONTACT SWITCH

PANEL DESIGNATIONS

2HEA-3
- "2" DENOTES FLOOR WHERE PANEL IS LOCATED
- "H" DENOTES VOLTAGE - "H" = 480Y/277V, "L" = 208Y/120V
- "E" DENOTES SYSTEM TYPE - BLANK = NORMAL POWER, E=EMERGENCY POWER, U = UPS POWER
- "A" DENOTES PANEL SEQUENCE

GENERAL NOTES

A. ALL ELECTRICAL WORK SHALL COMPLY WITH APPLICABLE STATE & LOCAL BUILDING CODES & REQUIREMENTS.

B. REFER TO THE SPECS FOR MATERIALS & METHODS FOR ELECTRICAL CONSTRUCTION.

C. REFER TO THE SPECS FOR SUBMITTAL REQUIREMENTS.

D. THE ELECTRICAL CONTRACTOR SHALL VISIT THE SITE & FAMILIARIZE THEMSELF WITH EXISTING CONDITIONS WHICH WILL IMPACT CONSTRUCTION OF THIS PROJECT, PRIOR TO SUBMITTING BIDS.

E. ALL INTERRUPTIONS TO UTILITY SERVICES & ALL WORK IN OCCUPIED SPACES SHALL BE SCHEDULED WITH THE BUILDING MANAGER AT LEAST 3 WEEKS IN ADVANCE & SHALL BE PERFORMED AT TIMES WHICH ARE ACCEPTABLE TO THE BUILDING MANAGER.

F. RE: ARCHITECTURAL REFLECTED CEILING PLANS FOR THE EXACT LOCATION OF ALL CEILING MOUNTED DEVICES.

G. RE: ARCHITECTURAL INTERIOR ELEVATIONS, IF PROVIDED FOR LOCATIONS OF WALL MOUNTED DEVICES.

H. FURNISH ACCESS DOORS FOR INSTALLATION BY THE GENERAL CONTRACTOR WHERE ACCESS IS REQUIRED TO CONCEALED ELECTRICAL EQUIPMENT.

I. ALL REQUIRED HVAC CONTROL WIRING & EQUIPMENT SHALL BE PROVIDED BY THE MECHANICAL CONTRACTOR.

J. ALL WIRING SHALL BE MINIMUM 2#12, #12G, 3/4"C, UNLESS NOTED OR SHOWN ON THE DRAWINGS OTHERWISE. REFER TO SPECIFICATIONS FOR REQUIREMENTS TO INCREASE WIRE SIZE FOR DISTANCES OVER 50 FEET FOR 120 VOLT AND 100 FEET FOR 277 VOLT. UNDER NO CIRCUMSTANCES SHALL THE VOLTAGE DROP BE WORSE THAN 3% FOR ANY BRANCH CIRCUIT AND 2% FOR ANY FEEDER.

GENERAL NOTES

K. COORDINATE ALL SLAB PENETRATIONS WITH THE EXISTING STRUCTURE AND OBTAIN WRITTEN APPROVAL FROM THE OWNER PRIOR TO CORE DRILLING. ALL RATED PARTITION PENETRATIONS SHALL BE SEALED WITH A UL-LISTED FIRE SAFING SYSTEM, IN ACCORDANCE WITH APPLICABLE STATE AND LOCAL REQUIREMENTS.

L. ALL FACEPLATES ON BRICK SHALL BE STAINLESS STEEL.

M. CONTRACTOR SHALL SUBMIT RECORD DRAWINGS AND O&M MANUALS AS REQUIRED IN ASHRAE 90.1-2010 . SECTION 8.7. THIS REQUIREMENT SHALL BE IN ADDITION TO RECORD DRAWINGS AS REQUIRED IN THE SPECIFICATIONS.

N. MULTI-OUTLET RACEWAY SHALL INCLUDE FACTORY ENTRANCE FITTINGS, COUPLINGS, ELBOWS , END CAPS, BRACKETS, COVERS AND BASE AS REQUIRED TO BE INSTALLED AS A COMPLETE SYSTEM.

O. THE MINIMUM CONDUIT SIZE ALLOWED IS 3/4", EXCEPT 3/8" PRE-MANUFACTURED FIXTURE WHIPS WITH A GROUND WIRE MAYBE USED FOR CONNECTION TO LIGHT FIXTURES.

P. ALL PANEL DIRECTORIES SHALL BE TYPED. LIST UNUSED BREAKERS AS SPARE. LIST AVAILABLE SPACES AS SPACE.

Q. CIRCUITS FROM DIFFERENT SOURCES SHALL NOT OCCUPY THE SAME RACEWAY, 120/208V AND 277/480 VOLT CIRCUITS SHALL NOT OCCUPY THE SAME RACEWAY. NORMAL AND EMERGENCY POWER SHALL NOT OCCUPY THE SAME RACEWAY.

R. CONTROL CIRCUITS OPERATING AT 50 VOLTS OR LESS SHALL NOT OCCUPY THE SAME CONDUIT AS CIRCUITS OPERATING AT GREATER THAN 50 VOLTS.

S. ALL ELECTRICAL EQUIPMENT SHALL BE LISTED AND LABELED FOR INSTALLATION PER RECOGNIZED ELECTRICAL TESTING LABORATORIES.

T. PROVIDE SEPERATE NETURALS FOR ALL BRANCH CIRCUITS. SHARED NEUTRALS ARE NOT ALLOWED.

U. PROVIDE SHEET METAL SLEEVES AT ALL PENETRATIONS WITH SURFACE MOUNTED FLANGES. FOR PENETRATIONS THAT ARE TOO SMALL FOR PROPER FIRE SAFING PER UL LISTING, CONTRACTOR TO INDICATE THOSE ARE TO BE IDENTIFIED AND BROUGHT TO THE ATTENTION OF UTHSCH FOR RESOLUTION DURING CONSTRUCTION.

V. RE: ARCHITECTURAL ELEVATIONS FOR TYPICAL MOUNTING HEIGHTS. RE: ARCHITECTURAL ELEVATIONS FOR ADDITIONAL MOUNTING HEIGHT INFORMATION IN SPECIFIC LOCATIONS.

W. CONTRACTOR SHALL SUBMIT RECORD DRAWINGS AND O&M MANUALS AS REQUIRED IN ASHRAE 90.1-2010 SECTION 8.7 & 9.7. THIS REQUIREMENT SHALL BE IN ADDITION TO RECORD DRAWINGS AS REQUIRED IN THE SPECIFICATIONS.

X. RE: SECTION 26 05 19 FOR VOLTAGE DROP REQUIREMENTS AND GUIDELINES. UNDER NO CIRCUMSTANCES SHALL THE VOLTAGE DROP REQUIREMENTS OF SECTION 8.4, ASHRAE 90.1-2010 BE EXCEEDED.

Y. SECURE AND PROTECT EXISTING ELECTRICAL AND CONTROLS SERVING OTHER EQUIPMENT DURING DEMO AND REINSTALL CONDUIT AND WIRE AFTER NEW UNIT IS INSTALLED.

Z. INTENT IS NOT TO REMOVE OR RELOCATE CONDUIT, SPRINKLER PIPE, ETC. CONTRACTOR MUST COORDINATE TEMPORARY RELOCATION OR REMOVAL OF SYSTEMS TO PERFORM CONSTRUCTION. CONTRACTOR SHALL RETURN ANY ITEMS RELOCATED AFTER CONSTRUCTION UNLESS INSTRUCTED BY OWNER.

LIGHTING FIXTURE CIRCUITING NOTES:

A. THE LIGHTING PLANS INDICATE SWITCHING AND BRANCH CIRCUIT NUMBERS FOR ALL LIGHTING FIXTURES. LOWER CASE LETTERS AT SWITCHES AND LIGHT FIXTURES INDICATE SWITCHING WHERE THE CONTROL PATTERN IS NOT OBVIOUS. INSTALL BRANCH CIRCUIT WIRING IN A RACEWAY TO ALL RIGIDLY ATTACHED LIGHT FIXTURES AND TO JUNCTION BOXES FOR ALL LAY-IN LIGHT FIXTURES, AS REQUIRED TO PROVIDE SWITCHING AND CIRCUITING AS SHOWN ON THE DRAWINGS. RE: SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.

B. BRANCH CIRCUIT HOMERUNS SHALL BE LIMITED TO THREE PHASE CONDUCTORS (ON DIFFERENT PHASES), ONE NEUTRAL CONDUCTOR PER PHASE AND ONE GROUND CONDUCTOR (WHERE SHOWN OR SPECIFIED), AND SHALL BE INSTALLED IN CONDUIT.

C. ALL LAY-IN LIGHTING FIXTURES SHALL BE CONNECTED TO A BRANCH CIRCUIT JUNCTION BOX WITH A FLEXIBLE FIXTURE TAIL, RE: SPECIFICATIONS. A MAXIMUM OF FOUR FIXTURE TAILS SHALL BE CONNECTED TO A SINGLE JUNCTION BOX. FIXTURE TO FIXTURE WIRING OF LAY-IN LIGHTING FIXTURES IS NOT PERMITTED.

POWER PLAN CIRCUITING NOTES:

A. THE POWER PLANS INDICATE BRANCH CIRCUIT NUMBERS FOR ALL RECEPTACLES. WHERE BRANCH CIRCUIT WIRING IS NOT SHOWN, INSTALL BRANCH CIRCUIT WIRING IN A RACEWAY, AS REQUIRED TO PROVIDE CIRCUITING AS SHOWN ON THE DRAWINGS. RE: SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.

DRAWING LIST

E000 ELECTRICAL SYMBOLS & ABBREVIATIONS

E108S ELECTRICAL PH SOUTH DEMOLITION DRAWING
E108N ELECTRICAL PH NORTH DEMOLITION DRAWING

E208S ELECTRICAL PH SOUTH RENOVATION DRAWING
E208N ELECTRICAL PH NORTH RENOVATION DRAWING

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STATE OF TEXAS — HEATHER CAMDEN — 86883 — LICENSED PROFESSIONAL ENGINEER

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E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

Date 04/13/2018
Drawn By
Checked By

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
ELECTRICAL SYMBOLS AND ABBREVIATIONS

DRAWING NO.
E000

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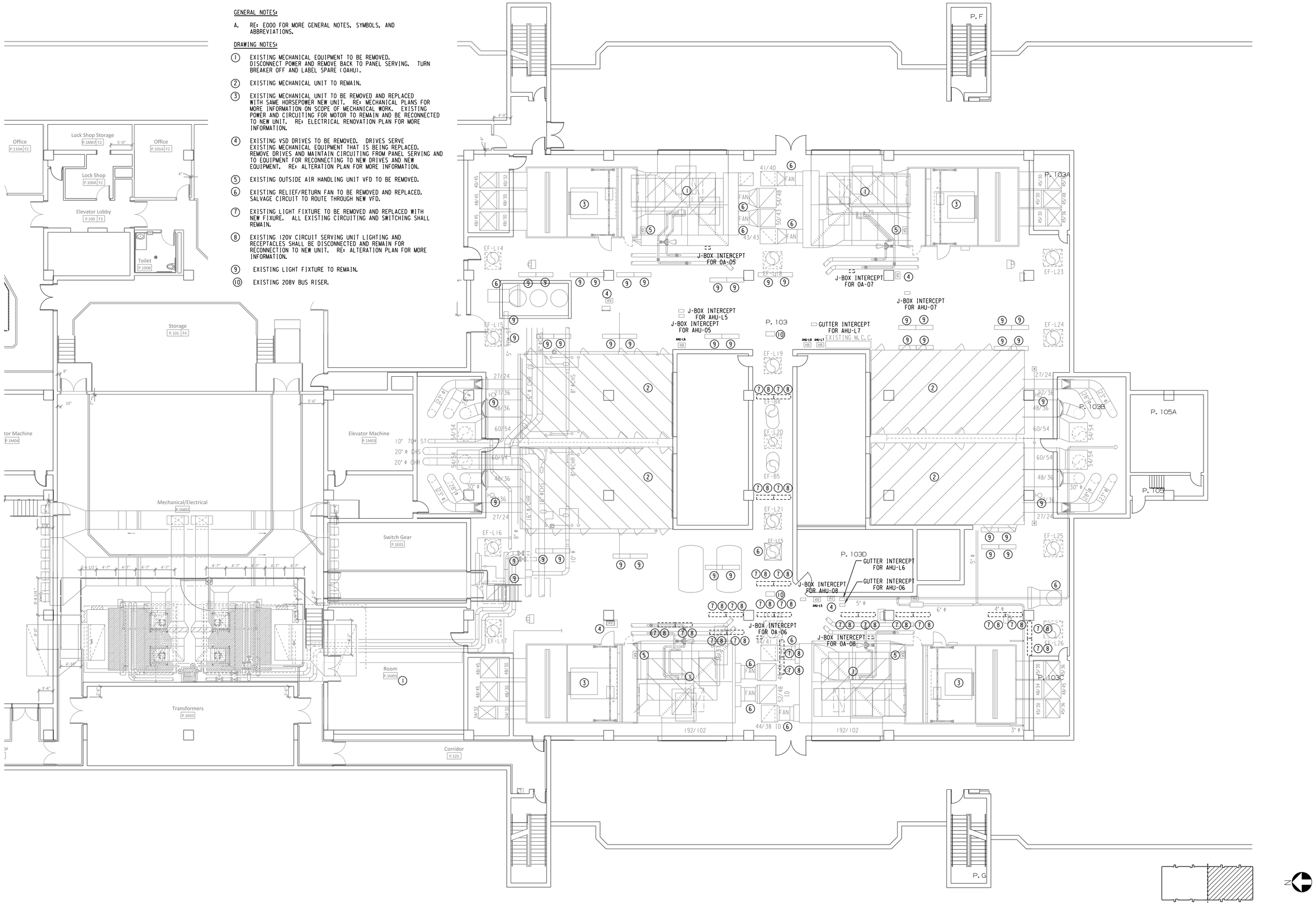
GENERAL NOTES:

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

DRAWING NOTES:

1. EXISTING MECHANICAL EQUIPMENT TO BE REMOVED. DISCONNECT POWER AND REMOVE BACK TO PANEL SERVING. TURN BREAKER OFF AND LABEL SPARE (OAHU).
2. EXISTING MECHANICAL UNIT TO REMAIN.
3. EXISTING MECHANICAL UNIT TO BE REMOVED AND REPLACED WITH SAME HORSEPOWER NEW UNIT. RE: MECHANICAL PLANS FOR MORE INFORMATION ON SCOPE OF MECHANICAL WORK. EXISTING POWER AND CIRCUITING FOR MOTOR TO REMAIN AND BE RECONNECTED TO NEW UNIT. RE: ELECTRICAL RENOVATION PLAN FOR MORE INFORMATION.
4. EXISTING VSD DRIVES TO BE REMOVED. DRIVES SERVE EXISTING MECHANICAL EQUIPMENT THAT IS BEING REPLACED. REMOVE DRIVES AND MAINTAIN CIRCUITING FROM PANEL SERVING AND TO EQUIPMENT FOR RECONNECTING TO NEW DRIVES AND NEW EQUIPMENT. RE: ALTERATION PLAN FOR MORE INFORMATION.
5. EXISTING OUTSIDE AIR HANDLING UNIT VFD TO BE REMOVED.
6. EXISTING RELIEF/RETURN FAN TO BE REMOVED AND REPLACED. SALVAGE CIRCUIT TO ROUTE THROUGH NEW VFD.
7. EXISTING LIGHT FIXTURE TO BE REMOVED AND REPLACED WITH NEW FIXURE. ALL EXISTING CIRCUITING AND SWITCHING SHALL REMAIN.
8. EXISTING 120V CIRCUIT SERVING UNIT LIGHTING AND RECEPTACLES SHALL BE DISCONNECTED AND REMAIN FOR RECONNECTION TO NEW UNIT. RE: ALTERATION PLAN FOR MORE INFORMATION.
9. EXISTING LIGHT FIXTURE TO REMAIN.
10. EXISTING 208V BUS RISER.



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E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
ELECTRICAL PH SOUTH DEMO DRAWING

DRAWING NO.
E108S

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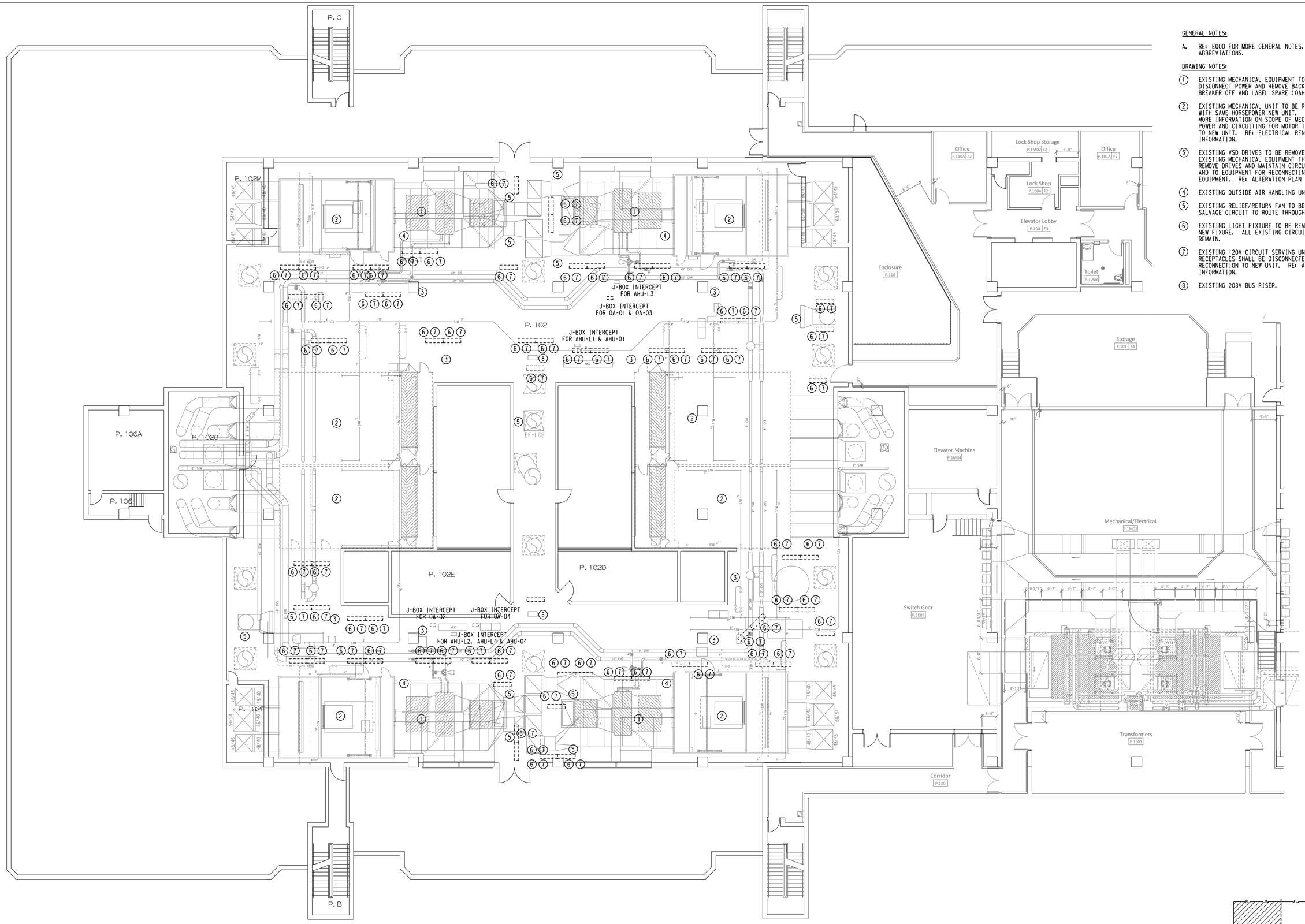

GENERAL NOTES:

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

DRAWING NOTES:

1. EXISTING MECHANICAL EQUIPMENT TO BE REMOVED. DISCONNECT POWER AND REMOVE BACK TO PANEL SERVING. TURN BREAKER OFF AND LABEL SPARE (OAHU).
2. EXISTING MECHANICAL UNIT TO BE REMOVED AND REPLACED WITH SAME HORSEPOWER NEW UNIT. RE: MECHANICAL PLANS FOR MORE INFORMATION ON SCOPE OF MECHANICAL WORK. EXISTING POWER AND CIRCUITING FOR MOTOR TO REMAIN AND BE RECONNECTED TO NEW UNIT. RE: ELECTRICAL RENOVATION PLAN FOR MORE INFORMATION.
3. EXISTING VSD DRIVES TO BE REMOVED. DRIVES SERVE EXISTING MECHANICAL EQUIPMENT THAT IS BEING REPLACED. REMOVE DRIVES AND MAINTAIN CIRCUITING FROM PANEL SERVING AND TO EQUIPMENT FOR RECONNECTING TO NEW DRIVES AND NEW EQUIPMENT. RE: ALTERATION PLAN FOR MORE INFORMATION.
4. EXISTING OUTSIDE AIR HANDLING UNIT VFD TO BE REMOVED.
5. EXISTING RELIEF/RETURN FAN TO BE REMOVED AND REPLACED. SALVAGE CIRCUIT TO ROUTE THROUGH NEW VFD.
6. EXISTING LIGHT FIXTURE TO BE REMOVED AND REPLACED WITH NEW FIXURE. ALL EXISTING CIRCUITING AND SWITCHING SHALL REMAIN.
7. EXISTING 120V CIRCUIT SERVING UNIT LIGHTING AND RECEPTACLES SHALL BE DISCONNECTED AND REMAIN FOR RECONNECTION TO NEW UNIT. RE: ALTERATION PLAN FOR MORE INFORMATION.
8. EXISTING 208V BUS RISER.

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File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING PENTHOUSE AHU REPLACEMENT

DRAWING TITLE
ELECTRICAL PH NORTH DEMO DRAWING

DRAWING NO.
E108N

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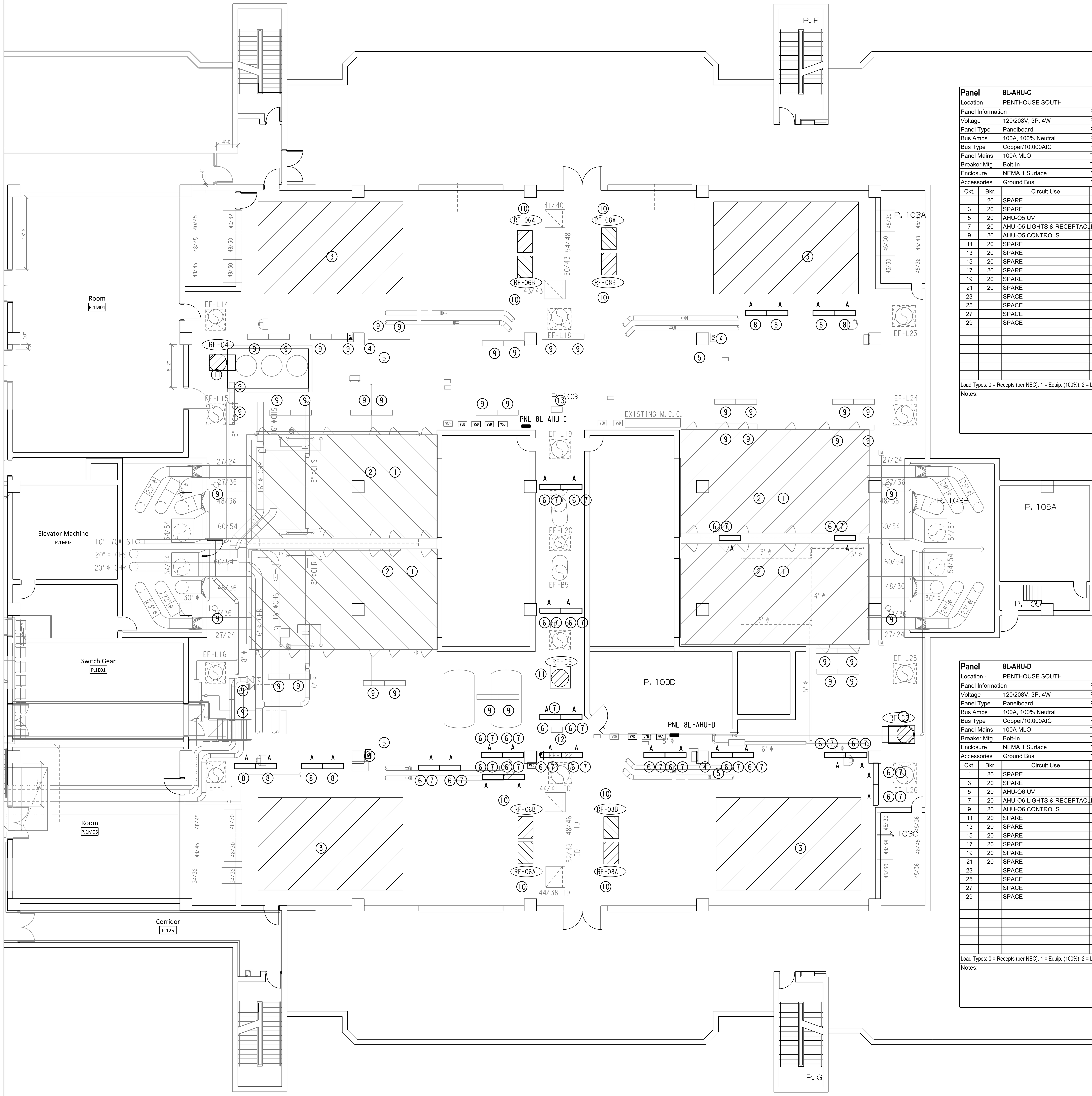


Panel	8L-AHU-C		Project - PENTHOUSE AHU REPLACEMENT			
Location -	PENTHOUSE SOUTH		E&C No.3302.00C			
Panel Information		Panel Loads	Phase A	Phase B	Phase C	Total
Voltage	120/208V, 3P, 4W	Panel Lighting VA	0	0	3840	3840
Panel Type	Panelboard	Panel Receptacle VA	2000	0	0	2000
Bus Amps	100A, 100% Neutral	Panel Equipment VA	0	1000	0	1000
Bus Type	Copper/10,000AIC	FTL VA	0	0	0	0
Panel Mains	100A MLO	Total Connected VA	2000	1000	3840	6840
Breaker Mtg	Bolt-In	Total Connected Amps	17	8	32	19
Enclosure	NEMA 1 Surface	NEC VA	2000	1000	4800	7800
Accessories	Ground Bus	NEC Amps	17	8	40	22

Ckt.	Bkr.	Circuit Use	Load	Type	Ph.	Ckt.	Bkr.	Circuit Use	Load	Type
1	20	SPARE			A	2	20	SPARE		
3	20	SPARE			B	4	20	SPARE		
5	20	AHU-O5 UV	1920	2	C	6	20	AHU-O7 UV	1920	2
7	20	AHU-O5 LIGHTS & RECEPTACLES	1000	0	A	8	20	AHU-O7 LIGHTS & RECEPTACLES	1000	0
9	20	AHU-O5 CONTROLS	500	1	B	10	20	AHU-O7 CONTROLS	500	1
11	20	SPARE			C	12	20	SPARE		
13	20	SPARE			A	14	20	SPARE		
15	20	SPARE			B	16	20	SPARE		
17	20	SPARE			C	18	20	SPARE		
19	20	SPARE			A	20	20	SPARE		
21	20	SPARE			B	22	20	SPARE		
23		SPACE			C	24		SPACE		
25		SPACE			A	26		SPACE		
27		SPACE			B	28		SPACE		
29		SPACE			C	30		SPACE		
					A					
					B					
					C					
					A					
					B					
					C					

Load Types: 0 = Recepts (per NEC), 1 = Equip. (100%), 2 = Lighting (125%), 3 = A/C (100%), 4 = Heating (100%), 5 = Lgst. Motor (125%), 6 = Kitchen Equip. (per NEC)

Notes:

Panel	8L-AHU-D		Project - PENTHOUSE AHU REPLACEMENT			
Location -	PENTHOUSE SOUTH		E&C No.3302.00C			
Panel Information		Panel Loads	Phase A	Phase B	Phase C	Total
Voltage	120/208V, 3P, 4W	Panel Lighting VA	0	0	3840	3840
Panel Type	Panelboard	Panel Receptacle VA	2000	0	0	2000
Bus Amps	100A, 100% Neutral	Panel Equipment VA	0	1000	0	1000
Bus Type	Copper/10,000AIC	FTL VA	0	0	0	0
Panel Mains	100A MLO	Total Connected VA	2000	1000	3840	6840
Breaker Mtg	Bolt-In	Total Connected Amps	17	8	32	19
Enclosure	NEMA 1 Surface	NEC VA	2000	1000	4800	7800
Accessories	Ground Bus	NEC Amps	17	8	40	22

Ckt.	Bkr.	Circuit Use	Load	Type	Ph.	Ckt.	Bkr.	Circuit Use	Load	Type
1	20	SPARE			A	2	20	SPARE		
3	20	SPARE			B	4	20	SPARE		
5	20	AHU-O6 UV	1920	2	C	6	20	AHU-O8 UV	1920	2
7	20	AHU-O6 LIGHTS & RECEPTACLES	1000	0	A	8	20	AHU-O8 LIGHTS & RECEPTACLES	1000	0
9	20	AHU-O6 CONTROLS	500	1	B	10	20	AHU-O8 CONTROLS	500	1
11	20	SPARE			C	12	20	SPARE		
13	20	SPARE			A	14	20	SPARE		
15	20	SPARE			B	16	20	SPARE		
17	20	SPARE			C	18	20	SPARE		
19	20	SPARE			A	20	20	SPARE		
21	20	SPARE			B	22	20	SPARE		
23		SPACE			C	24		SPACE		
25		SPACE			A	26		SPACE		
27		SPACE			B	28		SPACE		
29		SPACE			C	30		SPACE		
					A					
					B					
					C					
					A					
					B					
					C					

Load Types: 0 = Recepts (per NEC), 1 = Equip. (100%), 2 = Lighting (125%), 3 = A/C (100%), 4 = Heating (100%), 5 = Lgst. Motor (125%), 6 = Kitchen Equip. (per NEC)

Notes:

GENERAL NOTES:

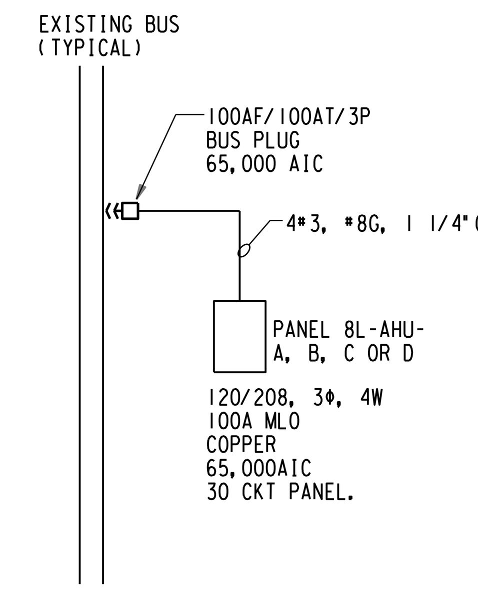
A. RE: E000 FOR MORE GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS.

B. TYPE A: LENSED LED STRIP LIGHT, 4 FEET LONG, 3500K, MEDIUM LUMEN OUTPUT, FIXED OUTPUT DRIVER, UNIVERSAL VOLTAGE BALLAST, CHAIN HANGER ACCESSORY. COLUMBIA LIGHTING # LCL4-35ML-EU-CSHC OR EQUAL BY COOPER, LITHONIA, OR OTHERS.

C. TYPE B: JUNCTION BOX MOUNTED LED FIXTURE, MOUNTED TO COLUMN, FROSTED GLASS GLOBE, ALUMINUM HOUSING, 5000 K, HUBBELL INDUSTRIAL # VL15P1G-VBLU15 OR EQUAL BY COOPER, LITHONIA, OR OTHERS.

DRAWING NOTES:

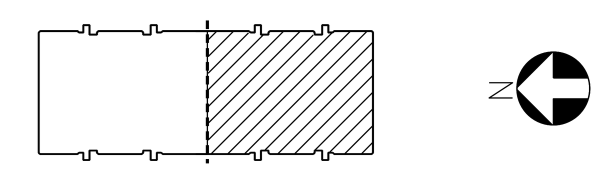
1. NO WORK AT THIS UNIT.
2. EXISTING MECHANICAL UNIT TO REMAIN.
3. NEW MECHANICAL UNIT OF SAME HORSEPOWER AS EXISTING UNIT TO BE RECONNECTED. RE: MECHANICAL PLANS FOR MORE INFORMATION ON SCOPE OF MECHANICAL WORK. EXISTING POWER AND CIRCUITING FOR MOTOR TO REMAIN AND BE RECONNECTED TO NEW UNIT. EXTEND EXISTING CIRCUITING AS REQUIRED. PROVIDE NEW WIRE WITH GROUND FROM THE VFD TO THE FAN. ELECTRICAL SWITCHGEAR PROJECT WILL BRING THE NEW GROUND TO THE VFD. RECONNECT TO EXISTING FIRE ALARM AND NEW SMOKE DETECTOR. NEW FIRE ALARM SHALL BRING NEW CONDUIT FROM THE MAIN TO THE UNITS. NEW FA COVERPLATES TO BE RED.
4. NEW VSD DRIVES FOR NEW EQUIPMENT. NEW DRIVES SERVE NEW MECHANICAL EQUIPMENT. RECONNECT CIRCUITING FROM PANEL SERVING DISCONNECTED EQUIPMENT TO NEW EQUIPMENT AS REQUIRED.
5. EXISTING HOMERUN TO REMAIN. CAPTURE HOMERUN AND CIRCUIT TO NEW VSD AND MECHANICAL EQUIPMENT AS REQUIRED IN NOTES 3 AND 4.
6. EXISTING 120V CIRCUIT SERVING UNIT LIGHTING AND RECEPTACLES SHALL BE RECONNECT TO NEW UNIT. NO MORE THAN 1440 WATTS ON A CIRCUIT.
7. NEW LIGHT FIXTURE TO REPLACE EXISTING FIXTURE. ALL EXISTING CIRCUITING AND SWITCHING SHALL REMAIN. RE: GENERAL NOTES FOR TYPE.
8. NEW LIGHT FIXTURE. EXTEND EXISTING CIRCUITING AND SWITCHING TO SERVE NEW FIXTURE. CHAIN HANG FIXTURE AT SAME ELEVATION AS EXISTING FIXTURES. NO MORE THAN 3000 WATTS ON A CIRCUIT. RE: GENERAL NOTES FOR TYPE.
9. EXISTING LIGHT FIXTURE TO REMAIN.
10. RECONNECT NEW RELIEF/RETURN FAN TO EXISTING CIRCUIT THROUGH NEW VFD. PROVIDE NEW WIRE WITH GROUND FROM THE VFD TO THE FAN. ELECTRICAL SWITCHGEAR PROJECT WILL BRING THE NEW GROUND TO THE VFD.
11. RECONNECT NEW CHASE EXHUAST FAN TO EXISTING CIRCUIT. PROVIDE NEW WIRE WITH GROUND.
12. TAP EXISTING 208V BUS RISER TO SERVE NEW 8L-AHU-D REFER TO TYPICAL DETAIL FOR MORE INFORMATION.
13. TAP EXISTING 208V BUS RISER TO SERVE NEW 8L-AHU-C REFER TO TYPICAL DETAIL FOR MORE INFORMATION.



TAP EXISTING BUS RISER WITH NEW BUS PLUG. VERIFY COMPATIBILITY OF BUS PLUG TO EXISITNG BUS SERVE NEW PANEL AS NOTED FOR LIGHTS, RECEPTACLES AND CONTROLS FOR THE AHUS. AMMEND THE RECENT SHORT CIRCUIT, ARC-FLASH AND COORDINATION STUDIES DONE UNDER THE ELECTRICAL GEAR RELOCATION PROJECT. CONTACT UTHSC-H PM FOR COPIES OF EXISITNG STUDIES.

1 TYPICAL BUS TAP DETAIL

SCALE: NTS



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UTHealth The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING TITLE
ELECTRICAL PH
SOUTH RENOVAITON
DRAWING

DRAWING NO.
E208S

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Panel	8L-AHU-A				Project - PENTHOUSE AHU REPLACEMENT					
Location -	PENTHOUSE NORTH				E&C No.3302.00C					
Panel Information		Panel Loads			Phase A	Phase B	Phase C	Total		
Voltage	120/208V, 3P, 4W	Panel Lighting VA			3840	7680	0	11520		
Panel Type	Panelboard	Panel Receptacle VA			0	0	4000	4000		
Bus Amps	100A, 100% Neutral	Panel Equipment VA			2000	0	0	2000		
Bus Type	Copper/10,000AIC	FTL VA			0	0	0	0		
Panel Mains	100A MLO	Total Connected VA			5840	7680	4000	17520		
Breaker Mtg	Bolt-In	Total Connected Amps			49	64	33	49		
Enclosure	NEMA 1 Surface	NEC VA			6800	9600	3667	20067		
Accessories	Ground Bus	NEC Amps			57	80	31	56		
Ckt.	Bkr.	Circuit Use	Load	Type	Ph.	Ckt.	Bkr.	Circuit Use	Load	Type
1	20	AHU-L1 UV	1920	2	A	2	20	AHU-L3 UV	1920	2
3	20	AHU-L1 UV	1920	2	B	4	20	AHU-L3 UV	1920	2
5	20	AHU-L1 LIGHTS & RECEPTACLES	1000	0	C	6	20	AHU-L3 LIGHTS & RECEPTACLES	1000	0
7	20	AHU-L1 CONTROLS	500	1	A	8	20	AHU-L3 CONTROLS	500	1
9	20	AHU-O1 UV	1920	2	B	10	20	AHU-O3 UV	1920	2
11	20	AHU-O1 LIGHTS & RECEPTACLES	1000	0	C	12	20	AHU-O3 LIGHTS & RECEPTACLES	1000	0
13	20	AHU-O1 CONTROLS	500	1	A	14	20	AHU-O3 CONTROLS	500	1
15	20	SPARE			B	16	20	SPARE		
17	20	SPARE			C	18	20	SPARE		
19	20	SPARE			A	20	20	SPARE		
21	20	SPARE			B	22	20	SPARE		
23		SPACE			C	24		SPACE		
25		SPACE			A	26		SPACE		
27		SPACE			B	28		SPACE		
29		SPACE			C	30		SPACE		
					A					
					B					
					C					
					A					
					B					
					C					

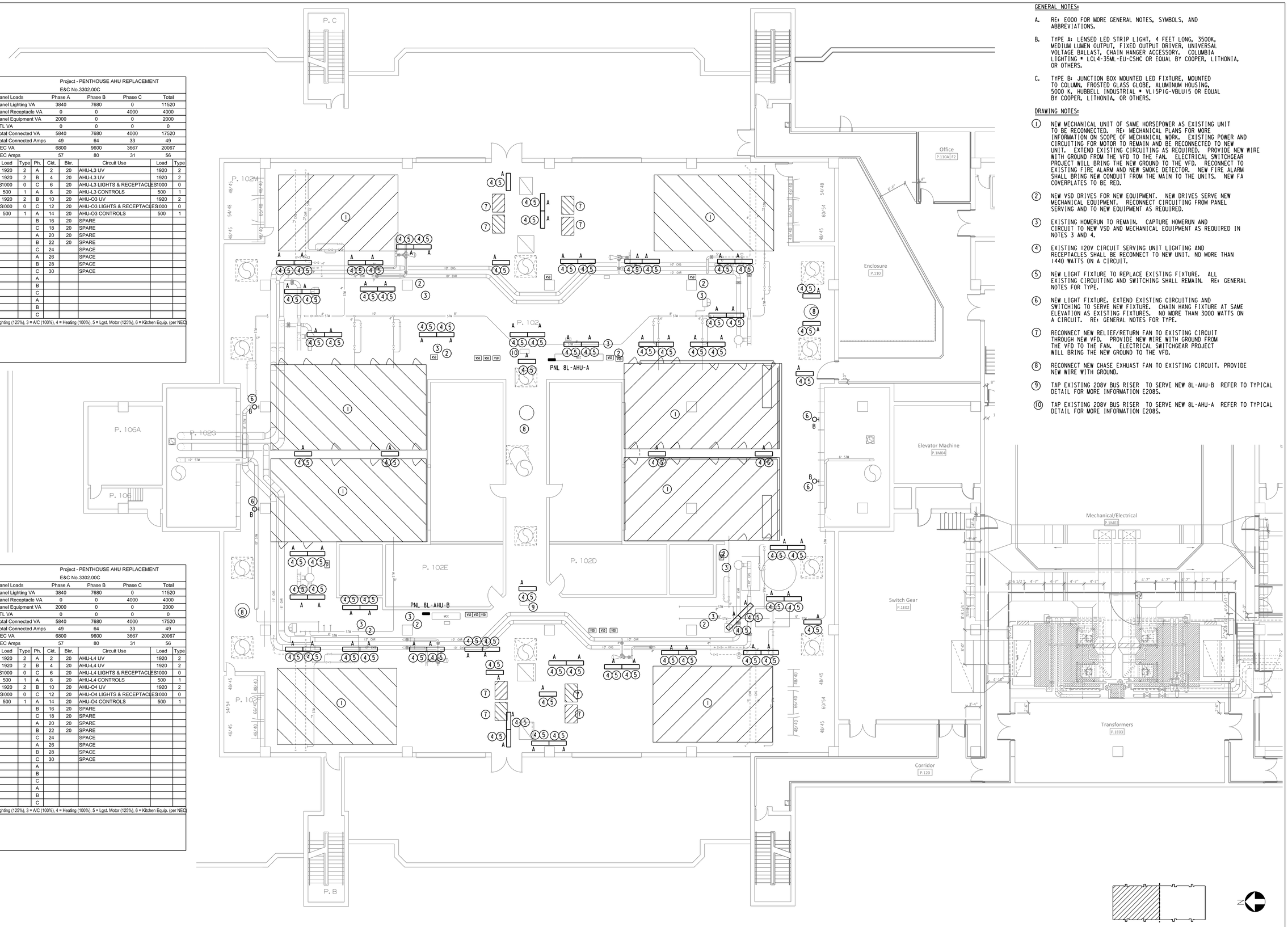
Load Types: 0 = Recepts (per NEC), 1 = Equip. (100%), 2 = Lighting (125%), 3 = A/C (100%), 4 = Heating (100%), 5 = Lgst. Motor (125%), 6 = Kitchen Equip. (per NEC)

Notes:

Panel	8L-AHU-B				Project - PENTHOUSE AHU REPLACEMENT					
Location -	PENTHOUSE NORTH				E&C No.3302.00C					
Panel Information		Panel Loads			Phase A	Phase B	Phase C	Total		
Voltage	120/208V, 3P, 4W	Panel Lighting VA			3840	7680	0	11520		
Panel Type	Panelboard	Panel Receptacle VA			0	0	4000	4000		
Bus Amps	100A, 100% Neutral	Panel Equipment VA			2000	0	0	2000		
Bus Type	Copper/10,000AIC	FTL VA			0	0	0	0		
Panel Mains	100A MLO	Total Connected VA			5840	7680	4000	17520		
Breaker Mtg	Bolt-In	Total Connected Amps			49	64	33	49		
Enclosure	NEMA 1 Surface	NEC VA			6800	9600	3667	20067		
Accessories	Ground Bus	NEC Amps			57	80	31	56		
Ckt.	Bkr.	Circuit Use	Load	Type	Ph.	Ckt.	Bkr.	Circuit Use	Load	Type
1	20	AHU-L2 UV	1920	2	A	2	20	AHU-L4 UV	1920	2
3	20	AHU-L2 UV	1920	2	B	4	20	AHU-L4 UV	1920	2
5	20	AHU-L2 LIGHTS & RECEPTACLES	1000	0	C	6	20	AHU-L4 LIGHTS & RECEPTACLES	1000	0
7	20	AHU-L2 CONTROLS	500	1	A	8	20	AHU-L4 CONTROLS	500	1
9	20	AHU-O2 UV	1920	2	B	10	20	AHU-O4 UV	1920	2
11	20	AHU-O2 LIGHTS & RECEPTACLES	1000	0	C	12	20	AHU-O4 LIGHTS & RECEPTACLES	1000	0
13	20	AHU-O2 CONTROLS	500	1	A	14	20	AHU-O4 CONTROLS	500	1
15	20	SPARE			B	16	20	SPARE		
17	20	SPARE			C	18	20	SPARE		
19	20	SPARE			A	20	20	SPARE		
21	20	SPARE			B	22	20	SPARE		
23		SPACE			C	24		SPACE		
25		SPACE			A	26		SPACE		
27		SPACE			B	28		SPACE		
29		SPACE			C	30		SPACE		
					A					
					B					
					C					
					A					
					B					
					C					

Load Types: 0 = Recepts (per NEC), 1 = Equip. (100%), 2 = Lighting (125%), 3 = A/C (100%), 4 = Heating (100%), 5 = Lgst. Motor (125%), 6 = Kitchen Equip. (per NEC)

Notes:



GENERAL NOTES:

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

B. TYPE A: LENSED LED STRIP LIGHT, 4 FEET LONG, 3500K, MEDIUM LUMEN OUTPUT, FIXED OUTPUT DRIVER, UNIVERSAL VOLTAGE BALLAST, CHAIN HANGER ACCESSORY. COLUMBIA LIGHTING * LCL4-35ML-EU-CSHC OR EQUAL BY COOPER, LITHONIA, OR OTHERS.

C. TYPE B: JUNCTION BOX MOUNTED LED FIXTURE, MOUNTED TO COLUMN, FROSTED GLASS GLOBE, ALUMINUM HOUSING, 5000 K, HUBBELL INDUSTRIAL * VL15PIG-VBLU15 OR EQUAL BY COOPER, LITHONIA, OR OTHERS.

DRAWING NOTES:

1. NEW MECHANICAL UNIT OF SAME HORSEPOWER AS EXISTING UNIT TO BE RECONNECTED. RE: MECHANICAL PLANS FOR MORE INFORMATION ON SCOPE OF MECHANICAL WORK. EXISTING POWER AND CIRCUITING FOR MOTOR TO REMAIN AND BE RECONNECTED TO NEW UNIT. EXTEND EXISTING CIRCUITING AS REQUIRED. PROVIDE NEW WIRE WITH GROUND FROM THE VFD TO THE FAN. ELECTRICAL SWITCHGEAR PROJECT WILL BRING THE NEW GROUND TO THE VFD. RECONNECT TO EXISTING FIRE ALARM AND NEW SMOKE DETECTOR. NEW FIRE ALARM SHALL BRING NEW CONDUIT FROM THE MAIN TO THE UNITS. NEW FA COVERPLATES TO BE RED.

2. NEW VSD DRIVES FOR NEW EQUIPMENT. NEW DRIVES SERVE NEW MECHANICAL EQUIPMENT. RECONNECT CIRCUITING FROM PANEL SERVING AND TO NEW EQUIPMENT AS REQUIRED.

3. EXISTING HOMERUN TO REMAIN. CAPTURE HOMERUN AND CIRCUIT TO NEW VSD AND MECHANICAL EQUIPMENT AS REQUIRED IN NOTES 3 AND 4.

4. EXISTING 120V CIRCUIT SERVING UNIT LIGHTING AND RECEPTACLES SHALL BE RECONNECT TO NEW UNIT. NO MORE THAN 1440 WATTS ON A CIRCUIT.

5. NEW LIGHT FIXTURE TO REPLACE EXISTING FIXTURE. ALL EXISTING CIRCUITING AND SWITCHING SHALL REMAIN. RE: GENERAL NOTES FOR TYPE.

6. NEW LIGHT FIXTURE. EXTEND EXISTING CIRCUITING AND SWITCHING TO SERVE NEW FIXTURE. CHAIN HANG FIXTURE AT SAME ELEVATION AS EXISTING FIXTURES. NO MORE THAN 3000 WATTS ON A CIRCUIT. RE: GENERAL NOTES FOR TYPE.

7. RECONNECT NEW RELIEF/RETURN FAN TO EXISTING CIRCUIT THROUGH NEW VFD. PROVIDE NEW WIRE WITH GROUND FROM THE VFD TO THE FAN. ELECTRICAL SWITCHGEAR PROJECT WILL BRING THE NEW GROUND TO THE VFD.

8. RECONNECT NEW CHASE EXHUAST FAN TO EXISTING CIRCUIT. PROVIDE NEW WIRE WITH GROUND.

9. TAP EXISTING 208V BUS RISER TO SERVE NEW 8L-AHU-B REFER TO TYPICAL DETAIL FOR MORE INFORMATION E208S.

10. TAP EXISTING 208V BUS RISER TO SERVE NEW 8L-AHU-A REFER TO TYPICAL DETAIL FOR MORE INFORMATION E208S.

ISSUE FOR:			
Area	Rev.	Date	Description
		04/13/18	CONSTRUCTION

E&C

ENGINEERS & CONSULTANTS, INC.
1010 LAMAR, SUITE 650
HOUSTON, TEXAS 77002
TEL 713/580-8800
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STATE OF TEXAS
HEATHER CAMDEN
86883
LICENSED
PROFESSIONAL ENGINEER

THE SEAL APPEARING ON THIS DRAWING WAS AUTHORIZED BY
Digitally signed by Heather Camden
Date: 2018.04.12 15:41:53-05'00'
E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068

Date 04/13/2018
Drawn By
Checked By

UTHSC Project No. 730022
E & C Project No. 3302.00C
File Name

UTHealth
The University of Texas Health Science Center at Houston

MEDICAL SCHOOL BUILDING
PENTHOUSE
AHU REPLACEMENT

DRAWING TITLE
ELECTRICAL PH
NORTH RENOVAITON
DRAWING

DRAWING NO.
E208N

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INDEX: Division 23-Mechanical

23 00 00	Basic Mechanical Requirements
23 05 13	Motors
23 05 29	Sleeves, Flashings, Supports and Anchors
23 05 48	Vibration Isolation
23 05 53	Mechanical Identification
23 05 93	Testing, Adjusting and Balancing
23 05 93A	Preparation for System Testing, Adjusting and Balancing
23 06 20	Hydronic Specialties
23 07 13	Ductwork Insulation
23 07 16	Equipment Insulation
23 07 19	Piping Insulation
23 09 23	Direct Digital Control Systems
23 20 00A	Piping, Valves and Fittings
23 21 00	Hydronic Piping
23 22 00	Steam and Steam Condensate Piping
23 22 00A	Steam and Steam Condensate Specialties
23 29 23	Variable Speed Drives
23 31 00	Ductwork
23 33 00	Ductwork Accessories
23 34 00	Fans
23 41 00	Filters
23 73 23	Air Handling Units and Outside Air Handling Units
23 82 16	Air Coils

STATE OF TEXAS
HEATHER CAMDEN
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INDEX: Division 26-Electrical

26 00 00	Basic Electrical Requirements
26 00 00.01	Electrical Demolition
26 05 00	Basic Electrical Materials and Method
26 05 19	Cable, Wire and Connectors, 600 Volts
26 05 26	Grounding
26 05 29	Securing and Supporting Methods
26 05 33	Raceways, Conduit and Boxes
26 05 53	Electrical Identification
26 05 73	Short Circuit Analysis and Coordination Studies
26 25 01	Feeder and Plug-in Busway

26 27 26	Wiring Devices and Floor Boxes
26 51 00	Interior and Exterior Lighting
28 31 00	Fire Alarm and Smoke Detection

For Construction
E&C Engineers & Consultants, Inc.
TX Firm Registration No: F-003068
Date: 04/13/2018
Engineer of Record: Heather Camden
State: Texas
License no: 86883

SECTION 23 00 00
BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Basic Mechanical Requirements specifically applicable to Division 23 Sections, in addition to Division 01 - General Requirements.

1.02 RELATED DOCUMENTS:

A. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and DIVISION 01 of the Specifications apply to the work specified in this Section.

B. All work covered by this Section of these Specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.03 GENERAL:

A. The Contractor shall execute all work hereinafter specified or indicated on accompanying Drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.

C. The Mechanical, Electrical, and associated Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

D. When the mechanical and electrical Drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

1.04 DEFINITIONS: (Note: These definitions are included here to clarify the direction and intention of this specification. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.)

A. CONCEALED / EXPOSED: Concealed areas are those areas which cannot be seen by the building occupants. Exposed areas are all areas which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

B. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements which are included in project. Basic contract definitions are included in the General Conditions.

C. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

D. Directed, requested, etc.: Where not otherwise explained, terms such as "directed", "requested", "authorized", "selected", "approved", "required", "accepted", and "permitted" mean directed by Architect/Engineer", "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

E. And/Or: Where "and/or" is used in these Specifications or on the Drawings, it shall mean "that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.

F. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

G. As required: Where "as required" is used in these Specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

H. Furnish:

1. The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations."

2. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

I. Install: The term "install" is used to describe operations at project site including "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operation."

J. Provide: The term "provide" means "to furnish and install, complete and ready for intended use."

1.05 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS:

A. General: Refer to DIVISION 01 for construction phasing and time increments.

B. Fees and Costs: Refer to Division 01 for payment requirements of fees and utility costs.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to City controlled services. If inspections by City personnel are specifically required by this document, refer to Division 01 for responsibility.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these Specifications and Drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the Specifications and Drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.06 CONTRACT DOCUMENTS:

A. All dimensional information related to new structures shall be taken from the appropriate Drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the Specifications, the Drawings, and the schedules are as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the Drawings or Specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.10 FUTURE WORK

A. Provide for future work as noted below..

B. Areas of the project are designed for future build-out.

C. Piping, conduit, etc. that is installed in the shell & core shall be installed as noted on the drawings with the understanding that there will be build-out in these areas and routing shall be done in a manner to provide adequate clearance for those future utilities.

1.11 SUBMITTALS

A. Refer to Uniform General Conditions Article 8.

B. Proposed Products List: Include Products specified in the following Sections:

1. Section 22 11 23 – Plumbing Equipment
2. Section 22 05 33 – Heat Trace for Plumbing Piping.
3. Section 23 05 16 – Piping Expansion Compensation.
4. Section 23 05 29 – Sleves, Flashings, Supports and Anchors.
5. Section 23 25 00 – Water Treatment Systems.
6. Section 23 20 00.A - Piping, Valves and Fittings
7. Section 23 05 29 - Sleeves, Flashings, Supports and Anchors
8. Section 21 13 13 - Fire Protection Systems
9. Section 22 13 16 - Plumbing Piping
10. Section 22 13 16.A - Plumbing Specialties
11. Section 22 40 00 - Plumbing Fixtures
12. Section 22 63 13 - Compressed Gas System
13. Section 22 66 00 – Lab Waste System
14. Section 22 67 13 - Reverse Osmosis Water System
15. Section 23 05 13 - Motors
16. Section 23 05 48 - Vibration Isolation
17. Section 23 05 53 - Mechanical Identification
18. Section 23 06 20 - Hydronic Specialties
19. Section 23 07 13 - Ductwork Insulation
20. Section 23 07 16 - Equipment Insulation
21. Section 23 07 19 - Piping Insulation
22. Section 23 09 23 - Direct Digital Control Systems
23. Section 23 09 43 - Pneumatic Controls
24. Section 23 09 93 – Sequence of Operation
25. Section 23 20 00 - HVAC Pumps
26. Section 23 20 00.A - Piping, Valves and Fittings
27. Section 23 21 00 - Hydronic Piping

28. Section 23 22 00 - Steam and Steam Condensate Piping

39. Section 23 22 00.A - Steam and Steam Condensate Specialties

30. Section 23 29 23 – Variable Speed Drives

31. Section 23 31 00 - Ductwork

32. Section 23 33 00 - Ductwork Accessories

33. Section 23 37 00 - Air Inlets and Outlets

34. Section 23 82 16 - Air Coils

35. Section 23 41 00 – Filters

36. Section 23 34 16 – Fans

37. Section 23 82 19 – Unit Heaters and Baseboard Heaters

38. Section 23 73 25 – Heat Recovery Units

39. Section 23 73 23 – Air Handling Units and Outside Air Handling Units

40. Section 23 73 00 – Fan Coil Units

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

D. Mark dimensions and values in units to match those specified.

E. Submit Fabrication Drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these Specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

F. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4" = 1'-0". Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8" = 1'-0". Submit three blueline prints of each Fabrication Drawing to the Architect/Engineer for review. Reproduction and submittal of the Construction Documents is not acceptable. The Architect/Engineer will review the drawing and return one print with comments.

1.12 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment which will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the Specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the

quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these Specifications have been met and samples shall be furnished when requested. All manufacturer's data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the Drawings and/or Specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the Shop Drawings.

L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.13 MATERIALS AND WORKMANSHIP:

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.14 FLAME SPREAD PROPERTIES OF MATERIALS:

A. Materials and adhesives incorporated in this project to be installed within return air plenums shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.15 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these Specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA):

1. NFPA No. 13, Sprinkler System, Installation

2. NFPA No. 14, Standpipes and Hose Systems

3. NFPA No. 20, Centrifugal Fire Pumps

4. NFPA No. 37, Stationary Combustion Engines & Gas Turbines

5. NFPA No. 45, Fire Protection for Laboratories Using Chemicals

6. NFPA No. 51, Welding & Cutting, Oxygen-Fuel Gas Systems

7. NFPA No. 54, Gas Appliances, Piping, National Fuel Gas Code

8. NFPA No. 70, National Electrical Code

9. NFPA No. 72D, Proprietary Signaling Systems

10. NFPA No. 78, Lightning Protection Code

11. NFPA No. 90A, Air Conditioning Systems

12. NFPA No. 91, Blower & Exhaust Systems

13. NFPA No. 99, Health Care Facilities

14 NFPA No. 101, Life Safety Code

15. NFPA No. 200, Series, Building Construction

16. NFPA No. 255, Method of Test of Surface Burning Characteristics of Building Materials

27. NFPA No. 258, Standard Research Test Method for Determining Smoke Generation of Solid Materials

C. American National Standards Institute (ANSI):

1. A40.8, National Plumbing Code

2. B31.1, Power Piping

3. B9.1, Safety Code for Mechanical Refrigeration

D. American Gas Association Publications (AGA): Directory of Approved Gas Appliances and Tested Accessories

E. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes

F. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.

G. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA): All current editions of applicable manuals and standards (See Sections 23 31 00.UT and 23 33 00.UT).

H. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards.

I. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards.

J. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

K. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.

L. City of Houston, Fire Department as may be applicable to construction on this site.

M. International Building Code, (Includes the International Mechanical and International Plumbing Codes)

N. Texas Occupational Safety Act: All applicable safety standards

O. Occupational Safety and Health Act (OSHA)

P. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

Q. Texas State Fire Marshal Rules

R. State Energy Code – ASHRAE 90.1 – 2004.

S. Ventilation Standard – ASHRAE 62.1 – 2004.

T. Refer to Specification Sections hereinafter bound for additional Codes and Standards.

U. All materials and workmanship shall comply with all applicable state and national codes, Specifications, and industry standards. In all cases where Underwriters' Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

V. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.16 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS:

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters' Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this Section of the Specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

H. All mechanical and Plumbing equipment that is to be controlled or monitored by the building automation system shall be BACnet compatible.

1.17 WALL, FLOOR AND CEILING PLATES:

A. See Section 23 05 29.

1.18 SLEEVES, INSERTS, AND FASTENINGS:

A. See Section 23 05 29.

1.19 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.

1.20 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturers' directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.21 SPACE AND EQUIPMENT ARRANGEMENT:

A. The size of mechanical and electrical equipment indicated on the Drawings is based on the dimensions of a particular manufacturer and a particular model. While other manufacturers and models may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space with all adequate clearances. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.22 LARGE APPARATUS:

A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.23 PROTECTION:

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workmen or their tools and equipment during the construction of the building.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.

1.24 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS:

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades (including Controls and Testing and Balancing), subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.25 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT:

A. The Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The Electrical Trades shall provide all interconnecting wiring for the installation of all power. The Electrical Trades shall provide all disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 26.

C. The Mechanical Trades shall provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control Drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the Electrical Trades by the Contractor. They shall be followed in detail.

1.26 SUPERVISION:

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all Drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the A/E for ruling.

1.27 SITE OBSERVATION:

A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.28 PRECEDENCE OF MATERIALS

A. The specifications determine the nature and setting of materials and equipment. The drawings establish quantities, dimensions and details.

B. The installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the contractor in the determination of which trade shall be given the "Right-of-Way".

Building lines
Structural Members
Soil and Drain Piping
Condensate Drains
Vent Piping
Supply, Return, and Outside Air Ductwork
Exhaust Ductwork
HVAC Water and Steam Piping
Steam Condensate Piping
Fire Protection Piping
Natural Gas Piping
Domestic Water (Cold and Hot)
Refrigerant Piping
Electrical Conduit

1.29 CONNECTIONS FOR OTHERS:

A. The Mechanical Contractor shall rough in for and make all gas, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, etc.

C. Provide all air gap fittings required, using materials hereinbefore specified. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.

D. All pipe fittings, valves, traps, etc., exposed in finished areas and connected to chrome plated lines provided by others shall be chrome plated to match.

E. Provide all sheet metal ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc., provided by others.

1.30 INSTALLATION METHODS:

A. Where to Conceal: All pipes, conduits, etc., shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping, ducts and conduits shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above-floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping, ducts and conduits run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping".

2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 10 working days.

3. All above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures, shall be complete and installed in accordance with contract requirements, including power to lighting fixtures, fans, and other powered items. Adequate lighting shall be provided to permit thorough inspection of all above-ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager's Construction Inspector(s), the Resident Construction Manager and Office of Facilities Planning and Construction (OFPC). Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.31 RECORDS FOR OWNER:

A. The Contractor shall maintain a set of "blueline" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these Drawings in connection with the final installation including exact dimensioned locations of all new

underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At Contract completion the Contractor shall provide a set of reproducible revised drawings per Division 01. The contractor shall transfer the information from the "blueline" prints maintained as described above, and turn over this neatly marked set of reproducible Drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information. These Drawings shall include as a minimum:

1. Addendum written drawing changes.

2. Addendum supplementary drawings.

3. Accurate, dimensioned locations of all underground utilities, services and systems.

4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.

5. Change Order written drawing changes.

6. Change Order supplementary drawings.

C. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.

2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.

3. Valve tag charts and diagrams specified herein.

4. Approved wiring diagrams and control diagrams representing "as installed" conditions.

5. Copies of approved Shop Drawings.

6. Any and all other data and/or drawings required as submittals during construction.

7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

F. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer.

1.32 ROOF PENETRATIONS AND FLASHING:

A. Pipe, conduit and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.33 EXCAVATION, TRENCHING AND BACKFILL:

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc. All exterior lines shall be installed with a minimum cover of 24", unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for lead pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6" below the trench depths specified. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations

shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

6. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

7. Trenches for cast iron drain, storm water and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

8. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the campus.

B. Backfilling:

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

C. Opening and Reclosing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.34 ACCESS DOORS:

A. General: This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed items of mechanical equipment or devices.

B. Doors: Access doors mounted in painted surfaces shall be of Milcor (Inland-Ryerson Construction Products Company) manufacture, Style K for plastered surfaces and Style M or DW for non-plastered surfaces. The Style K doors shall be set so that the finished surface of the door is even with the finished surface of the adjacent finishes. Access doors mounted on tile surfaces shall be of similar construction as noted above, except they shall be of stainless steel materials. Access doors shall be a minimum of 12" x 12" in size.

1.35 OPERATION PRIOR TO COMPLETION:

A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Construction Inspector's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.36 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT:

A. Before the work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. The qualifications of the representative shall be appropriate to the technical requirements of the installation. The qualifications of the representative shall be submitted to the owner for approval. The decision of the owner concerning the appropriateness of the representative shall be final. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Architect/Engineer a signed statement from each representative certifying as follows: "I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations".

B. Check inspections shall include plumbing equipment, heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

1.37 TESTS:

A. The Contractor shall make, at no additional cost to the Owner, any tests deemed necessary by the inspection departments having jurisdiction, and in the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials, and labor for making such tests. Reasonable amounts of fuel and electrical energy costs for system tests will be paid by the Owner. Fuel and electrical energy costs for system adjustment and tests which follow beneficial occupancy by the Owner will be borne by the Owner.

B. Additional tests specified hereinafter under the various Specification Sections shall be made.

C. The Construction Inspector shall be notified in writing at least 10 working days prior to each test and other Specification requirements requiring action on the part of the Construction Inspector. All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

D. Maintain Log of Tests as hereinafter specified.

E. See Specifications hereinafter for additional tests and requirements.

1.38 LOG OF TESTS:

A. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance". All Test Log entries shall be legibly signed by the Project Contractor or his authorized job superintendent.

1.39 COOPERATION AND CLEANUP:

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.40 CLEANING AND PAINTING:

A. All equipment furnished and installed in exposed areas under Divisions 23 and 26 of these Specifications shall be cleaned, prepared, and painted according to the specification for the equipment.

B. All purchased equipment furnished by the mechanical and electrical subcontractors shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal

work shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

D. Color of finish painting noted shall be painted using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. Two coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

ITEM	COLOR	"P and L" PAINT NUMBER
Pump Couplings and Fuel Gas Piping	Safety Yellow	Y361M (Daisy Yellow)
Fire Protection Equipment and Piping	Safety Red	R131R (Vibrant Red)

Note that the paint specified above is included for purposes of establishing a quality which shall be used on this project. The proposed paint shall be submitted, and alternatives will be considered using the submittal procedures specified in this document.

E. Jacketing on insulation shall not be painted.

F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

G. Scope of painting for Division 23 and 26 work in areas other than those defined as "exposed" is as follows:

1. All canvas finishes including those underfloor and in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.

2. All fuel piping (natural gas, LPG, etc.) and all fire protection piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fuel piping shall be painted safety yellow, and fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA. Primer and first color coat may be omitted on piping above ceilings.

3. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting specification or instruction, should a conflict in the Construction Documents exist.

H. The surfaces to be finish painted shall first be prepared as follows:

1. On canvas finishes pretreat as specified above. Insulated surfaces having vapor barrier jacket exposed to view shall first be painted with one (1) coat of sealer.

2. Galvanized and black steel surfaces shall first be painted with one (1) coat of P&L galvanized metal primer. Primer may be eliminated on concealed fire and gas piping.

3. Aluminum surfaces shall first be painted with one (1) coat of P&L zinc chromate primer. (See Section 1.51.5)

4. Cast iron pipe shall first be primed with a "nonbleed" primer.

5. The underside of all cast iron sinks not recessed in a cabinet are included as items to be painted in exposed areas.

I. Where factory applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory fresh condition by competent refinishers using the spray process.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 PIPE PRESSURE TESTS:

A. The following lines shall be tested 1.5 times working pressure or at least at the following stated pressure for the length of time noted:

Service	Testing Medium	Pressure (PSIG)	Testing Time in Hours
Chilled Water	Water	150	24
Steam M.P. & L.P.	Water	150	24
Steam Condensate M.P.	Water	150	24
Steam H.P.	Water	300	24
Steam Condensate H.P.	Water	300	24
Pumped Condensate Return	Water	150	24
Domestic Hot & Cold Water	Water	150	24
Sanitary & Storm Piping	Water	Fill to top	24
Compressed Air	Air	150	24
Compressed Gases	Nitrogen	150	24
Medical Vacuum	Nitrogen	150	24
Natural Gas	Air	100	24
Fire Protection Systems	Water	200	2

B. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

3.02 TRAINING REQUIREMENTS

	Hours of Training Required 0 = Specific # not defined
Motors	0 Hours
Plumbing Specialties	2 Hours
Plumbing Fixtures and Trim	0 Hours
Hydronic Specialties	0 Hours
Steam and Steam Condensate Specialties	4 Hours
HVAC Pumps	0 Hours
Fan Coil Units	2 Hours
Electronic Variable Speed Drives	4 Hours
Pneumatic Controls	8 Hours
DDC Building Controls	8 Hours
Sequence of Operation	8 Hours

END OF SECTION

SECTION 23 05 13
MOTORS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Single phase electric motors.

B. Three phase electric motors.

C. The Contractor shall provide all motors required for equipment supplied under this Division of the work.

1.02 RELATED WORK

A. Section 23 73 23 - Air Handling Unit with Coils: Fan motors

1.03 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

D. ANSI/NEMA MG 1 - Motors and Generators.

E. ANSI/NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00.

B. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.

C. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience. Marathon motors shall not be accepted.

1.07 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.09 WARRANTY

A. Provide five year manufacturer's warranty under provisions of Section 23 00 00.

B. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Drawing Schedules for required electrical characteristics.

B. All Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

C. Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.

D. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

E. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.

F. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

G. Motors shall be built in accordance with the latest ANSI, IEEE, and NEMA Standards, and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled, and of approved manufacture as described herein or of the same manufacture as the equipment which they serve. All motors provided by the Contractor shall be of the same manufacture unless they are an integral part of the piece of equipment to which they are attached. Nameplate rating of motors shall match the characteristics scheduled.

H. All motors shall be designed for NEMA Design B starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.

I. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

J. Dynamic Balance shall be no greater than the vibration limits of the driven equipment as defined in Section 23 34 16 for fans and Section 23 20 00 for pumps.

K. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

L. All motors installed with direct-drive equipment shall be selected for rpm to match the rpm of the unit being served.

2.02 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

F. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with dripproof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.03 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

E. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.

B. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 3-phase and shall be squirrel cage high efficiency induction type with standard NEMA frame sizes.

C. Motors 1 HP and larger shall have integral frames.

D. Starting Torque: Between one and one and one-half times full load torque.

E. Starting Current: Six times full load current.

F. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.

G. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.

H. Insulation System: NEMA Class B or better.

I. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Test and balance motors to limits defined in 2.01J.

J. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of

cast iron or aluminum with steel inserts.

K. Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory prepacked with a nondetergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for B-10, 200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: Refer to ANSI/NEMA MG 1.

M. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

N. Weatherproof Epoxy SealedMotors (Where Indicated): Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

O. Nominal Efficiency: Meet or exceed values per 23 05 13-3.03 at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

P. Nominal Service Factor: Meet or exceed values per 23 05 13-3.02 at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

Q. Motors 1 HP and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

R. Motors 10hp and larger shall be inverter duty rated and shall be provided with shaft grounding device.

2.06 STARTING EQUIPMENT:

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted. The Mechanical Subcontractor shall furnish all starters for Division 23 work, except those starters scheduled to be provided in Division 26 Motor Control Centers.

B. Motor starters shall conform to NEMA Standards for Industrial Control, #IC-1, latest issue, and shall be housed in NEMA Standard enclosures. Control voltage in each starter shall be not more than 120 volts to ground, with an individual control transformer provided in each starter as required. Manual starters for fractional horsepower single phase motors shall be on-off or snap switch type combined with thermal overload device. The switch shall be so constructed so that it cannot be held closed under a sustained motor overload.

C. Magnetic starters shall have thermal overload protection in each of the ungrounded legs and shall be solenoid operated. Provide the correct size heater element to protect motors exposed to exterior conditions and allow it to operate based on motor nameplate amperes and ambient temperatures anticipated for each individual motor. Each starter shall be provided with a control power transformer or 120v control power circuit.

D. Pushbuttons with or without pilot lights, hand-off-automatic switches and other scheduled apparatus shall be standard duty type mounted in NEMA enclosures or in cover of starter as specified or scheduled, and shall be furnished by the trade furnishing the starter except as specifically indicated elsewhere.

E. Hand-Off-Automatic switches for equipment which could damage itself if left in the "hand" position (such as sump pumps), shall be spring return to "off" from the "hand" position.

PART 3 EXECUTION

3.01 APPLICATION

A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors shall be energy efficient type.

D. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

E. Single phase motors for fans and pumps shall be capacitor start, capacitor run type.

F. Motors located in exterior locations shall be totally enclosed weatherproof epoxy-sealed type.

3.02 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600_RPM	1800_RPM	1200_RPM	900_RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.03 Motor Efficiencies – Nominal, full load, three phase

	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7
20	92.4	93.0	92.4	92.4	93.0	92.4
25	93.0	93.6	93.0	93.0	93.6	93.0
30	93.6	94.1	93.0	93.6	93.6	93.0
40	94.1	94.1	93.6	94.1	94.1	93.6
50	94.1	94.5	93.6	94.1	94.5	94.1
60	95.0	95.0	94.1	94.5	95.0	94.1
75	95.0	95.0	94.5	95.0	95.4	94.5
100	95.0	95.4	94.5	95.4	95.4	94.5
125	95.4	95.4	95.0	95.4	95.4	95.0
150	95.8	95.8	95.4	95.8	95.8	95.4
200	95.4	95.8	95.4	95.8	96.2	95.8

END OF SECTION

SECTION 23 05 29
SLEEVES, FLASHINGS, SUPPORTS AND ANCHORS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.02 RELATED SECTIONS

A. Section 23 07 19 - Piping Insulation

B. Section 23 07 16 - Ductwork Insulation

C. Section 23 21 00 - Hydronic Piping

D. Section 23 22 00 - Steam and Steam Condensate Piping

1.03 REFERENCES

A. ASME B31.1 - Power Piping

B. ASME B31.2 - Fuel Gas Piping

C. ASME B31.5 - Refrigeration Piping

D. ASME B31.9 - Building Services Piping

E. ASTM F708 - Design and Installation of Rigid Pipe Hangers

F. MSS SP69 - Pipe Hangers and Supports - Materials, Design and Manufacturer

G. MSS SP89 - Pipe Hangers and Supports - Selection and Application

H. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

I. NFPA 13 - Installation of Sprinkler Systems

J. NFPA 14 - Installation of Standpipe and Hose Systems

K. UL 203 - Pipe Hanger Equipment for Fire Protection Service

1.04 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data: Provide manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.05 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of plumbing, hydronic, steam and steam condensate piping.

B. Supports for Sprinkler Piping: Shall be in conformance with NFPA 13.

C. Supports for Standpipes: Shall be in conformance with NFPA 14.

PART 2 PRODUCTS

2.01 HANGERS AND SUPPORTS

A. Manufacturers:

1. Grinnell.

2. Kindorf

3. B-Line

4. Power Strut

5. Anvil International

B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

C. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.

D. The supports, hangers, anchors, and guides for the chilled water supply and return piping, steam piping, condensate return piping, etc. of the Campus Loop System routed above covered walk shall be provided as indicated on the Drawings.

E. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

F. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

G. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

H. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

I. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.

J. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

K. Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Grinnell Fig. CT-99c, adjustable, copper plated, tubing ring. Hangers supporting and contacting brass or copper lines 4" and larger shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Grinnell Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.

L. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8" diameter pipe or smaller in size and supporting all ferrous lines 6" and smaller in size shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

M. Hangers supporting and contacting ferrous lines larger than 6" in size and outside of insulation on lines with the outside diameter equivalent to 10" diameter pipe shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

N. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

O. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support shields as specified in Section 23 07 19 - PIPING INSULATION. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.

P. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Grinnell Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and

located at each floor. Two-hole rigid pipe clamps at 4 ft. o.c. or Kindorf channels and Grinnell Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. When piping is subject to expansion and contraction, provide spring isolators (see Section 23 05 48 - Vibration Isolation). Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.

Q. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use a Grinnell No. 595 Socket Clamp with Grinnell No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

R. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

S. All electrical conduits shall be run parallel or perpendicular to adjacent building lines. Single conduits running horizontally shall be supported by "Caddy" or "Minerallac" type hangers from adequately sized rods (minimum 1/4") from the building structure. Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips." All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8' centers. Where feasible, conduits may be fastened to the concrete by one-hole straps thoroughly anchored to the concrete in an approved manner. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above-ceiling equipment, and to support it from touching the ceiling system. Conduit shall be located so as not to inhibit removal of ceiling tiles.

T. Vertical conduits shall be supported as often as necessary for rigidity by clamps resting on adjacent beams or floor slabs, using a minimum of one support per floor.

U. <u>Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material</u>.

V. <u>Where specifically noted on the drawings that one material is to be hung from the support of another material due to space restrictions, the hangers shall be sized to properly cary the weight of all items to be supported by such</u>.

W. Vibration Isolation: Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc.). Piping or ductwork that may vibrate and create an audible noise shall also be isolated. Spring hangers or supports shall be provided where indicated on the Drawings

and/or specified under Section 23 05 48.

X. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.

3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

4. Hangers shall be attached to the structure as follows:

   a) Poured In Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.

   b) Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.

   c) Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.

   d) Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees."

e) If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.

Power-actuated fasteners (shooting) will not be acceptable under any circumstances.

Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

Y. Finishes: All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, and brackets, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. Universal concrete inserts shall be cadmium plated.

Z. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Kindorf, Uni-Strut, Power Strut, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

AA. Miscellaneous: Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer.

BB. Ductwork supported from the floor: Ductwork supported from the floor shall be done by the same means as that supported from above, but shall include a neoprene vibration isolation spcer to restrict vibration transmission to the structure below.

CC. Fire Protection Systems: All hangers and supports for fire standpipe systems and fire sprinkler systems shall be Factory Mutual and Underwriters Laboratories, Inc. listed and labeled. Construction of hangers shall be as described above for common piping, except for the above-mentioned requirements.

DD. Supports for piping on roofs shall consist of molded reinforced nylon support base with black neoprene support pad and 3/8” diameter stainless steel continuously threaded rods, and hard cast rubber roller for pipe support, adjustable in height. Support shall be secured to roof, per roof manufacturers recommendations. Manufactured by MAPA Products No. MS4L, or approved equal.

2.03 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

2.04 FLASHING AND EQUIPMENT CURBS

A. Metal Flashing: 26 gauge galvanized (stainless steel) steel.

B. Metal Counterflashing: 22 gauge galvanized (stainless steel) steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

E. Curbs: Welded 18 gauge galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, factory installed wood nailer.

F. Concrete foundations for the support of equipment shall be provided by the General Contractor and are shown and detailed by the Architect. Coordinate exact sized required with the GC.

2.05 WALL, FLOOR AND CEILING PLATES:

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

2.09 SLEEVES

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.

2. Sleeves through interior walls to be galvanized sheetmetal with gauge as required by wall fire rating, 20 gauge minimum.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link-seal closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.

D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Vermin proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.

F. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

G. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

H. Fireproofing: Seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2000° F for two hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be a silicone RTV foam or an approved equal. For dry locations, a premixed putty equal to Nelson Flameseal Firestop putty may be used.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.02 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.03 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Hanger Rods: (NOTE: All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage.)

3.04 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor drains, shower, mop sink, and trench drains watertight to adjacent materials.

E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

F. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

G. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above

roof jacks. Screw vertical flange section to face of curb.

3.05 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors (except in stairwells) two inches above finished floor level. Sleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe.

D. Where piping, ductwork or conduit penetrates floor, ceiling, or wall, close space between pipe or duct and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.

E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.06 PIPE SUPPORT SCHEDULES

STEEL PIPE SIZE Inches	MAX. HANGER SPACING Feet	HANGER ROD DIAMETER Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8
14 and Over	20	1
PP, PVDF, PVC, CPVC (All Sizes)	4	3/8
C.I. Bell and Spigot (or No-Hub), and at all Joints	5	5/8
Glass, and at all Joints	4	1/2

COPPER PIPE SIZE Inches	MAXIMUM HANGER SPACING Feet	MIN HANGER ROD DIAMETER Inches
1/2 to 1	5	3/8
1-1/4 to 1-1/2	7	3/8
2 and Over	10	1/2

3.07 LOW PRESSURE DUCT SUPPORT SCHEDULE:

A. All horizontal ducts up to and including 40 inches in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets, or clamps and fastened to above inserts with toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8' 0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.

B. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one pair of supports 8' 0" on centers according to the following:

Angle Length	Angle	Rod Diameter
4' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8' 0"	2" x 2" x 1/8"	5/16"
10' 0"	3" x 3" x 1/8"	3/8"

C. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60." Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

Angle Length	Angle	Rod Dia.
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

D. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

3.08 MEDIUM PRESSURE DUCT SUPPORT SCHEDULE:

A. All horizontal rectangular ducts shall have duct hanger requirements as follows:

Minimum Hanger Size

Max. Duct Dimen.	Steel Rod	Galv. Steel Strap Width	Max. Spacing	Min.# Hngrs	Trapeze Size
0 through 18"	--	1" x 16 ga.	10'	2	--
19" through 36"	--	1" x 16 ga.	10'	2	--
37" through 60"	3/8"	1" x 16 ga.	8'	2	2" x 2" x 1/4"
61" through 120"	3/8"	1-1/2" x 12 ga.	8'	2	2" x 2" x 1/4"
121" through 240"	3/8"	--	4'	3	2-1/2" x 2-1/2" x 3/16"

B. All horizontal round ducts shall have ducts hangers spaced 10' 0" maximum with requirements as follows:

Duct Diameter	Min. Hanger Size	No. Hangers	Hanger Ring Size
Up through 18"	1" x 16 gauge	1	1" x 16 ga.
19" to 36"	1" x 12 gauge	1	1" X 12 ga.
37" to 50"	1-1/2" x 12 gauge	1	1-1/2" x 12 ga.
51" to 84"	1-1/2" x 12 gauge	2	Support Bracing Angle

3.09 DUCT HANGERS - GENERAL NOTES (all pressures)

A. Hanger straps on duct width of 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the side.

B. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8" bolts minimum.

C. Use 3/8" minimum bolts for securing duct hanger to band straps.

D. All round ducts shall be supported within 3 feet of all horizontal or vertical turns.

END OF SECTION

SECTION 23 05 48

VIBRATION ISOLATION

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. 23 00 00 -- Basic Mechanical Requirements

B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors

C. 23 05 53 -- Mechanical Identification

1.01 WORK INCLUDED

A. Inertia bases.

B. Vibration isolation.

1.02 SCOPE OF WORK:

A. Furnish and install all labor, materials, equipment tools and service and perform all operations required in connection with or properly incidental to the construction of complete system of vibration and noise control, as indicated on the Drawings, reasonably implied therefrom or as specified herein, unless specifically excluded.

1.03 REFERENCES

A. ASHRAE - Guide to Average Noise Criteria Curves.

1.04 QUALITY ASSURANCE

A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.

B. Indicate inertia bases on shop drawings.

C. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.

D. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.06 CERTIFICATES

A. Submit a certificate from the manufacturer that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

1.07 INTENT OF RESPONSIBILITY:

A. It is the intent of this specification to provide for vibration isolation supports for all equipment, piping, and ductwork as set out below. The transmission of perceptible vibration, structural borne noise, or objectionable air borne noise to occupied areas by equipment installed under

this contract will not be permitted. The Contractor shall be held responsible for installing the vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria; and one which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Inertia bases shall be included as part of mechanical work. Pads under electrical gear shall be included as part of electrical work. The concrete work shall meet the requirements specified in the General Contract Specifications.

C. The Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.

D. The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the isolation manufacturer or his qualified representative, in company with the Architect or his designated representative, shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

E. Vibration isolation devices shall be as manufactured by Mason, Amber/Booth Company, Consolidated Kinetics, Korfund Dynamics Corporation, or approved equal.

PART 2 PRODUCTS

2.01 GENERAL DESIGN FEATURES:

A. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.

B. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cad-plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

C. All isolators exposed to the weather shall have steel parts PVC coated, hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.

D. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.

E. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

F. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".

G. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

H. Isolators for equipment installed out-of-doors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 PSF (pounds per square foot) applied to any exposed surface of the equipment without failure.

2.02 ISOLATOR TYPES: Isolator types and required deflections are specified under "Schedule of Isolated Equipment", paragraph 3.02. The isolators shall comply with the following descriptions for each type required on the project:

A. Type 1 - An adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring(s) shall be rigidly attached to the mounting baseplate and to the spring compression plate. The isolator shall be designed for a minimum Kx/Ky (horizontal to vertical spring rate) of 1.0. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Baseplates shall be sized to limit pad loading to 100 psi.

B. Type 2 - An aluminum-housed, or cast iron housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Sheet or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate.

E. Type 5 - A spring hanger consisting of a rectangular steel box, coil springs, spring cups, Neoprene impregnated fabric washer, steel washer, and Neoprene insert designed to prevent metal to metal contact between the hanger rod and bottom of the hanger box. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.

F. Type 6 - A spring hanger, as described in Type 5, with the addition of an elastomeric element at the top of the box for acoustic isolation. The design shall be such to prevent metal - to metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type 3 mountings.

G. Type 7 - An elastomeric hanger, consisting of a rectangular steel box and an elastomeric isolation element, which shall be of Neoprene or high quality synthetic rubber with anti-ozone and anti-oxidant additive. The elements shall be so designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the element. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the steel box.

H. Type 8 - 1/4" thick closed cell Neoprene ASTM Grade S.E.C. 44 in sheets cut to fit penetrations, as required.

2.03 BASE TYPES: Base types and required deflections are specified under "Schedule of Isolated Equipment", paragraph 7.8, or are indicated on the Drawings. The bases shall comply with the following descriptions for each type required on the project.

A. Type B-1 - A structural steel fan and motor base with motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive, and specifically shall be sized to limit deflection of the beam on the drive side to 0.05" due to starting torque. Snubbers to prevent excessive motion on starting or stopping shall be furnished, if required; however, the snubbers shall not be engaged under steady running conditions.

B. Type B-2 - A concrete inertia base, consisting of a perimeter steel pouring forming, reinforcing bars welded in place, bolting templates, anchor bolts, and height-saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6" deep. The inertia base for pumps shall be at least equal in weight to the pump with its driving motor and be sized for a minimum overlap of 4" around the base of the equipment. Concrete inertia bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS:

A. Install vibration isolators for motor driven equipment.

B. Set steel bases for one inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch clearance. Adjust equipment level.

C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

D. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, to be mounted on the scheduled vibration isolator type to prevent the transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. After the piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. The isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length which will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load.

E. Piping:

1. Floor mounted supports shall have the same type of isolator or media as is used for the

nearest isolated equipment connected to the piping.

2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights, and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

4. All springs supporting piping shall be capable of an additional 1/2" deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.

F. Resilient Sleeves:

1. Resilient sleeves shall be provided at all points where equipment room walls, floors, or ceilings are penetrated by ducts, piping, or refrigerant line, etc.

G. Fans and Air Handling Units:

1. Such units shall have electrical flexible connections not less than 36" long and the flexible duct connections with a free length of not less than 8".

3.02 SCHEDULE OF ISOLATED EQUIPMENT:

A. Tabulated below is a schedule of equipment on this project requiring vibration isolation and base isolators of the types listed above. Any equipment, system, construction or condition that may be altered, added, or changed; or that is not specifically considered herein or on the plans shall be treated in a manner that is set out for similar equipment system or construction in order to comply with the above requirements heretofore cited.

	ISOLATOR EQUIPMENT	ISOLATOR EQUIP. TYPE	BASE DEFLECTION	ISOL. TYPE
1.	Piping	5	1"	---
2.	All piping and duct floor penetrations in equipment room	8	---	---
3.	Piping in Mechanical Rooms	5	1"	---
4.	All piping and duct floor penetrations	8	---	---
5.	All pipe and duct wall penetrations	8	---	---
6.	AIR HANDLING UNITS	internally isolated	---	---

END OF SECTION

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SECTION 23 05 53
MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.02 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. NONE

1.03 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

1.04 REFERENCES

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.05 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified or implied in the specification.

F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.06 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00.

B. Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Manufacturers:

1. Seaton.
2. Other acceptable manufacturers offering equivalent products.
   a. Brady
   b. Bunting
   c. EMED

B. Description: Laminated three-layer plastic with engraved letters on contrasting background as hereinafter specified.

2.02 TAGS

A. Manufacturers:

1. Seaton
2. Other acceptable manufacturers offering equivalent products.
   a. W.H. Brady
   b. Bunting

A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

B. Chart: Typewritten letter size list in anodized aluminum frame.

2.03 PIPE MARKERS

A. Manufacturers:

1. Seton
2. Other acceptable manufacturers offering equivalent products.
   c. W.H. Brady
   d. Bunting
   e. EMED

B. Color: Conform to ASME A13.1.

C. 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.

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

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.04 CEILING TACKS

A. Manufacturers:

1. Seton
2. Other acceptable manufacturers offering equivalent products.
   a. W.H. Brady
   b. Bunting
   c. EMED

B. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

C. Color code as follows:

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

2.05 General: The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings. For example, pumps will be identified as 3A, 3B, 3C, etc.; exhaust fans will be E-1, E-2, etc.; supply fans will be S-1, S-2, etc.

2.06 Mechanical: All items of mechanical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed Gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

Pumps	Exhaust Fans	
Fan and Coil Units	Zoning Boxes/Valves	Fire/Smoke dampers
Air Conditioning Control	Miscellaneous - similar	
Panels and Switches	and/or related items	

2.07 Piping: Pipe markers and arrow markers also shall be provided on but not limited to the piping of the following systems:

Primary Chilled Water Supply	Pumped Steam Condensate	Natural Gas
Primary Chilled Water Return	High Pressure Steam Condensate	Oxygen
Instrument (Pneumatic) Air		RO Water
Atmospheric Relief	Clean Steam	Plumbing Piping

		Systems
Low Pressure Steam	Compressed Air	Roof Drain
Heating Hot Water Supply	Heating Hot Water Return	Domestic Hot Water Supply
Domestic Hot Water Return	Domestic Cold Water Supply	Domestic Cold Water Return
Medium Pressure Steam	Lab Waste	

2.08 Electrical: Nameplates shall be 2 or 3 ply laminated plastic, a minimum of 3/32" thick, such that letters will be white on black background. Letters shall be similar to Roman Gothic of a size that is legible and appropriate to the application. Attachment of nameplates shall be by screws. Rivets or adhesives are not acceptable.

A. Electrical equipment to be identified includes: All switchgear, distribution panels, transformers, motor control centers, panelboards, disconnect switches, starters, contactors and time switches.

B. Nameplates on distribution panels, motor control centers and panelboards shall give voltage characteristics.

Example:

PANEL LA
120/208V, 3 PH, 4 W
served from ___.

C. Individual circuit breakers in distribution panels, individual units in motor control centers, disconnecting means, and motor starters, shall have nameplates showing the load served.

D. Branch circuit panelboards shall have neatly typed circuit directories behind clean plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner; not necessarily those given on contract Drawings. If a circuit serves more than one room, list each room. Spares and spaces shall be indicated with erasable pencil; not typed.

2.09 The Contractor shall prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:

HPS-1-3 High Pressure Steam	1st Level - Valve No. 3
CHS-2-4 Chilled Water Supply	2nd Level - Valve No. 4

2.10 Valve Tags:

A. The Contractor shall provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves except simple service and drain valves located within 10' and within sight of the device or equipment served. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. These tags shall be 1/8" thick brass discs, 1 1/2" in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

B. Valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2 1/2" wide by 1 1/2" high with these color codings:

Red = normally closed; Green = normally open; Blue = open in winter, closed in summer; and Yellow = closed in winter, open in summer. Tags should be engraved on both sides.

2.11 In addition, pipe runs throughout the building including those above lift out ceilings, under floor, and those exposed to view when access doors or access panels are opened shall be identified by means of Seton Setmark or Brady Mechanical Pipe Markers. Concealed areas, for purposes of this identification section, are those areas which cannot be seen except by demolition of the building elements. In addition to the pipe markers, arrow markers shall be used to indicate direction of flow. The following specific instructions shall apply to the application of these markers:

A. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one header, it is necessary to mark only the header.

B. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

C. Provide a double ended arrow marker when flow can be in either or both directions.

D. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line goes through a wall or service column.

E. Provide pipe markers and arrow markers at intervals not exceeding 50 feet.

F. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.

G. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, 3/4" thru 6". For piping systems larger than 6", use Seton or Brady strap on markers.

H. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems". Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

I. Locate markers so as to be visible from floor.

2.12 Specials: Refer to special requirements noted in the various sections hereinafter bound.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 91 00 for stencil painting.

3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 91 00.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's

instructions.

F. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify thermostats relating to terminal boxes or valves with nameplates.

J. Identify valves in main and branch piping with tags.

K. Identify air terminal units and radiator valves with numbered tags.

L. Tag automatic controls, instruments, and relays. Key to control schematic.

M. Provide ceiling tacks to locate valves, dampers or other concealed equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 05 93
SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. 23 00 00 -- Basic Mechanical Requirements

B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors

C. 23 05 53 -- Mechanical Identification

1.01 SUMMARY

A. Testing, adjusting and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed by the Owner, separate and apart from the construction contract.

B. The firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up the basic work as may be required.

1.02 QUALIFICATIONS

A. The Firm shall be one which is organized to provide professional services of this specified type in the State of Texas and as a minimum shall have one (1) professional engineer licensed in the State of Texas, with current registration, to perform such professional services. This engineer shall be personally responsible for developing the job site data as required in the test procedures outlined in these Specifications.

B. The Firm shall have operated a minimum of five (5) years under its current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status.

C. The Firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted, or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.

D. All personnel used on the job site shall be either professional engineers or engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.

E. The TAB firm shall submit biographical data on the individual proposed to directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.

1.03 REFERENCES

A. AABC - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, Sixth Edition 2002.

B. ASHRAE - 2007 HVAC Applications Chapter 37: Testing, Adjusting and Balancing.

C. ANSI/ASHRAE Standard 111-2008 - Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

1.04 DOCUMENTS

A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one set of mechanical specifications, all pertinent change orders, and the following:

1. One complete set of Drawings less the structural sheets.

2. One set of mechanical floor plans of the conditioned spaces. These Drawings shall be ozalid type (blue or black on light background) reproductions to facilitate marking.

B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.06 through 1.10 of this Specification will be available through the Construction Inspector.

1.05 RESPONSIBILITIES OF THE TAB FIRM

A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC 2002 Standard, Sixth Edition.

B. Liaison and Early Inspection:

1. The TAB firm personnel on the job shall act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:

a. During the design stage, before the documents are finalized, review the mechanical drawings and specifications for balanceability and provide commentary.

b. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to commissioning work and balanceability.

c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Commentary will be provided to the RCM of each observation.

d. Test one (1) 8" single duct terminal box for performance capability and leakage as described in Section 23 36 00.. The shipment of the box to the

TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received at the TAB Agency.

e. Test one (1) 8" fan powered box for performance capability and leakage as described in Section 23 36 00A.. The shipment of the box to the TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received by the TAB agency.

f. Test 10% of the single and dual duct boxes for casing and damper leakage when the shipment arrives at the project site. All testing (except for the initial boxes) shall be performed on site.

Boxes requiring re-testing will be charged to the Contractor at the unit price provided to the Owner.

2. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.06 FINAL AIR BALANCE

General: When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within ±5% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:

1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.

2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Division 23 Contractor shall make any required changes.

3. Ampere Readings: Measure and record full load amperes for motors.

4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.

5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.

6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).

7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.

8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within ±5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.

9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.

10. Maximum and minimum air flow on terminal boxes.

1.07 FINAL CHILLED AND STEAM BALANCE

General: When systems are completed and ready for operation, the TAB Consultant will perform a final water balance for each chilled and hot water system. The general scope of balancing by the TAB Consultant will include, but not be limited to, the following:

1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger for design flow, ±5%. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve (Note: If discharge valves on the pumps are used for balancing record the head being restricted by the valves).

2. Temperature Readings: Read and record entering and leaving water temperature at each water coil, converter and heat exchanger. Adjust as necessary to secure design and conditions. Provide final readings at all thermometer well locations.

3. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is obtained and total water flow is verified by flow measuring status. For coils equipped with 3 way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.

4. Ampere Readings: Reading and record full load amperes for each pump motor.

1.08 SOUND VIBRATION AND ALIGNMENT

A. Sound: Read and record sound levels at up to 15 locations in the building designated by the Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet in the presence of the Engineer, if he so desires.

B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 HP. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed 1 mil on fans and 1 mil on pumps unless otherwise specified. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.09 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. In the process of performing the TAB work, the TAB Agency shall:

1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.

2. Verify that all control devices are properly connected.

3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.

4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).

5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes and fire/smoke dampers.

6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.

7. Observe the calibration of all controllers.

8. Verify the proper application of all normally opened and normally closed valves.

9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.

10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.

11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.

12. Verify that all controller setpoints meet the design intent.

13. Check all dampers for free travel.

14. Verify the operation of all interlock systems.

15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

16. Warm/cool adjust setting should be set to +/-0 by the TAB and JCI for owner manipulation in the future. No calibration shall be necessary.

B. A systematic listing of the above testing and verification shall be included in the final TAB report.

1.10 STAIRWELL PRESSURIZATION SYSTEMS

A. With all doors closed, measure the door pull to determine that the opening force required is below 30 #/ft.

B. With all doors closed, measure the pressure differential across each door to verify the pressure differentials at each floor.

C. Measure the air flow in the stairwell with the maximum number of doors fully open by pitot tube traverse, if traverse locations are available. If traverse locations are not available, measure air flow at each outlet.

D. Verify with smoke that the smoke detector in the stair pressurization fan inlet shuts the fan down.

1.11 REPORTS

A. The activities described in this section shall culminate in a report to be provided in a single (1) bound copy to the RCM and six (6) electronic versions on CD or USB drive.. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.

B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or engineers of the firm.

C. At the option of the Construction Inspector, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Construction Inspector. Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.

D. Submit reports on forms approved by the Owner & Engineer which will include the following information as a minimum:

1. Title Page

a) Company Name
b) Company Address
c) Company telephone number
d) Project name
e) Project location
f) Project Manager
g) Project Engineer
h) Project Contractor

i) Project Identification Number

2. Instrument List

a) Instrument
b) Manufacturer
c) Model
d) Serial Number
e) Range
f) Calibration date
g) What test instrument was used for

3. Fan Data (Supply and Exhaust)

a) Location
b) Manufacturer
c) Model
d) Air flow, specified and actual
e) Total static pressure (total external), specified and actual
f) Inlet pressure
g) Discharge pressure
h) Fan RPM

4. Return Air/Outside Air Data (If fans are used, same data as for 3 above)

a) Identification/location
b) Design return air flow
c) Actual return air flow
d) Design outside air flow
f) Return air temperature
g) Outside air temperature
h) Required mixed air temperature
i) Actual mixed air temperature

5. Electric Motors

a) Manufacturer
b) HP/BHP
c) Phase, voltage, amperage, nameplate, actual
d) RPM
e) Service factor
f) Starter size, heater elements, rating

6. V-Belt Drive

a) Identification/location
b) Required driven RPM
c) Driven sheave, diameter and RPM
d) Belt, size and quantity
e) Motor sheave, diameter and RPM
f) Center-to-center distance, maximum, minimum and actual

7. Duct Traverse

a) System zone/branch
b) Duct size

c) Area
d) Design velocity
e) Design air flow
f) Test velocity
g) Test air flow
h) Duct static pressure
i) Air temperature
j) Air correction factor

8. Air Monitoring Station Data

a) Identification/location
b) System
c) Size
d) Area
e) Design velocity
f) Design air flow
g) Test velocity
h) Test air flow

9. Air Distribution Test Sheet

a) Air terminal number
b) Room number/location
c) Terminal type
d) Terminal size
e) Area factor
f) Design velocity
g) Design air flow
h) Test (final) velocity
i) Test (final) air flow

10. Pump Data

a) Identification/number
b) Manufacturer
c) Size/model
d) Impeller
e) Service
f) Design flow rate, pressure drop, BHP
g) Actual flow rate, pressure drop, BHP
h) Discharge pressure
i) Suction pressure
j) Total operating head pressure
k) Shut off, discharge and suction pressure
l) Shut off, total head pressure
m) Pressure differential settings

11. Cooling Coil Data

a) Identification/number
b) Location
c) Service
e) Manufacturer
f) Entering air DB temperature, design and actual
g) Entering air WB temperature, design and actual

h) Leaving air DB temperature, design and actual
i) Leaving air WB temperature, design and actual
j) Water pressure flow, design and actual
k) Water pressure drop, design and actual
l) Entering water temperature, design and actual
m) Leaving water temperature, design and actual
n. Air pressure drop, design and actual

12. Heating Coil Data

a) Identification/number
b) Location
c) Service
d) Manufacturer
e) Air flow, design and actual
f) Water flow, design and actual
g) Water pressure drop, design and actual
h) Entering water or steam temperature, design and actual
i) Leaving water temperature, design and actual
j) Entering air temperature, design and actual
k) Leaving air temperature, design and actual
l) Air pressure drop, design and actual

13. Sound Level Report

a) Location (Location established by the design engineer)
b) NC curve for eight (8) bands - equipment off
c) NC curve for eight (8) bands - equipment on

14. Vibration Test on equipment having 10 HP motors or above

a) Location of points:

1) Fan bearing, drive end
2) Fan bearing, opposite end
3) Motor bearing, center (if applicable)
4) Motor bearing, drive end
5) Motor bearing, opposite end
6) Casing (bottom or top)
7) Casing (side)
8) Duct after flexible connection (discharge)
9) Duct after flexible connection (suction)

b) Test readings:

1) Horizontal, velocity and displacement
2) Vertical, velocity and displacement
3) Axial, velocity and displacement

c) Normally acceptable readings, velocity and acceleration

d) Unusual conditions at time of test

e) Vibration source (if non-complying)

15. Control verification indicating date performed and any abnormalities identified.

a) Point Location/Description and verification back to graphics

b) EMS Readout (Setpoint and Actual)

c) Actual Readout

d) Interlocks

e) Safeties
   1) VSD Normal Operation
   2) VSD Bypass Operation

f) Alarms

g) Sequences of Operation

END OF SECTION

SECTION 23 05 93.A
SYSTEM PREPARATION FOR
TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SUMMARY

A. Perform all work required to prepare the building HVAC systems for testing, adjusting and balancing indicated by the Contract Documents as follows:

1. Responsibilities of project contractor.

2. Preparation for balancing of air systems.

3. Preparation for balancing of hydronic and steam systems.

B. The scope of the TAB work as defined in Section 23 05 93 is indicated in order that the Contractor will be advised of the coordination, adjustment, and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB. The TAB firm will not have a contractual relationship with any Contractor referred to herein, but will be responsible to the Construction Inspector and the Owner for the satisfactory execution of the TAB work. The Contractor in his original bid shall allow for the costs required to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.02 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 06 20.13 - Hydronic Specialties.

C. Section 23 22 00.A - Steam and Steam Condensate Specialties.

D. Section 23 82 16 - Air Coils.

E. Section 23 73 23 - Air Handling Units

F. Section 23 31 00 - Ductwork.

G. Section 23 33 00 - Ductwork Accessories.

H. Section 23 09 23 - Direct Digital Control Systems.

I. Section 23 05 93 - System Testing, Adjusting & Balancing.

1.03 SCOPE OF WORK

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed directly by the Owner, separate and apart from the Construction Contract. However, the preparation for and corrections necessary for the Testing, Adjusting and Balancing of these systems, as described herein, are the responsibility of the Contractor.

B. As a part of this project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, etc. required for correct balance as advised by the TAB firm, at no additional cost to the Owner.

C. The Contractor shall provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting and balancing period.

D. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate said systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. This length of time shall be subject to the approval of the Construction Inspector.

E. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The contractor shall allow adequate time for the testing and balancing activities of the owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

F. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Construction Inspector shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.04 RESPONSIBILITIES OF THE PROJECT CONTRACTOR:

A. The Contractor shall:

1. Have the building and air conditioning systems in complete operational readiness for TAB work to begin.

2. The contractor shall allow sufficient time for the TAB firm to perform his contracted work within the construction schedule. The contractor shall complete his work by systems or floors whichever is the most efficient for scheduling. After awarding of the contract and the contractor has developed a construction schedule, a TAB coordination meeting shall be held at the RCM's office with the TAB agency, the general contractor and his primary subcontractors (i.e. mechanical, electrical, building automation etc.) to develop a testing schedule for the project. The contractor shall submit copies of the proposed schedule two (2) weeks prior to this meeting to the RCM and TAB Agency.

   The following are minimum time requirements:

   TAB Agency will provide Engineer with tentative schedules for each area, floor and/or system to be included in this section.

Note: The hot water and chilled water systems must be 100% complete to balance. The air systems are pressure independent and can be balanced by floors, risers, systems, etc., but once the total system is complete the total flows and system tracking will require finalization. Lab certification will be performed when the building is 100% operational and balanced.

3. Promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB work.

4. Be responsible for any added costs to the Owner resulting from his failure to have the building and air conditioning systems ready for TAB when scheduled, or from his failure to correct deficiencies promptly.

B. Complete operational readiness of the building requires that construction status of the building shall permit the closing of doors, windows, ceilings installed, etc., to obtain simulated or projected operating conditions.

C. Complete operational readiness of the air conditioning systems also requires that the following be accomplished:

1. Air Distribution Systems:

a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated and pressure tested for leakage as required by the Specification.

b. All volume, smoke and fire/smoke dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation.

c. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices installed.

d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessive bypass or leakage of air.

e. All fans (supply, return and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating; record motor amperage and voltage on each phase at start-up and running, and verify they do not exceed nameplate ratings.

f. All single and/or double duct variable and constant volume terminal units ("mixing boxes") shall be installed and functional (i.e. controls functioning).

2. Water Circulating Systems:

-

a. Check and verify pump alignment and rotation.

b. Open all valves to their full open position, close bypass stop valves. Set mixing valves to full-flow through systems components. After the system is flushed and checked for proper operation, remove and clean all strainers. The Contractor shall repeat the operation until circulating water is clean.

c. Record each pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating.

d. Verify that the electrical heater elements are of the proper size and rating.

e. In preparation of TAB all water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Systems shall be cleaned and flushed. Chemicals shall be added to closed systems to treat piping and inhibit corrosion.

f. Check and set operating parameters of the heat exchangers and control devices to the design requirements.

3. Automatic Controls:

a. The Contractor shall schedule a meeting with the Engineer, Control Contractor, TAB firm and Owner's representative for a pre-submittal review to establish that their interpretations of the sequences of operation are correct.

b. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, dampers sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.

c. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats or sensors, which shall be calibrated at the completion of TAB services with cooperation between the TAB firm and Control Contractor.

d. The Automatic Temperature Control Contractor and/or Energy Management System Contractor shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB agency that the Automatic Temperature Controls and Energy Management System are operational. The Automatic Temperature Contractor and/or Energy Management System Contractor shall provide technical support (technicians and necessary computers) to the TAB agency for a complete check of these systems.

4. Tabulated Data: The motor amperages, voltages shall be recorded showing "actual" and "nameplate" voltage and amperage and submitted and actual RPM. This applies to each piece of electrically driven air conditioning equipment in the system including supply and exhaust fans, fans of fractional horsepower, pumps, etc.

D. Notification of System Readiness:

1. After completion of the work in Paragraph 1.05 A through C above, the Contractor shall notify the Owner in writing, certifying that the work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing. He shall include a copy of the tabulated data of Paragraph 1.04C.4 above.

2. The Owner will, in turn, notify the TAB firm of the readiness for balancing and forward copies of the Contractor's certification and the tabulated voltages and currents.

3. Should the TAB firm be notified as described above, and the TAB work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by duly appointed representative of the Owner, Architect, TAB firm and the Contractor. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriated parties by the Project Contractor.

1.05 RESPONSIBILITIES OF THE TAB FIRM

A. Refer to Section 23 05 93 entitled "System Testing, Adjusting and Balancing".

END OF SECTION

SECTION 23 06 20
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED

A. Expansion tanks.

B. Air vents.

C. Strainers.

D. Pump suction fittings.

E. Relief valves.

F. Water flow measuring and balancing system.

1.02 RELATED WORK

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 21 00 - Hydronic Piping.

1.03 REFERENCES

A. ANSI/ASME - Boilers and Pressure Vessels Code.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks.

1.05 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.06 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project.

C. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

PART 2 PRODUCTS

2.01 AUTOMATIC AIR VENTS:

A. Provide at the highest points of the chilled water system and on the chilled water coils as shown on the Drawings, an automatic air vent, Armstrong No. 21AR or approved equal, with a pressure rating of 250 psig. Provide shut-off valve to facilitate maintenance of air vent. Locate all air vents and their discharge lines in accessible locations, preferably clustered.

2.02 STRAINERS:

A. Each control valve for chilled water and heating water, and each pressure reducing valve assembly regardless of its size shall be preceded by a sediment strainer. The arrangement of these sediment strainers shall be such that the screens may be removed for cleaning with ease through a gasketed plug. Monel or stainless steel shall be used to fabricate the noncollapsible, lapped screens, which shall contain no soldered joints.

B. Sediment strainers shall be placed in piping systems wherever shown on the Drawings and at such other points as may be required for the removal of foreign material from the piping systems.

C. Strainers for water piping 2-1/2" and larger shall be Crane No. 989-1/2 Sediment Separators or approved equal. In piping two inches (2") and smaller, they shall be Crane No. 988-1/2, or approved equal.

D. Strainers, 2" and smaller, bronze body, screwed ends, No. 10 mesh strainer, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap). Cast iron body, 2 1/2" and larger, isolating type flanged ends where installed in copper lines, No. 7 perforated monel strainer, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap). Special Note: All strainers 6" and larger shall have studs
mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6" and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.

E. Full sized blow off valves shall be installed on all strainers in steam, condensate, chilled and hot water lines and a drain shall be installed from each valve to the nearest floor drain.

2.03 GAUGES AND GAUGE CONNECTIONS:

A. Furnish and install Ashcroft No. 1279A Duragauges on both suction and discharge sides of pumps, complete with Ashcroft No. 1095 lever handle shut-off cocks, and Ashcroft No. 1106B pulsation piston type dampeners, or approved equal. Porous type will not be accepted. See pump Specifications. Gauges shall have stainless steel movement and 1/2

of 1% accuracy. Gauges shall have back connection when used on a panel; otherwise they shall have bottom connections. The graduation of the dials and the arrangement of the mechanisms shall conform to the pressure range details shown on the Drawings.

B. Combination pressure or vacuum gauges shall be Ashcroft Duragauges No. 1279AC, or approved equal. The accessories for these gauges shall conform to those prescribed for pressure gauges.

C. Furnish and install, where noted or indicated on the accompanying Drawings or called for elsewhere in these Specifications, gauge connections complete with Ashcroft No. 1095 lever handle union shutoff cocks, or approved equal. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.

2.04 THERMOMETER AND THERMOMETER WELLS:

A. Furnish and install thermometers of not less than 9" scale complete with brass separable sockets with extension neck to allow for insulation of piping. These thermometers shall be mercury red reading type in one piece glass tubes extending from top of scale to sensor, and shall be located so that they may be easily read. Field adjustable angle thermometers are acceptable. Thermometers shall in all cases be installed upright or at the proper angle to be read while standing on the floor. The wells for thermometers shall be located in vertical pipes where possible and when necessary in horizontal pipes they shall be installed in the side and not on the top of the pipe. They shall be Weksler Industrial Thermometers, or approved equal, with range of 0 to 100 degrees F. for chilled water, and 0 to 220 degrees F for hot water.

B. Thermometer wells and thermometers shall be located where noted on the accompanying Drawings and where called for in other sections of the Specifications. Thermometer test wells only shall be installed in a vertical position in horizontal lines and at 45 degrees, in vertical lines to hold a fluid in the well.

C. Thermometer test wells shall be 3/4" Weksler Thermal Wells, brass with stem of minimum length to extend beyond the mid-diameter of the pipe, 2-1/2" extension neck, and brass screw plug. Wells shall be suitable for use of industrial type thermometers.

D. Indicating thermometers shall be placed in lines wherever shown on the Drawings. These thermometers shall be Weksler Industrial Thermometers having stainless steel separable sockets and scales of the range shown on the Drawings.

2.05 WATER RELIEF VALVES:

A. The pressure relief valves installed for the protection of the water circulating circuits shall be McAlear No. 307 single seated diaphragm and spring type valves with screwed connections or approved equal. They shall be 3/4" size of bronze construction with bronze seat, composition shut-off disc and rubber diaphragm.

PART 3 EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Support tanks inside building from building structure in accordance with manufacturer's instructions.

C. Provide manual air vents at system high points and as indicated.

D. Provide manual air vents at entrance to all heating hot water coils, with a "cane" shaped discharge tube, positioned to permit draining to a portable receptacle.

E. For automatic air vents in ceiling spaces or other concealed locations, extend vent tubing to nearest drain.

F. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.

G. Support pump fittings with floor mounted pipe and flange supports.

H. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

J. Pipe relief valve outlet to nearest floor drain.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

L. Heating water branch lines serving reheat coils shall have a balancing valve with memory stop and flow measuring station located upstream of the shut-off valve on the return side similar to Tour and Anderson.

M. Provide pressure/temperature test port in a straight run of pipe adjacent to each temperature or pressure sensor installed in the hydronic piping and at the inlet and outlet of each pump and coil to facilitate proper calibration and maintenance.

N. Provide to the owner, one portable flow meter equivalent to Omega FDT-81. Provide a removable insulation section on each AHU where this section can be removed to utilize the flowmeter.

END OF SECTION

SECTION 23 07 13
DUCTWORK INSULATION

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Ductwork insulation.

B. Insulation jackets.

1.02 RELATED SECTIONS

A. Section 09 91 00 - Painting: Painting insulation jackets.

B. Section 23 00 00- General Mechanical Requirements.

C. Section 23 05 53 - Mechanical Identification.

D. Section 23 31 00 - Ductwork: Duct liner.

E. Section 23 33 00 - Ductwork Accessories: Duct liner.

1.03 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.

D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

E. ASTM E84 - Surface Burning Characteristics of Building Materials.

F. ASTM E96 - Water Vapor Transmission of Materials.

G. NFPA 255 - Surface Burning Characteristics of Building Materials.

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

I. UL 723 - Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

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

C. Samples: Submit two samples of any representative size illustrating each insulation type.

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

1.05 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 255.

1.06 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 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 Insulation A:

A. Four pound per cubic foot minimum density glass fiber semi-rigid board insulation with fiber perpendicular to the surface and with factory applied white foil reinforced vapor barrier jacket (ASJ). Insulation shall be equal to E.O. Woods Company "Rigid-Wrap". The insulation shall be directly in contact with the duct, no air gap shall be allowed between the insulation and the metal.

B. The insulation shall be secured to the ducts with mechanical fasteners; "Stick-clips", Graham Pins or Speed Clips, and shall be spaced approximately 12" on center on bottom of duct and where required elsewhere to hold insulation securely against the duct as noted in the published recommendations of the Insulation Manufacturer.

C. After insulation is in place, all joints and seams shall be sealed with vapor barrier water based emulsion applied over a 3" wide strip of Duramesh Glass Fabric. All protrusions through the vapor barrier shall be thoroughly sealed.

D. On ducts that are reinforced with standing seams or angle iron stiffeners 1" and over in height, the Contractor shall apply a strip of fiberglass board (insulation A type) 1" thick by 6" wide, sealing same to the other insulation with glass fabric with water based emulsion as noted in 2.01C.

2.02 Insulation B:

A. Three pound per cubic foot minimum density glass fiber rigid board insulation with factory applied white foil reinforced All Service Jacket (ASJ).

B. Insulation B shall be applied as specified for Insulation A.

C. Contractor at his option may substitute Insulation A where Insulation B is called for.

2.03 Insulation C:

A. Blanket insulation similar in construction to Owens-Corning Fiberglass Series or Johns Manville Microlite, one pound per cubic foot minimum density with foil reinforced Kraft (FRK) vapor barrier facing. Insulation shall be wrapped on the ductwork in accordance to manufacturer's stretched-out criteria, with all circumferential joints butted and longitudinal joints overlapped a minimum of 2". Adhere insulation to metal with 4" strips of insulation bonding adhesive at 8" on center. On circumferential and longitudinal joints, the 2" flange of the facing shall be secured using 9/16" flare door staples applied 6" on center and taped with 4" wide fiberglass tape embedded in vapor barrier Emulsion and covered with vapor barrier emulsion until the tape is completely covered. All penetrations or punctures in facing shall also be taped. Vapor sealing of joints is not required on hot duct application where concealed.

2.04 Vapor Seal Emulsion – Where specified herein, joint and seam vapor sealant shall be water based materials equal to Foster 30-35, Hardcast "Flex-Grip" 550 (sprayed to 20 mil thickness), or Childers Chil-Perm WB CP-35.

2.05 All ductwork in the building and in the crawl spaces except exhaust and return ducts shall be insulated externally unless specifically excluded. Only sound attenuated return ducting may be insulated internally, if specifically designated as such.

2.06 Where ducts are lined internally, (see Drawings for Scope) no exterior insulation will be required, except where specifically stated otherwise. Where internal and external insulation join, they shall lap at least 24 inches.

2.07 Low pressure supply duct taps to ceiling diffusers shall be externally insulated including top of ceiling diffuser.

2.08 Flexible round ducts are specified in Section 23 31 00 as factory insulated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

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

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Insulated ductwork conveying air below ambient temperature:

1. Provide insulation with vapor barrier jackets.

2. Finish with tape and vapor barrier jacket.

3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:

1. Provide with or without standard vapor barrier jacket.

2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. For ductwork exposed in mechanical equipment rooms or in finished spaces, finish with aluminum jacket up to 8’0” above finished floor.

E. For exterior applications, provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

F. External Duct Insulation Application:

1. Secure insulation without vapor barrier with staples, tape, or wires.

2. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.

3. Seal vapor barrier penetrations by mechanical fasteners with fiberglass tape embedded in vapor barrier Emulsion and covered with vapor barrier emulsion until the tape is completely covered as specified above.

4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Duct and Plenum Liner Application:

1. Adhere insulation with adhesive for 100 percent coverage.

2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.

3. Seal and smooth joints.

4. Seal liner surface penetrations with adhesive.

5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.03 All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

3.04 All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

3.05 All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

3.06 All surfaces to be insulated shall be clean and dry before applying the insulation. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. <u>No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight</u>. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable..

3.07 Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

3.08 Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.

3.09 Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. <u>Do not use wheat paste</u>. In addition, <u>cover all canvas insulation with a fire retardant coating</u>.

3.10 For purpose of definition in this Specification: "<u>concealed</u>" areas are those areas which cannot be seen by the building occupants, and "<u>exposed</u>" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

3.11 The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer’s recommendations.

3.12 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.13 DUCT INSULATION SCHEDULE:

Duct Type	Insulation Type
Medium Pressure Rectangular Supply Duct In Mechanical Rooms 8' AFF and below	1 1/2" Insulation B
Outside Air Duct	1 1/2" Insulation A
Medium & Low Pressure Supply Duct Other than noted above (including tops of diffusers)	2" Insulation C

END OF SECTION

SECTION 23 07 16
EQUIPMENT INSULATION

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

C. Breaching insulation.

1.02 RELATED SECTIONS

A. Section 09 91 00 - Painting: Painting insulation covering.

B. Section 23 00 00 - General Mechanical Requirements.

C. Section 23 05 53 - Mechanical Identification.

1.03 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded- Hot-Plate Apparatus.

C. ASTM C195 - Mineral Fiber Thermal Insulation Cement.

D. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

E. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

F. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

G. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

I. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

J. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.

K. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

L. ASTM C640 - Corkboard and Cork Pipe Thermal Insulation.

M. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

N. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

O. ASTM E84 - Surface Burning Characteristics of Building Materials.

P. ASTM E96 - Water Vapor Transmission of Materials.

Q. NFPA 255 - Surface Burning Characteristics of Building Materials.

R. UL 723 - Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide product description, list of materials and thickness for equipment scheduled.

C. Samples: Submit two samples of any representative size illustrating each insulation type.

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

1.05 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 255.

1.06 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 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

2.02 CONDENSATE RECIEVER

A. Receivers of the condensate shall be insulated with 6 lb. (minimum) density fiberglass board or rigid wrap insulation with a factory applied All Service Jacket. All joints shall be filled with insulating cement and covered with All Service Jacket material stapled in place and sealed with adhesive. Thickness shall be 1 ½" and provide a vapor barrier similar to chilled water piping.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Do not insulate factory insulated equipment.

C. On exposed equipment, locate insulation and cover seams in least visible locations.

D. Apply insulation close to equipment by grooving, scoring, and bevelling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.

2. Finish with glass cloth and vapor barrier adhesive.

3. Insulate entire system.

G. For insulated equipment containing fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Finish with glass cloth and adhesive.

3. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

4. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.

H. Inserts and Shields:

1. Application: Equipment 2 inches diameter or larger.

2. Shields: Galvanized steel between hangers and inserts.

3. Insert location: Between support shield and equipment and under the finish jacket.

4. Insert configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: Heavy density insulating material suitable for the planned temperature range.

I. Finish insulation at supports, protrusions, and interruptions.

J. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.

K. For exterior applications, provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

L. Cover cellular glass and cellular foam insulation with aluminum jacket.

M. Do not insulate over any nameplate or ASME stamps. Bevel and seal insulation around such.

N. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

O. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

P. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

Q. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

R. All surfaces to be insulated shall be clean and dry before applying the insulation. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. <u>No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight</u>. All materials used shall be fire retardant or nonflammable.

S. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation

with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

T. Extreme Care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and mixing boxes) ductwork to insure the duct is not pierced with sheetmetal screws or fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.

U. Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied 3 to a section of pipe. Fitings, valves, etc., shall have bands on each side.

V. Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

W. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

X. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 23 07 19
PIPING INSULATION

PART 1 GENERAL

1.00. The following sections are to be included as if written herein:

A. 23 00 00 -- Basic Mechanical Requirements

B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors

C. 23 05 53 -- Mechanical Identification

1.01. SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.02. PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

C. Section 23 21 00 - Hydronic Piping: Placement of hangers and hanger inserts.

D. Section 23 22 00 - Steam Piping: Placement of hangers and hanger inserts.

1.03. RELATED SECTIONS

A. Section 09 91 00 - Painting: Painting pipe and insulation jacket.

B. Section 23 00 00 - General Mechanical Requirements.

C. Section 23 05 53 - Mechanical Identification.

1.04. REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded- Hot-Plate Apparatus.

C. ASTM C195 - Mineral Fiber Thermal Insulation Cement.

D. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

E. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal

F. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

G. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

I. ASTM C547 - Mineral Fiber Preformed Pipe Insulation.

J. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

K. ASTM C578 - Preformed, Block Type Cellular Polystyrene Thermal Insulation.

L. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

M. ASTM C591 - Rigid Preformed Cellular Urethane Thermal Insulation.

N. ASTM C610 - Expanded Perlite Block and Pipe Thermal Insulation.

O. ASTM C640 - Corkboard and Cork Pipe Thermal Insulation.

P. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

Q. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

R. ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).

S. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.

T. ASTM E84 - Surface Burning Characteristics of Building Materials.

U. ASTM E96 - Water Vapor Transmission of Materials.

V. NFPA 255 - Surface Burning Characteristics of Building Materials.

W. UL 723 - Surface Burning Characteristics of Building Materials.

1.05. SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide product description, list of materials ‘k’ value, ‘R’ value, mean temperature rating, and thickness for each service, and locations.

C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.

D. Manufacturer’s Installation Instructions: Submit the manufacturer’s published installation documents for installation details, support and anchor methods, sealing, installation procedures and installation environment. Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.06. QUALITY ASSURANCE

A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this section of the Specifications. No material may be used that, when tested by the

ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together without voids. A mastic filler is not acceptable to fill voids. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”) on end sections and the longitudinal tape shall be 4” on jackets. Where insulation terminates, it shall be neatly beveled and finished moisture proof. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 23 00 00.

C. No insulation material shall be installed in combination with or contiguous to other types of insulation in a manner which could adversely impact the performance of either insulation material.

D. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

E. The manufacturer’s representative for the insulation shall visit the site a minimum of 4 times to review the installation practices, confer with the installer and prepare a field observation report that notes variations from manufacturer’s recommendations or recommendations to improve the installations.

F To be considered, alternate materials shall have equivalent thermal, permability, water absorption and moisture resistance of the specified materials.

1.07. QUALIFICATIONS

A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work and torn vapor jackets will not be acceptable and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years experience specializing in the trade.

1.08. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer’s identification, including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

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.

C. All insulation materials to be asbestos free.

PART 2 PRODUCTS

2.03 STEAM AND CONDENSATE PIPING:

A. Steam and condensate piping in the main loop system and up to and including PRV's and in the building shall be insulated with Manville's Thermo-12 or Owens/Corning "Kaylo" calcium silicate insulation with a factory applied aluminum cover .016" thick (Metal-On). If metal-on factory applied cover is not available, provide a manufacturer's written letter and provide for a filed-installed aluminum jacket as specified herein. Joints shall be sealed with aluminum snap straps provided, fastened in place with ¾" wide x .020" stainless steel bands. Fittings and valves shall be insulated with the same thickness as that applied to the adjacent pipe and shall have an outer removable covering of aluminum as manufactured by Premetco.

B. Consideration will be given to the use of Manville's Thermo-12 or Owens/Corning "Kaylo" with an outer covering of Premetco smooth finish, pre-cut, pre-rolled, Kraft paper lined aluminum Jacketing with zee type closure and 1-3/4" wide snap strap with permanent sealant in lieu of "Metal-On". Thickness of this jacketing shall be .016" on pipe sizes 8" and smaller and .020" on 10" pipe and larger.

C. If Premetco jacketing is used, it shall be aluminum banding (.020N thick) using three section of covering

D. Pipe insulation shall be firmly wired in place by the use of no less than six (6) loops of No. 16 annealed copper clad iron wire per three foot section of insulation. These sections shall be staggered. The ends of these loops shall be twisted together tightly and bent over and hammered into the insulation so as to leave no projection. Bands shall be .020" thick, ¾" wide, 3 bands per section of insulation. Fittings, valves, etc., shall have bands on each side.

E. All fittings on pipe 4" and larger shall be covered with the same material as the pipe, mitered and smoothed, and securely wired to the pipe.

F. Fittings and valves for pipe smaller than 4" shall be insulated with Manville's No. 301 hydraulic setting cement and each application shall be in layers not thicker than ½". Each layer shall be allowed to dry before the next layer is applied.

G. All cracks and voids in this insulation shall be filled carefully with Manville's Cement No. 301 so that the resulting surface is smooth and continuous.

H. At all pipe flanges, the insulation shall be beveled in such a manner that access may be had to the bolt studs and nuts without injuring the insulation where removable covers have been specified.

I. A layer of 40 pound rosin-size paper or ¾ pound deadening felt shall be wrapped around the insulation before an 8 ounce canvas jacket is pasted in place. This canvas jacket shall be pasted onto the covered pipe valves and fittings (where insulated) in a neat and workmanlike fashion, using Arabol adhesive.

J. All flanges, valves, pressure regulating valves, strainers, and any other hot surfaces shall be covered with a built-up removable covering made of Thermo-12 or “Kaylo” Pipe Covering with a finishing coat of Ryder hydraulic setting cement. This removable covering shall be banded on the valve or joint in such a fashion that it can readily be removed and replaced; it shall be of the same thickness as the insulation on the adjoining pipe.

K. Piping insulated with calcium silicate pipe insulation and finished with canvas outer jacket shall be properly labeled.

L. Refer to Section 23 05 53 for Mechanical Identification requirements.

M. Blankets by Specialty Insulation Solutions or equal manufacturer, may be used on steam traps, strainers, and all other items that require regular maintenance for ease in removal and replacement.

2.04. CHILLED WATER PIPING:

A. Chilled Water Piping - “FOAMGLAS” as manufactured by the Pittsburgh Corning Corporation Insulation and shall be installed on chilled water lines in tunnels and in buildings. The “FOAMGLAS” “StrataFab System” may also be installed on larger pipe sizes as appropriate. Prior to application of any insulation, all metal surfaces shall be thoroughly cleaned. The metal shall then be primed with an asphaltic primer consisting of one (1) coat of Foster No. 60-26 Primer or Pittcote 300 Primer. Cleaning and priming specified in this paragraph is not included in requirements for “Cleaning and Painting” specified in other sections of the Specifications. Regular “FOAMGLAS” insulation shall be applied to the piping with butt joints staggered and all joints tightly butted and sealed with a ¼” bead of joint sealer ½” from outside edge. Hold in place with 14 ga. copper clad wire 9” o.c. After insulation has been wired in place, a 1/16” minimum thick, 3” wide band of asphaltic vapor seal mastic shall be brushed or trowelled on the outside of the “FOAMGLAS” insulation at the approximate location of the aluminum bands. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) Any voids in “”the completed installation of the insulation shall not be filled with vapor seal coating but shall be eliminated by refitting or replacing insulation.

B. Chilled Water Piping Alternate: Insul-Phen as manufactured by Reolco or “KOOLPHEN K” as manufactured by Kooltherm. These materials shall be installed in strict compliance with the more stringent of these specifications or the manufacturer’s published installation manual which shall be available on site at all times. For cold water pipe all horizontal and circumferential joints shall be sealed with a very thin coat of vapor barrier mastic prior to closing the joints. All joints shall be staggered. The vapor barrier jacket shall be equal to Venture Wrap 1555W/U 3.4 mil, “0” perm cleanable material with 4” seam tape overlap and 6” joint tape or equal. Refer to the foamglass above for the method of insulating valves, fittings, etc. If Insulphen or Koolphen are used, an aluminum jacketing 0.016” thickness equal to Premetco precast will be required, pre rolled Z-lock Kraft paper lined pipe covering with zee type closure and ¾” wide snap straps with permanent sealant shall then be fitted to O.D. of insulation and applied over the insulated pipe with 4” end and side caps secured with aluminum bands on 12” centers. Longitudinal joint of aluminum jacketing shall be placed with overlap directed to bottom of pipe.

C. For cold water pipe, seal the ends of insulation and provide vapor dams at each end location or every 18’, which ever is shorter. Provide vapor dams between pipe and insulation at each flange, valve, change to vertical and end of insulation at equipment.

D. "FOAMGLAS", "Insul-Phen" or "KOOLPHEN K" insulation on flanges, valves and other fitting shall consist of prefabricated fitting covers of the same thickness as specified for adjoining pipe insulation per the manufacturer's published installation instructions.

C. Fitting covers shall be applied in same manner as pipe application except that 16 ga. aluminum wire may be used to secure fitting covers. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Papco or RPR Metals prefabricated fitting covers of 0.016" paper coated aluminum, secured as recommended by the manufacturer.

D. The insulation thickness shall be as scheduled.

E. "FOAMGLAS" , Insul-Phen, or "KOOLPHEN K" installed inside the building (where ambient conditions are typically below 76°F and humidities are below 60% RH) shall be installed with factory applied Class I, Fire Rated, Kraft-Aluminum jacketing on heating water and "0" perm jackets on cold water pipe, with 4" longitudinal laps and 6" joint tape. It shall be applied in strict accordance with the manufacturer's recommendations after the pipe has been primed with one (1) coat of Foster No. 60-26 Primer or Pittcoat 300 Primer. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) It will be necessary to include expansion joints at regular intervals on dual temperature service. Thickness shall be as scheduled.

F. Fitting covers shall be built up of shaped segments of "FOAMGLAS", Insul-Phen or "KOOLPHEN K". These fitting covers shall be adhered in place using "Foster No. 30-35 80" water based vapor seals, then smoothly covered by a one-quarter inch (1/4") thick application of one coat white insulating cement. All this piping and fittings shall be finished with an eight ounce canvas jacket neatly applied using Arabol adhesive.

G. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and premolded sections, plus white vapor seal mastic, plus Manville No. 301 finishing cement to smooth surfaces, plus canvas applied and sized for painting with fire resistant adhesive. In addition, all manufactured vapor barrier jacketing in mechanical rooms and finished spaces shall be finished with canvas applied and sized for painting with fire resistant adhesive.

H. No chilled water pipe supporting structures shall pierce the insulation except as anchor points as shown on the Drawings. At these points, the anchor member shall occur on the bottom of the piping to allow condensation to drain.

I. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings. Heavy density insulation shall be installed at every hanger and supported by pipe saddles as scheduled herein.

2.05. PROTECTIVE JACKETING:

A. Provide protective jacketing as described elsewhere.

B. Jacketing and fitting covers shall be .016 aluminum smooth as manufactured by Premetco or Childers. The jacket shall be pre-cut, pre-rolled, and lapped a minimum of two inches (2") In all directions to shed water. The metal shall be secured at each joint with a minimum of one each (1 ea.) ¾" wide .020 aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016" aluminum or stainless steel with a smooth finish.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions in the absence of more restrictive requirements or specific instruction herein.

B. For domestic cold water pipe, seal the ends of fiberglass insulation and provide vapor dams at each end location or every 18', which ever is shorter. Provide vapor dams between pipe and insulation on elastomeric insulation at each section end location or every 20' which ever is shorter.

C. For cold water pipe, seal the ends of insulation and provide vapor dams at each end location or every 18' which ever is shorter. Provide vapor dams between pipe and insulation on elastomeric insulation at each section end location or every 18' which ever is shorter.

D. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the "90°" position, with the seam lapped such that the lap is directed down.

D. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature: Vapor barriers are required. The vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

1. Provide vapor barrier jackets, factory applied or field applied. Vapor barrier jacket shall be equal to a Venture Wrap 3.4 mil, "0" perm, cleanable surface vapor jacket with 4" overlap tape strip.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.

3. Finish with glass cloth and vapor barrier adhesive.

E. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

F. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

G. If PVC fitting covers are used they shall have 25/50 rating.

H. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

I. For hot piping conveying fluids over 140°F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union. See 2.04K.

3.03 INSERTS, SUPPORTS and SHIELDS:

A. Application: Piping 2 inches diameter or larger for all systems except direct buried.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for Insulated pipes 2” and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi, shall be curved to fit up to mid-perimeter of the insulated pipe and to prevent sharp corners from contacting the jacket. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal IPS	Metal Thickness	Lengths of Shield
up thru 2”	14 gauge	12”
thru 6”	12 gauge	16”
and above	10 gauge	20”

C. Insert Location: Between support shield and piping and under the finish jacket.

D. Insert Configuration: Minimum 2” inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.

E. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

F. The shields at support points shall be secured with ½” x 0.016” stainless steel bands and seals.

G. Finish insulation at supports, protrusions, and interruptions.

H. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings.

I. In lieu of the above the following system of support may be used:

1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft^3 Phenolic Foam material to withstand the bearing loads transmitted from the pipe to the support, it shall extend for at least 1" on either side of the support to allow sealing of the joints with the pipe insulation jacket.

2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table 1.

Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1" thickness of 2.2 lbs/ft^3 standard insulation including FSK/ASJ vapor barrier.

Table 1 K Block Support Centers

Nominal Pipe Size	3/4	1	1 1/4	2	2 1/2	3	4	6	8	10	12	14	16	18	20	24
Max support centers (feet) Sch 80 pipe filled with water covered with 1" of Standard Insulation	6.5	6.5	6.5	10	10	10	10	10	14	14	14	20	20	20	20	20
Metal Saddle Gauge (Galvanized Steel)	22	22	22	20	20	20	16	14	14	14	14	14	114	14	14	14
Length of K Block (inches)	6	6	6	6	6	6	6	9	9	9	9	9	9	12	12	12

1. The Insulation at supports shall be a equal to Kooltherm K Block. K Blocks shall be faced with factory applied vapor barrier and fitted with a galvanized steel 180^0 saddle bonded to the bottom section of the K Block, for all pipe sizes 1 1/2" and larger.

2. The vapor barrier shall be completed by the use of a vapor barrier jacket 4” overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.

3. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval. e.g. Of the type Kooltherm Insulation products K Block. Ref:- Kooltherm sketch 106/2c for use with Roller or flat beam support.

4. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

C. Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

D. For purpose of definition in this Specification: “concealed” areas are those areas which cannot be seen by the building occupants, and “exposed” areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

E. Self Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.

F. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140°F on the hot surfaces.

G. Special Protection: All insulated piping in the mechanical rooms within 8'-0" of the floor shall be encased in a protective jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

H. Interior or conditioned areas are those where ambient conditions are typically below 76°F and humidities are below 60% RH. All other areas shall be considered exterior or exposed to outside conditions. Where enclosed and not conditioned but subject to high humidities the insulation shall be designed to prevent condensation at 80°F and humidities are at 90% RH.

I. All exposed outdoor piping shall have metal jacket.

J. Fitting insulation shall be applied in same manner as pipe application. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Pabco or RPR Metals prefabricated fitting covers of 0.016" paper coated aluminum, secured as recommended by the manufacturer.

K. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and premolded sections as necessary.

L. No pipe supporting device (other than guides or anchors attached directly to the pipe) shall penetrate the insulation.

M. Provide a removable insulation section on each AHU where this section can be removed to utilize the flowmeter provided by the Mechanical Contractor.

3.04 INSULATION TABLE:

Insulation 'R' Value Schedule (R = thickness / k)

Service	Oper Temp °F	'k' @ Mean Temp °F	Min. R value for each Pipe Size 1" & less	1-1/4" to 2"	2-1/2" to 4"	5" & 6"	8" & over
Hot(1)	350+	.33 @ 250	7.5	7.5	10.0	12.0	13.0
Hot(2)	251-350	.30 @ 200	6.5	8.5	8.5	11.5	12.5
Hot(3)	201-250	.29 @ 150	5.2	5.2	6.9	6.9	12.1
Hot(4)	141-200	.27 @ 125	5.6	5.6	5.6	5.6	5.6
Hot(5)	105-140	.26 @ 100	3.8	3.8	5.8	5.8	5.8
Cold(6)	40-55	.25 @ 75	2.0	3.0	4.0	4.0	4.0
Cold(7)	below 40	.25 @ 75	4.0	6.0	6.0	6.0	6.0

(1) HTHW; Steam @ over 120#
(2) HTHW; Steam @ 16# to120#; med & hp condensate; water and fire line freeze protection
(3) HTHW; Steam @ 0# to 15#; LP Condensate
(4) HW
(5) HW
(6) Ch. Wtr; Dom. cold wtr; Storm; Cold condensate
(7) Ch. Wtr; Brine; Refrig lines

Minimum 'R' does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.

A minus 15 percent tolerance, on the insulation performance listed shall be permitted for manufacturers' standard insulation systems

No chilled or heating water, steam or condensate insulation shall be less than 2” thickness. No chilled water pipe insulation in unconditioned space shall be less than three inch thickness.

Insulation may be ½” less inside the AHU downstream of the coils.

END OF SECTION

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEMS

PART 1 GENERAL

1.00 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Control equipment.

B. Software.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 21 00 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps, flow meters.

B. Section 23 22 00 - Steam and Steam Condensate Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps, flow meters.

C. Section 23 33 00 - Ductwork Accessories: Installation of automatic dampers, smoke detectors. Connection of damper end switches.

1.04 RELATED SECTIONS

A. Section 23 09 43 - Pneumatic Control Systems.

B. Section 23 09 93. - Sequence of Operation.

C. Section 26 05 00 - Equipment Wiring Systems.

1.05 REFERENCES

A. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.

B. ASME MC85.1 - Terminology for Automatic Control.

C. NEMA EMC1 - Energy Management Systems Definitions.

1.06 DEFINITIONS

A. Ensure terminology used in submittals conforms to ASHRAE 85.

1.07 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to the existing Metasys Campus Building Management System.

B. Central and remote hardware, software, and interconnecting wire and conduit.

C. Terminal unit controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, pneumatic or electric unless indicated otherwise.

D. Damper Motors and Valve Operators: Pneumatic & Electronic.

E. The DDC systems shall be installed by a JCI authorized contractor under a direct contract with the General Contractor. The JCI authorized contractor shall provide "open-book" pricing to the General Contractor and OFPC per the existing UTHSC-H/JCI agreement.

F. All sensors that are installed in insulated pipe or ductwork shall be installed with standoffs to allow proper insulation of all materials and continuation of vapor barriers.

G. NOTE ALL CONTROL CONDUIT SHALL BE COLOR CODED BLUE.

1.08 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Shop Drawings:

1. Trunk cable schematic showing programmable control unit locations, and trunk data conductors.

2. List of connected data points, including connected control unit and input device.

3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

5. Descriptive data and sequence of operation of operating, user, and application software.

6. Provide one additional submittal above that which is asked for in Division 1 to be distributed by UTHSC-H to the IT department for verification.

C. Product Data: Provide data for each system component and software module.

D. Manufacturer's Installation Instructions: Include for all manufactured components.

1.09 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01 77 00.

B. Accurately record actual location of control components, including panels, thermostats, and sensors.

C. Revise shop drawings to reflect actual installation and operating sequences.

D. Include data specified in "Submittals" in final "Record Documents" form.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01 77 00.

B. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.

C. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

D. Include graphics of the controlled system as they appear on the system graphics with variable, adjustable and fixed pints with showing identified and numbered systems, system components and devices.

E. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.11 QUALIFICATIONS

A. Manufacturer: JCI controls.

B. Installer: JCI controls

C. Design system software under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.

D. Watchdog system shall be supplied and installed by approved manufacturers listed within description below.

1.12 PRE-INSTALLATION CONFERENCE

A. Convene a conference one week prior to commencing work of this Section, under provisions of Section 01200.

B. Require attendance of parties directly affecting the work of this Section.

1.13 COORDINATION

A. Coordinate work under provisions of Section 00 10 05.

B. Ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

D. Coordinate the startup and control sequence verification with the test and balance agent.

E. Ensure system is completed and commissioned.

1.14 WARRANTY

A. Provide five year warranty under provisions of the Owners Special Conditions.

B. Warranty: Include coverage for field programmable micro-processor based units.

1.16 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Section 01 77 00.

B. Provide two of each type of exposed sensor under provisions of Section 01 77 00.

C. Provide spare controllers/hardware equal to the greatest of 5% or 2 units. The controllers include, but are not limited to the NAE, FEC(X610), VMA, IOM(X710) and BTCTV.

1.17 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.

2. Limiting copying.

3. Preserving confidentiality.

4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.00 MANUFACTURERS OF CONTROLS

A JCI (other than Watchdog system)

2.01 GENERAL DESCRIPTION

A The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. 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. Prior to submittal update equipment to the latest technology and coordinate with the Engineer.

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 Portable Operator's Terminal(s)

6 Distributed User Interface(s)

7 Network processing, data storage and communications equipment

8 Other components required for a complete and working BMS

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.

1 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2 The System shall maintain all settings and overrides through a system reboot.

3 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

2.02 BMS ARCHITECTURE

A Automation Network

1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.

2 The BMS 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.

3 The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

4 Network Automation Engines (NAE) shall reside on the automation network.

5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B Control Network

1 Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:

(a) BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9

(i) The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

(ii) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

(b) LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).

(c) The Johnson Controls N2 Field Bus.

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.

4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

5 A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

6 The PICS shall be submitted 10 days prior to bidding.

C Integration

1 BACnet Protocol Integration - BACnet

(a) The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.

(b) A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

(c) The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.03 USER INTERFACE

A Dedicated Web Based User Interface

B Operating System Software

1 Windows XP Professional or Windows Vista. Verify operating system with the user to ensure the system will be compatible with the current systems.

2 Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.

3 Provide software registration cards to the Owner for all included software.

4 Upgrade the Metasys server software to the latest version.

2.04 DISTRIBUTED WEB BASED USER INTERFACE

A 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.

B The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.

C Laptop minimum hardware requirements:

1 256 MB RAM

2 2.0 GHz Clock Speed Pentium 4 Microprocessor

3 40.0 GB Hard Drive.

4 1 Keyboard with 83 keys (minimum).

5 SVGA 1024x768 resolution display with 64K colors and 16 bit color depth

6 Mouse or other pointing device

2.05 USER INTERFACE APPLICATION COMPONENTS

A Operator Interface

1 An integrated browser based client application shall be used as the user operator interface program.

2 The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.

3 All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

4 The user interface software shall provide help menus and instructions for each operation and/or application.

5 The system shall support customization of the UI configuration and a home page display for each operator.

6 The system shall support user preferences in the following screen presentations:

(a) Alarm

(b) Trend

(c) Display

(d) Applications

7 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

8 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

(a) User access for selective information retrieval and control command execution

(b) Monitoring and reporting

(c) Alarm, non-normal, and return to normal condition annunciation

(d) Selective operator override and other control actions

(e) Information archiving, manipulation, formatting, display and reporting

(f) FMS internal performance supervision and diagnostics

(g) On-line access to user HELP menus

(h) On-line access to current FMS as-built records and documentation

(i) Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications

9 The system shall support a list of application programs configured by the users that are called up by the following means:

(a) The Tools Menu

(b) Hyperlinks within the graphics displays

(c) Key sequences

10 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

B Navigation Trees

1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

3 The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

C Alarms

1 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:

(a) Log date and time of alarm occurrence.

(b) Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.

(c) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

(d) 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.

(e) Provide the ability 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.

(f) Any attribute of any object in the system may be designated to report an alarm.

2 The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.

3 The FMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.

4 The FMS shall annunciate application alarms at minimum, as required by Part 3.

D Reports and Summaries

1 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:

(a) All points in the BMS

(b) All points in each BMS application

(c) All points in a specific controller

(d) All points in a user-defined group of points

(e) All points currently in alarm

(f) All points locked out

(g) All BMS schedules

(h) All user defined and adjustable variables, schedules, interlocks and the like.

2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

3 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.

4 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.

E Schedules

1 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:

(a) Weekly schedules

(b) Exception Schedules

(c) Monthly calendars

2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

3 It shall be possible to define one or more exception schedules for each schedule including references to calendars

4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

5 Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.

6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.

7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

F Password

1 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.

2 Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.

3 The system shall allow each user to change his or her password at will.

4 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

5 A minimum of five levels of access shall be supported individually or in any combination as follows:

(a) Level 1 = View Data

(b) Level 2 = Command

(c) Level 3 = Operator Overrides

(d) Level 4 = Database Modification

(e) Level 5 = Database Configuration

(f) Level 6 = All privileges, including Password Add/Modify

6 A minimum of 100 unique passwords shall be supported.

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.

8 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

G Screen Manager

1 The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

H Dynamic Color Graphics

1 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.

2 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.

(a) The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.

3 Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:

(a) All graphics shall be fully scalable

(b) The graphics shall support a maintained aspect ratio.

(c) Multiple fonts shall be supported.

(d) Unique background shall be assignable on a per graphic basis.

(e) The color of all animations and values on displays shall indicate if the status of the object attribute.

4 Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device

5 Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

(a) The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.

(b) In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

6 Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

7 The graphics shall be submitted for review no later than one month prior to the beginning of testing and balancing. Coordinate with the Mechanical and General Contractor.

I Historical trending and data collection

1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

(a) Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

Defined time interval
Upon a change of value

(b) 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 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

3 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.

J Trend data viewing and analysis

1 Provide a trend viewing utility that shall have access to all database points.

2 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.

3 The trend viewing utility shall have the capability to define trend study displays to include multiple trends

4 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.

5 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.

6 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

7 Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

8 The Display shall support the user's ability to change colors, sample sizes, and types of markers.

K Database Management

1 The System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.

2 Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.

3 The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

(a) Backup

(b) Purge

(c) Restore

4 The Database Manager shall support four tabs:

(a) Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the Metasys Databases.

(b) Maintenance – shall provide an easy method of purging records from the Metasys Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.

(c) Backup – Shall provide the means to create a database backup file and select a storage location.

(d) Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.

5 The Status Bar shall appear at the bottom of all Metasys Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:

(a) Ready

(b) Purging Record from a database

(c) Action Failed

(d) Refreshing Statistics

(e) Restoring database

(f) Shrinking a database

(g) Backing up a database

(h) Resetting internet information Services

(i) Starting the Metasys Device Manager

(j) Shutting down the Metasys Device Manager

(k) Action successful

6 The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.

7 The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

8 The Monitoring Settings window shall have the following sections:

(a) General – Shall allow the user to set and review scan intervals and start times.

(b) Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.

(c) Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.

(d) Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.

(e) Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.

9 The Monitoring Settings Taskbar shall provide the following informational icons:

(a) Normal – Indicates by color and size that all databases are within their limits.

(b) Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.

(c) Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.

10 The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

L Demand Limiting and Load Rolling

1 The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.

2 The System shall support both Sliding Window and Fixed Window methods of predicting demand.

3 The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.

(a) Low Setting – Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.

(b) Medium Setting – Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.

(c) High Setting – Sheds loads earlier over a longer amount of time than the Medium Setting. Minimizes the probability of exceeding the Tariff Target.

4 The System shall have both a Shed Mode and a Monitor Only Mode of operation.

(a) When the Shed Mode is engaged, the System shall actively control the Demand.

(b) When the Monitor Mode is engaged, the System will simulate the shedding action but will not take any action.

5 The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.

6 The Demand Limiting program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.

7 The Demand Limiting program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.

8 The System shall support a Maximum Shed Time for each load as determined by the user. The system shall restore the load before the Maximum Shed time has expired.

9 The System shall support a Minimum Shed Time for each load as determined by the user. The system shall not restore the load sooner than the Minimum Shed Time has expired.

10 The System shall support a Minimum Release Time for each load as determined by the user. The System shall not shed the load until it has been off for the Minimum Release time.

11 The System shall support three user defined options if the meter goes unreliable.

(a) Shedding – The currently shed loads will be released as their Maximum shed Times expire.

(b) Maintain the Current Shed Rate – The System will use the Demand Limiting shed rate that was present when the meter went unreliable.

(c) Use Unreliable Meter Shed Rate – the system will control to a user defined Unreliable Shed Rate target.

12 The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.

13 The Load Rolling program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.

14 The Load Rolling program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.

15 The System shall provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.

16 The System shall provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:

(a) Load is Offline

(b) Load is Disabled

(c) Load is Shed

(d) Load is Locked

(e) Load is in Comfort Override

17 The Load Summary shall include a Load Summary Runtime view listing the following load conditions:

(a) Load Priority

(b) Shed Strategy

(c) Load Rating

(d) Present Value

(e) Ineligibility Status

(f) Active Timer

(g) Time Remaining

(h) Last Shed Time

2.06 PORTABLE OPERATOR TERMINAL

A For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:

1 Laptop Computer Manufacturer – Dell, Compaq or HP latest technology at the time of submittal

2 1 GB RAM (minimum) – Windows 2000 or XP Professional

3 1.8 GHz Clock Speed Pentium 4 Microprocessor (800 MHz minimum)

4 80 GB Hard Drive (minimum)

5 (1) CD-ROM Drive CD/RW, 32x speed

6 (1) Serial (1) Parallel (2) USB ports

7 1 Keyboard with 83 keys (minimum).

8 Integral touch pad and cordless mouse.

9 10” SVGA 1024x768 resolution color display

10 Two PCMCIA Type II or one Type III card slot

11 Complete operator workstation software package, including any hardware or software.

12 Original printed manuals for all software and peripherals.

13 Original installation disks or CD for all software, device drivers, and peripherals

14 Software registration cards for all included software shall be provided to the Owner.

15 Carrying case

16 Spare battery.

17 External power supply/battery charger

B Software

1 Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.

2 When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.

3 When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.

2.07 NETWORK AUTOMATION ENGINES (NAE)

A Network Automation Engine

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.

(a) The NAE shall have the capability to communicate directly with the Johnson Control N2 Field Bus devices through the automation network via a Serial to Ethernet Converter (SECVT).

3 User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

(a) The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user’s personal computer are not acceptable.

(b) The NAE shall support up a minimum of four (4) concurrent users.

(c) The web based user shall have the capability to access all system data through one NAE.

(d) Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

(e) Systems that require the user to address more than one NAE to access all system information are not acceptable.

(f) The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

(g) Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

(h) The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:

(i) Configuration

(ii) Commissioning

(iii) Data Archiving

(iv) Monitoring

(v) Commanding

(vi) System Diagnostics

(i) Systems that require workstation software or modified web browsers are not acceptable.

(j) The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

4 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.

5 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.

6 Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.

7 The NAE shall include troubleshooting LED indicators to identify the following conditions:

(a) Power - On/Off

(b) Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic

(c) Ethernet Connection Speed – 10 Mbps/100 Mbps

(d) FC Bus A – Normal Communications/No Field Communications

(e) FC Bus B – Normal Communications/No Field Communications

(f) Peer Communication – Data Traffic between NAE Devices

(g) Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running

(h) Bat Fault – Battery Defective, Data Protection Battery Not Installed

(i) 24 VAC – 24 VAC Present/Loss Of 24VAC

(j) Fault – General Fault

(k) Modem RX – NAE Modem Receiving Data

(l) Modem TX – NAE Modem Transmitting Data

8 Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

(a) Two (2) USB port

(b) Two (2) URS-232 serial data communication port

(c) Two (2) RS-485 port

(d) One (1) Ethernet port

9 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.

10 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.

11 Certification – The NAE shall be listed by Underwriters Laboratories (UL).

12 Controller network – The NAE shall support the following communication protocols on the controller network:

(a) The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

(i) The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

(ii) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

(iii) A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.

(iv) The Conformance Statements shall be submitted 10 days prior to bidding.

(v) The NAE shall support a minimum of 100 control devices.

(b) The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.

(i) All LonWorks controls devices shall be LonMark certified.

(ii) The NAE shall support a minimum of 255 LonWorks enabled control devices.

(c) The NAE shall support the Johnson Controls N2 Field Bus.

(i) The NAE shall support a minimum of 100 N2 control devices.

(ii) The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.

(iii) The Bus shall employ a master/slave protocol where the NAE is the master.

(iv) The Bus shall employ a four (4) level priority system for polling frequency.

(v) The Bus shall be optically isolated from the NAE.

(vi) The Bus shall support the Metasys Integrator System.

13 User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

(a) The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

(b) The NAE shall support a minimum of two (2) concurrent users.

(c) The web based user shall have the capability to access all system data through one NAE.

(d) Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

(e) Systems that require the user to address more than one NAE to access all system information are not acceptable.

(f) The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

(g) Systems that support UI Graphics from a central data base or require the graphics to reside on the user's personal computer are not acceptable.

(h) The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:

(i) Configuration

(ii) Commissioning

(iii) Data Archiving

(iv) Monitoring

(v) Commanding

(vi) System Diagnostics

(i) Systems that require workstation software or modified web browsers are not acceptable.

2.08 DDC SYSTEM CONTROLLERS

A Field Equipment Controller (FEC X610)

1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

(a) The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

(i) The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

(ii) The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

(iii) A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

(iv) The Conformance Statement shall be submitted 10 days prior to bidding.

2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

3 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.

4 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

5 The FEC shall include a removable base to allow pre-wiring without the controller.

6 The FEC shall include troubleshooting LED indicators to identify the following conditions:

(a) Power On

(b) Power Off

(c) Download or Startup in progress, not ready for normal operation

(d) No Faults

(e) Device Fault

(f) Field Controller Bus - Normal Data Transmission

(g) Field Controller Bus - No Data Transmission

(h) Field Controller Bus - No Communication

(i) Sensor-Actuator Bus - Normal Data Transmission

(j) Sensor-Actuator Bus - No Data Transmission

(k) Sensor-Actuator Bus - No Communication

7 The FEC shall accommodate the direct wiring of analog and binary I/O field points.

8 The FEC shall support the following types of inputs and outputs:

(a) Universal Inputs - shall be configured to monitor any of the following:

(i) Analog Input, Voltage Mode

(ii) Analog Input, Current Mode

(iii) Analog Input, Resistive Mode

(iv) Binary Input, Dry Contact Maintained Mode

(v) Binary Input, Pulse Counter Mode

(b) Binary Inputs - shall be configured to monitor either of the following:

(i) Dry Contact Maintained Mode

(ii) Pulse Counter Mode

(c) Analog Outputs - shall be configured to output either of the following

(i) Analog Output, Voltage Mode

(ii) Analog Output, current Mode

(d) Binary Outputs - shall output the following:

(i) 24 VAC Triac

(e) Configurable Outputs - shall be capable of the following:

(i) Analog Output, Voltage Mode

(ii) Binary Output Mode

9 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 also support Input/Output Module (IOM) communications with the FEC and with the NAE.

(d) The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.

(e) The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.

10 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.

11 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

12 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

13 The FEC shall support a Local Controller Display (DIS1710) either as an integral part of the FEC or as a remote device communicating over the SA Bus.

(a) The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.

(b) The Display shall allow the user to view monitored points without logging into the system.

(c) The Display shall allow the user to view and change setpoints, modes of operation, and parameters.

(d) The Display shall provide password protection with user adjustable password timeout.

(e) The Display shall be menu driven with separate paths for:

(i) Input/Output

(ii) Parameter/Setpoint

(iii) Overrides

(f) The Display shall use easy-to-read English text messages.

(g) The Display shall allow the user to select the points to be shown and in what order.

(h) The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.

(i) The display shall be a minimum of 4 lines and a minimum of 20 characters per line

(j) The Display shall have a keypad with no more than 6 keys.

(k) The Display shall be panel mountable.

2.09 FIELD DEVICES

A Input/Output Module (IOM X710)

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 the FC Bus or the SA Bus.

3 The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

(a) The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

(b) The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

(c) A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

(d) The Conformance Statement shall be submitted 10 days prior to bidding.

4 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

5 The IOM shall have a minimum of 4 points to a maximum of 17 points.

6 The IOM shall support the following types of inputs and outputs:

(a) Universal Inputs - shall be configured to monitor any of the following:

(i) Analog Input, Voltage Mode

(ii) Analog Input, Current Mode

(iii) Analog Input, Resistive Mode

(iv) Binary Input, Dry Contact Maintained Mode

(v) Binary Input, Pulse Counter Mode

(b) Binary Inputs - shall be configured to monitor either of the following:

(i) Dry Contact Maintained Mode

(ii) Pulse Counter Mode

(c) Analog Outputs - shall be configured to output either of the following

(i) Analog Output, Voltage Mode

(ii) Analog Output, current Mode

(d) Binary Outputs - shall output the following:

(i) 24 VAC Triac

(e) Configurable Outputs - shall be capable of the following:

(i) Analog Output, Voltage Mode

(ii) Binary Output Mode

7 The IOM shall include troubleshooting LED indicators to identify the following conditions:

(a) Power On

(b) Power Off

(c) Download or Startup in progress, not ready for normal operation

(d) No Faults

(e) Device Fault

(f) Normal Data Transmission

(g) No Data Transmission

(h) No Communication

B Network Sensors (NS-XXX700X)

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

(d) Discharge Air Temperature

2 The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.

3 The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

(a) The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).

(b) A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.

(c) The Conformance Statement shall be submitted 10 days prior to bidding.

4 The Network Zone 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

(e) Available in either surface mount or wall mount

(f) Available with either screw terminals or phone jack

5 The Network Discharge Air Sensors shall include the following:

(a) 4 inch or 8 inch duct insertion probe

(b) 10 foot pigtail lead

(c) Dip Switches for programmable address selection

(d) Ability to provide an averaging temperature from multiple locations

(e) Ability to provide a selectable temperature from multiple locations

2.10 SYSTEM TOOLS

A General: The control contractor shall provide the TAB Agent a means to manipulate the control systems. The control contractor will provide hardwire interfacing and all software to allow communication to stand alone controllers and the ability to globally command valves, terminal boxes, temperature settings, dampers, turn systems on and off, and will perminantly store daily all coefficients established. If the schedule demands more teams, the control contractor will supply the TAB agency with multiple hardware interfaces and the appropriate software.

B System Configuration Tool (SCT)

1 The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NAE).

2 The configuration tool shall provide an archive database for the configuration and application data.

3 The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.

4 The configuration tool shall include the following features:

(a) Basic system navigation tree for connected networks

(b) Integration of Metasys N1, LonWorks, and BACnet enabled devices

(c) Customized user navigation trees

(d) Point naming operating parameter setting

(e) Graphic diagram configuration

(f) Alarm and event message routing

(g) Graphical logic connector tool for custom programming

(h) Downloading, uploading, and archiving databases

5 The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:

(a) BACnet Devices

(b) LonWorks devices

(c) N2 Bus devices

(d) Metasys N1 networks

6 The configuration tool shall be capable of programming the Field Equipment Controllers.

(a) The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.

(b) The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.

(c) The configuration tool shall contain a library of standard applications to be used for configuration.

7 The configuration tool shall be capable of programming the field devices.

(a) The configuration tool shall provide the capability to configure, simulate, and commission the field devices.

(b) The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.

(c) The configuration tool shall contain a library of standard applications to be used for configuration

8 A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.

(a) The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).

(b) The wireless use of configuration tool shall be the same as a wired connection in every respect.

(c) The wireless connection shall use the Bluetooth Wireless Technology.

C Wireless MS/TP Converter (BTCVT)

1 The converter shall provide a temporary wireless connection between the SA or FC Bus and a wireless enabled portable PC.

2 The converter shall support downloading and troubleshooting FEC and field devices from the PC over the wireless connection.

3 The converter shall employ Bluetooth Wireless Technology.

4 The converter shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.

5 The converter shall operate over a minimum of thirty three (33) feet within a building.

6 The converter shall have LED indicators to provide information regarding the following conditions:

(a) Power - On/Off

(b) Fault – Fault/No Fault

(c) SA/FC Bus – Bus Activity/ No Bus Activity

(d) Blue – Bluetooth Communication Established/ Bluetooth Communication Not Established

7 The SWCVT shall comply with FCC Part 15.247 regulations for low-power unlicensed transmitters.

D Handheld VAV Balancing Sensor (ATV7003)

1 The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.

2 The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.

3 The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.

4 The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.

5 The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.

6 The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.

7 The sensor shall include the following

(a) 5 foot retractable cable

(b) Laminated user guide

(c) Nylon caring case

8 The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47 and be available for the TAB contractor to properly test the balancing of the system.

2.11 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:

Point Type	**Accuracy**
Chilled Water	± .5°F.
Duct Temperature	± .5°F.
All Others	± .75°F.

2 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.

3 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.

4 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. Sensors shall be installed so that the box sits on the outside of the duct insulation.

(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.

5 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.

(d) Only platinum sensors shall be used.

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, 0-10 V, 0-100% linear proportional output.

3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 2% for general applications and 1% for process control 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 Dew Point Sensors

1 The sensor shall be a solid-state type, dew point sensor. The sensor element shall resist service contamination.

2 The dew point transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 0-10 V, 0-100% linear proportional output.

3 The humidity transmitter shall meet the following overall accuracy of 2 degrees, including lead loss and Analog to Digital conversion.

4 Outside air relative dew point 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 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.

E Differential Pressure Transmitters

1 Provide digital displays to all DP transmitters.

2 General Air and Water Pressure 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.

3 Low Differential Water Pressure Applications (0” - 20” 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 flow meter differential pressure or water 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:

(i) .01-20” w.c. input differential pressure range.

(ii) 4-20 mA output.

(iii) Maintain accuracy up to 20 to 1 ratio turndown.

(iv) Reference Accuracy: +0.2% of full span.

(c) Acceptable Manufacturers: Setra and Mamac.

4 Medium to High Differential Water Pressure Applications (Over 21” w.c.)

(a) The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:

(i) Differential pressure range 10” w.c. to 300 PSI.

(ii) Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability).

(b) 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.

(c) Acceptable Manufacturers: Setra and Mamac.

5 Building Differential Air Pressure Applications (-1” to +1” 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:

(i) -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)

(ii) 4-20 mA output.

(iii) Maintain accuracy up to 20 to 1 ratio turndown.

(iv) Reference Accuracy: +0.2% of full span.

(c) Acceptable Manufacturers: Johnson Controls and Setra.

6 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:

(i) (0.00 - 1.00” to 5.00”) w.c. input differential pressure ranges. (Select range appropriate for system application.)

(ii) 4-20 mA output.

(iii) Maintain accuracy up to 20 to 1 ratio turndown.

(iv) Reference Accuracy: +0.2% of full span.

(c) Acceptable Manufacturers: Johnson Controls and Setra.

7 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:

(i) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.

(ii) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.

(iii) Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).

(b) 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.

(c) Acceptable manufacturers: Johnson Controls and Setra.

F Flow Monitoring

1 Air Flow Monitoring

(a) Static Pressure Traverse Probe

(i) Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

(ii) Acceptable manufacturers: Cleveland Controls

(b) Shielded Static Air Probe

(i) A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

2 Water Flow Monitoring

(a) Water flow meters are specified under Hydronic Specialties 23 06 20 and are required to be able to be monitored by the JCI Metasys system. Provide a monitoring point and alarm for each Onicon meter provided.

G 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.

(i) Operating frequency – 50 - 400 Hz.

(ii) Insulation – 0.6 Kv class 10Kv BIL.

(iii) UL recognized.

(iv) Five amp secondary.

(v) Select current ration as appropriate for application.

(vi) Acceptable manufacturers: Veris Industries

(c) Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

(i) 6X input over amp rating for AC inrushes of up to 120 amps.

(ii) Manufactured to UL 1244.

(iii) Accuracy: +.5%, Ripple +1%.

(iv) Minimum load resistance 30kOhm.

(v) Input 0-20 Amps.

(vi) Output 4-20 mA.

(vii) Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).

(viii) Acceptable manufacturers: Veris Industries

H 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.

I Status and Safety Switches

1 General Requirements

(a) Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS 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 have adjustable thresholds and 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 Water Flow Switches

(a) Water flow switches shall be equal to the Johnson Controls P74.

7 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.

8 Pressure transducers on Glycol heat recovery system

(a) Pressure transducers shall have LCD display.

2.12 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 Dampers

1 The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

2 All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

3 All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

4 Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

5 Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, and Vent Products 5650.

6 One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls D-1600, Ruskin CD36, and Vent Products 5800.

7 Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C 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

2 Lighting Control Relays

(a) Lighting control relays shall be latching with integral status contacts.

(b) Contacts shall be rated for 20 amps at 277 VAC.

(c) The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.

(d) Lighting control relays shall be controlled by:

(i) Pulsed Tri-state Output – Preferred method.

(ii) Pulsed Paired Binary Outputs.

(iii) A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the “dry-contact” type.

(e) The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

D Control Valves

1 All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.

2 Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Valves up to 4" shall be modulating characterized ball valves only. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving **variable** flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving **constant** flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.

3 Valves 5" and larger shall be Neles Segment Control Valves with flanged body, face to face acc to ISA S75.04 and DIN/IEC Part 3-2 ANSI 150. Standard construction with drive shaft with ANSI Keyway to Actuator ASTM A216 Gr WCB Body, SS+Cobalt Hard Facing, PTFE Vrings, live loaded. Provide Valvcon LADCW 1000U2Y-UP-Weathertight, 1000Torque (inlbs), Universal Power and H23415 Linkage Kit.

4 Ball valves shall be characterized and used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.

5 Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.

6 Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

7 Acceptable manufacturers: Johnson Controls, Bray.

E Electronic Signal Isolation Transducers

1 A signal isolation transducer shall be provided whenever an analog output signal from the BMS 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

F 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.

G 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

2.13 MISCELLANEOUS DEVICES

A Local Control Panels

1 All control panels shall be factory constructed, incorporating the BMS 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.

7 Label control panels as required by section 23 05 29.

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.

C Thermostats

1 Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

2 Actuation / Control Type

3 Primary Equipment

(a) Controls shall be provided by equipment manufacturer as specified herein.

(b) All damper and valve actuation shall be electric.

4 Air Handling Equipment

(a) All air handers shall be controlled with a HVAC-DDC Controller

(b) All damper and valve actuation shall be electric.

5 Terminal Equipment:

(a) Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.

(b) All Terminal Units shall be controlled with HVAC-DDC Controller)

PART 3 EXECUTION

3.01 TRAINING

A. The contractor shall provide 10 days or 80 hours of off-site digital controls classroom training. Dates to be coordinated with UTHSC-H personnel.

END OF SECTION

SECTION 23 20 00.A
PIPING, VALVES AND FITTINGS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Valves.

1.02 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 05 29 - Sleeves, Supports and Anchors.

C. Section 23 05 53 - Mechanical Identification.

D. Section 23 05 48 - Vibration Isolation.

E. Section 23 07 19 - Piping Insulation.

1.03 REFERENCES

A. AGA - American Gas Association.

B. ANSI B31.1 - Power Piping.

C. ANSI B31.9 - Building Service Piping.

D. ASME Sec. 9 - Welding and Brazing Qualifications.

E. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.

F. ASME B16.3 - Malleable Iron Threaded Fittings.

G. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.

H. ASME B16.18 - Cast Bronze Solder-Joint Pressure fittings.

I. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings

J. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV.

K. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes.

L. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

M. ASME B16.32 - Cast Copper Alloy Solder-Joint Fittings for Solvent Drainage Systems.

N. ASTM A47 - Ferric Malleable Iron Castings.

O. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

P. ASTM A74 - Cast Iron Soil Pipe and Fittings.

Q. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

R. ASTM B32 - Solder Metal.

S. ASTM B42 - Seamless Copper Pipe.

T. ASTM B43 - Seamless Red Brass Pipe.

U. ASTM B75 - Seamless Copper Tube.

V. ASTM B88 - Seamless Copper Water Tube.

W. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

X. ASTM B302 - Threadless Copper Pipe (TP).

Y. ASTM B306 - Copper Drainage Tube (DWV).

Z. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.

AA. ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings.

BB. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

CC. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

DD. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.

EE. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

FF. ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings.

GG. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).

HH. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

II. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

JJ. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite-Sewer Piping.

KK. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.

LL. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

MM. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

NN. ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.

OO. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

PP. ASTM D3033 - Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

QQ. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

RR.ASTM D3309 - Polybutylene (PB) Plastic Hot Water Distribution System.

SS. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

TT. ASTM F493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

UU. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Pipe.

VV.AWS A5.8 - Brazing Filler Metal. BA. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.

WW.AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.

XX.AWWA C111- Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.

YY.AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

ZZ.AWWA C651 - Disinfecting Water Mains.

AAA. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.

BBB.CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.

CCC.CAN-3 B281 - Aluminum Drain, Waste, and Vent Pipe and Components.

DDD. NCPWB - Procedure Specifications for Pipe Welding.

EEE.TDH - Texas Department of Health, Water System Regulations

1.04 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

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

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00.

B. Record actual locations of valves, etc. and prepare valve charts.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.07 QUALITY ASSURANCE

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

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ASME Sec. 9. Submit welder's certifications prior to any shop or field fabrication. Welder's certifications shall be current within six months of submission.

D. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

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

B. Installer: Company specializing in performing the work of this section with minimum of three years documented experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

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

C. Provide temporary protective coating on cast iron and steel valves.

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

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

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding are wet or frozen.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two repacking kits for each size valve.

PART 2 PRODUCTS

2.01 STEEL PIPING:

A. Scope: This section applies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water, hot water, steam, steam condensate, and fire protection systems.

B. Pipe: Unless otherwise indicated, chiller and boiler plants piping shall be Schedule 40, and underground and building piping shall be Standard weight, Grade A or B, seamless black steel pipe conforming in all details to Standard ASTM Designation A135, A106, and A53, latest revisions. Steam condensate shall be Schedule 80. All piping shall be domestic made.

C. Fittings:

1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9, latest edition, as made by Weld Bend, Tube Turn, Hackney, or Ladish Company. Attach to only pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

2. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Grinnell Company, Crane Company or Walworth Company manufacture (300 lb. for unions).

D. FABRICATION:

1. Welded piping and fittings in chiller and boiler plants and distribution systems shall be fabricated in accordance with ASME/ANSI the latest editions of Standard B31.1 Downstream of building PRV station Standard B31.3 shall be used for Steam and Condensate systems. Standard B31.9 –Building Services Piping may be used within buildings for non-steam and condensate systems. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.

8. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

E. WELD TESTING:

1. All welds are subject to inspection, visual and/or X-ray, for compliance with specifications. The owner will, at the owners option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the owner. The contractor shall be responsible for all labor, material and travel expenses involved in the reinspection and retesting of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1, B31.9 and B31.3 due to the discovery of poor, unacceptable or rejected welds. For every failed x-ray, contractor shall be liable to provide five additional joint x-rays.

2. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators Code, current edition.

2.02 CAST IRON PIPING:

A. PIPE & FITTINGS:

1. Service weight cast iron soil pipe conforming to ASTM Specification A-74 and CISPI Standard 301, hub and spigot for pipe ten inch (10") and larger and hubless for eight inch (8") and smaller. Each piece of pipe and each fitting shall be coated at the factory with asphaltum or coal tar pitch and with the manufacturer's mark or name cast on it.

2. All joints in hub and spigot cast iron pipe shall be made water and gas tight with Tyseal neoprene gaskets. Lead and Oakum may be used only under special conditions, with prior written permission from the Resident Construction Manager. Joints in hubless cast iron soil pipe and fittings shall be made by the use of a neoprene sleeve and 24 gage, Type 304 Stainless Steel shield made tight with a torque wrench and torqued to a minimum of 100 inch-pounds. Each clamp shall consist of a neoprene gasket with a stainless steel outer band which effectively captures the gasket material. Each clamp shall bear the FM and UPC stamp, shall be approved to Class I of Factory Mutual Standard #1680, and shall be Clamp-All or approved equal. All elbows and tees shall be braced against thrust loads

which might result in joint separation due to **static pressure or** dynamic forces caused by sudden, heavy impulse loading (water hammer) conditions. Hubless piping systems shall not be used in a directly buried, underground application.

2.03 DUCTILE IRON PIPING

A. Pipe: All pipe used for underground water piping mains shall be Class 52 centrifugally cast, close grained cast iron pipe or Class 50 DUCTILE iron pipe arranged with bell and spigot mechanical joints and shall conform in every detail to Federal Specifications WW-P-421, E-4, Type II for CAST IRON PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS. This pipe shall be provided in laying lengths of sixteen feet (16'). Each length of pipe shall be plainly marked in such a fashion as to indicate the name or trademark of the manufacturer and the year in which the pipe was cast. Exterior surfaces shall be completely coated with coal tar pitch varnish to which sufficient oil has been added to effect a smooth coating, tough and tenacious when cold, not "tacky" and not brittle.

B. Fittings:

1. All fittings used for underground water piping mains shall be Class D bell and spigot mechanical joint fittings made in strict conformity with the Specifications of the American Water Works Association A.W.W.A.-C100-08. All dimensions and weights of such fittings shall conform to the dimensions and weights shown in tables included in the latest edition HANDBOOK OF CAST IRON PIPE published by Cast Iron Pipe Research Association. All fittings shall be coated outside with the same coal tar pitch varnish used on cast iron pipe.

2. All mechanical joints shall be for cast iron pressure pipe made by pit cast or by centrifugal methods and cast iron pressure fittings. Mechanical joints shall be of the stuffing box type and shall consist of a bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting; a pipe or fitting spigot; a sealing gasket; a separate cast iron follower gland having cored or drilled bolt holes. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe line.

3. Bolts shall be high strength, heat treated cast iron tee-head bolts with hexagon nuts.

4. Gaskets shall be made of a vulcanized crude rubber compound and, unless otherwise specified, the rubber shall be first grade plantation rubber. The joint, gaskets, bolts, and nuts shall meet the latest requirements of ANSI 21.11 for Mechanical Joints for Cast Pressure Pipe and Fittings.

5. All underground cast iron or ductile iron pipe shall be encased in black 8-mil thick, polyethylene plastic sheet, per ANSI/AWWA, C105/A21.5-82, Method C.

6. Tie rods and retaining bolts shall be all stainless steel construction.

C. Valves: All valves used in underground water piping systems shall be A.W.W.A., iron body, mechanical joint, double hump, double disc, parallel seats, brass trimmed nonrising stem gate valves.

2.04 CONCRETE PIPING:

A. Precast concrete sewer pipe conforming to ASTM Specification C-14 in sizes up to and including eight inches (8") and shall be precast reinforced concrete sewer pipe conforming to ASTM Specification C-76 in size twelve inches (12") and larger. Bell and spigot fittings with elastomeric seal joints.

2.05 GALVANIZED STEEL PIPE

A. Pipe: Schedule 40 and shall conform in every detail to ASTM Standard Specifications for BLACK AND HOT-DIPPED ZINC-COATED GALVANIZED WELDED AND SEAMLESS STEEL PIPE ASTM Designation A-135, latest revision. This threaded pipe shall be supplied with thread protectors on each end. All steel water pipe shall be hot-dipped galvanized pipe zinc coated both inside and outside.

B. Fittings: All fittings for six inch (6") and larger water lines shall be 125 lb., cast iron, flanged pattern fittings. These fittings shall be hot-dipped galvanized, after all machining operations have been completed. These fittings shall be of Crane Company, or approved equal, manufacture and their flanges shall be dimensioned, faced drilled and spot faced to conform to the Class 150 American Standard for Steel Pipe Flanges and Flanged Fittings.

2.06 COPPER PIPE

A. Copper Pipe: Piping four inches (4") and smaller shall be fabricated of Type K, hard drawn, copper pipe made of deoxidized copper (99.9% pure). This Type K copper pipe shall conform in every detail to ASTM Standard Specifications for COPPER WATER TUBE, Serial Designation B-88-66, and it shall be provided in 20 foot straight lengths. Copper pipe 4” and smaller may only be joined using non-lead-bearing solder, such as 95-5 silver or antimony solder (95 percent tin, and 5 percent silver or antimony). Copper pipe 4” and larger may be joined using roll grooved fittings.

(Note: For U.T. Austin, substitute the following sentence for the previous two sentences: "Copper pipe may only be joined using "Silvabrite" solder. No other solders may be used.")

B. Fittings: All fittings for four inch (4") and smaller water lines shall be Streamline Solder Fittings manufactured by Streamline Pipe and Fittings Division, Mueller Brass Company, or approved equal. These wrought copper fittings shall be rigid and strong with openings machined to accurate capillary fit for the pipe.

C. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

2.07 VALVES:

A. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this project. All bronze and iron body gate and globe valves shall be the product of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.

B. All valves used in circulating systems, plumbing and steam systems (low and medium pressure) shall be Class 150 SWP. Class 300 valves shall be constructed of all ASTM B-61 composition. All gate, globe and angle valves shall be union bonnet design. Metal used in the stems of all

bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials. Alloys used in all bronze ball, gate, globe, chackcheck,, or angle valves shall contain no more than 15% zinc. **No yellow brass valves will be allowed.**

C. All iron body valves shall have the pressure containing parts constructed of ASTM designated of 126 class B iron. Stem material shall meet ASTM B16 Alloy 360 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing.

D. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation A-216-GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ANSI B16-34-1977. Stems shall meet ASTM designation A-186-F6 chromium stainless steel. Wedge (gate valves) may be solid or flexible type and shall meet ASTM A-182-F6 chromium stainless steel on valves from 2" to 6". Sizes 8" and larger may be A-216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13% chromium A-182-F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or Ductile Iron ASTM A536.

E. All forged steel body valves shall have the pressure containing parts constructed of ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM A-182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.

F. All valves shall be repackable, under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

G. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to the Owner, with a packing material selected by the Owner.

H. Valves 12" and larger located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 to accommodate a drain valve and equalizing by-pass valve assembly.

I. Balancing and/or Shutoff Valves for Hot Water Systems: Two inches and smaller, three piece full port bronze body ball valve, stainless steel ball and stem. Teflon seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle, with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use in insulated lines. Cold water service valves shall be as above, except two piece construction. All valves 2 1/2" and larger shall be tapped full lug butterfly valves with aluminum bronze discs of ASTM B148 Alloy C955 and 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valve must be capable of providing a bubble tight seal at 200 psi for valves up to 12" (150 psi for larger valves) when used for end of line service without requiring the installation of a blind flange on the downstream side. Liners shall be resilient material suitable for 225 °F temperature and bodies of ductile iron. Butterfly valves 8" and larger and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators, with malleable iron handwheel or crank. Valves 2 1/2" through 6"

shall have lever handles which can be set in interim positions between full open and full closed. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi.

J. Check Valves for Water Systems: Bronze body, 2" and smaller, bronze body regrinding disc and seat with screw-in cap. Iron body, 2 1/2" and larger, bronze disc and seat or non slam wafer type with stainless pins and springs, and bronze plate. Forged steel lift check valves, 2" and smaller shall be bolted cap and body, screwed end connections and conform to ANSI B16.34 and pressure temperature rating.

K. Valves for Fire Protection Service: 2" and smaller, bronze body ball valve as above, Underwriters' Laboratories Listed and Factory Mutual Approved, screw pattern. 2 1/2" and larger, Underwriters Laboratories Listed and Factory Mutual Approved butterfly valves with tapped full lug body and gear operated with malleable iron hand-wheel and position indicator. All valves to be furnished with two factory mounted internal supervisory switches.

Gate valves 2 1/2” and larger shall have approved rating of 175 psi WWP or greater. Iron body with resilient rubber encapsulated wedge, epoxy-coated interior, pre-grooved stem for supervisory switch.

L. Check Valves Fire Protection System: Iron body, swing-check, bronze disc, seat ring and hinge pin, 300 psi rated working pressure, Underwriters' Laboratories and Factory Mutual approved. Complete with ball drip assembly.

M. All underground direct-burried valves shall be ductile-iron butterfly with a Pratt “Ground Hog” gear box. Valves shall be flanged with stainless steel rim.

N. Standards of Quality for Valves:

Standard of Quality for Valves:

			Class	Milwaukee	Nibco	Stockham or as noted
2" & smaller	Gate Valve	L.P. Steam	150	1151	T-134	B-105
2-1/2" & larger	Gate Valve	L.P. Steam	125	F-2885	F-617-0	G-623
*2" & smaller	Ball Valve for shut-off	Domestic Cold Water Plbg. Systems Recirculating Chilled Water	150 --	Apollo T-585-70	77-100	

Requires extended stems in insulated lines with adjustable memory stop.

					Nibco	Apollo
*2” &	Ball Valve	Domestic Hot Water Plumbing Systems & Recirculating Hot Water	150	--	T-595-Y-66	77-140

Requires extended stems in insulated lines with adjustable memory stop.

2" & smaller	Globe, Angle & Balancing Valve	Chilled Water, L.P. Steam	150	590T	T-235	B-22
2-1/2" & larger	Globe, Angle & Balancing Valve	Plumbing, Chilled Water, L.P. Steam	125	F-2981	F-718-B	G-514-T
2-1/2" & larger	Butterfly Valve for shutoff	Domestic Hot & Cold Water Plbg. Systems Recirculating Chilled and Heating Water	150	NE-C,NF	LD2000	DeZurik 632,L,D, RS66,6

Valves 8” and larger, and valves used for balancing service regardless of size shall have a heavy duty weatherproof encased operator.

2" & smaller	Ball Valve (UL,FM)	Fire Protection	300	BB_SC	T-505-4	--
2-1/2" &	Butterfly Valve	Fire	175	--	LD3510-8	LG72UF

larger		Protection				
2-1/2" & larger	Gate Valve OS&Y	Fire Protection	175	--	F-607-RW	G-610
2-1/2" & larger	Check Valve	***Fire Protection	175	--	F-908-W	G-940
2" & smaller	Check Valve	All Water Systems	150	510T-433	B-345	
2-1/2" & larger	Check Valve	All Water Systems	150	1400 Series	W-920-W	Stockham 'Duo-Check'
1-1/2" & smaller	Gate Valve	High Pressure Steam	300	--	--	--
2" & larger	Gate Valve	High Pressure Steam	300	--	--	Stockham 30-OF
2" to 12" (below ground)	Hub End	(AWWA)	150	--	--	Mueller 2380-5
1-1/2" & smaller	Lubricated Gas Cock	Medical, Lab gases & Natural Gas	150	BB2-100		Rockwell 1796 & 142 With Wrench
2" & larger	Lubricated Gas Cock	Medical, Lab gases & Natural Gas	150	--		Rockwell 143 & 1797 With Wrench
2" & smaller	Isolation Ball Valve	Medical, Lab gases, & Natural Gas	150			Spirax Sarco Model 60

* Requires extended stem in insulated lines.

** Valves 8" and larger, and valves used for balancing service regardless of size, shall have heavy duty weather proof encased gear operators.

*** Requires ball drip assembly.

**** All modulating ball valves shall be characterized.

2.08 UNIONS:

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass

flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to Epco.

C. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a dielectric coupling shall be used at the transition.

2.09 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

C. FLANGE GASKETS

1. Gaskets shall be placed between the flanges of all flanged joints.

2. Gaskets for steam piping - All steam flange joints shall use Flexitallic Class 150 spiral wound for low pressure applications and Flexitallic Class 300 spiral wound gaskets for medium or high pressure applications. Raised and flat face flange gaskets shall be Flexitallic compression gauge (CG) style. External ring shall be Type 304 stainless steel and color coded yellow. Filler material shall be Flexite Super and color coded with pink stripe. Equivalents may be submitted with all design data so that an evaluation of the gasket can be made.

3. Gaskets for all other applications: Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16” thick asbestos free material recommended for service by Anchor, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

4. Spares - Contractor shall provide ten spares for every flange size and rating.

D. Flange Bolt Installation:

1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.

2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

Nominal Bolt Dia. (Inch)	Torque (Ft-Lbs)
.25	6
.3125	12
.375	18
.4375	30
.5	45
.5625	68
.625	90
.75	150
.875	240
1.0	368
1.125	533
1.25	750
1.375	1020
1.5	1200

3. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.

4. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30% of full torque increases.

5. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.

6. Inspection - Owner shall verify hot torquing of all medium and high pressure steam flange bolts.

PART 3 EXECUTION

Refer to other Sections for service specific requirements.

3.01 EXAMINATION

A. Verify excavations under provisions of Section 23 00 00.

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

3.02 PREPARATION

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

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

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

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

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Establish elevations of buried piping outside the building to ensure a minimum of cover. Refer to Section 23 00 00.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Provide support for utility meters in accordance with requirements of utility companies.

K. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to Division 09.

L. Excavate in accordance with Section 23 00 00 for work of this Section.

M. Backfill in accordance with Section 23 00 00 for work of this Section.

N. Install bell and spigot pipe with bell end upstream.

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

3.04 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

END OF SECTION

SECTION 23 21 00
HYDRONIC PIPING

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED

A. Pipe and pipe fittings.

B. Valves.

C. Chilled water piping system.

1.02 SCOPE OF WORK: Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with, or properly incidental to, the construction of complete HVAC piping and accessories systems as indicated on the Drawings, reasonably implied therefrom, or as specified herein unless specifically excluded.

1.03 RELATED WORK

A. Section 08 31 13 - Access Doors.

B. Section 09 91 00 - Painting.

C. Section 23 00 00 - Basic Mechanical Requirements

D. Section 23 20 00.A - Piping, Valves and Fittings

E. Section 21 05 29 - Sleeves, Flashings, Supports and Anchors.

F. Section 23 05 53 - Mechanical Identification.

G. Section 23 07 19 - Piping Insulation.

H. Section 23 06 20 - Hydronic Specialties.

1.04 REFERENCES

A. ANSI/ASME - Boiler and Pressure Vessel Code.

B. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

C. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.

D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

F. ANSI/ASME B31.9 - Building Services Piping.

G. ANSI/ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

H. ANSI/AWS A5.8 - Brazing Filler Metal.

I. ANSI/AWS D1.1 - Structural Welding Code.

J. ANSI/AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.

K. ANSI/AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.

L. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.

M. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

N. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

O. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
P. ASTM B32 - Solder Metal.

Q. ASTM B88 - Seamless Copper Water Tube.

R. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

S. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

T. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).

U. ASTM D2310 - Machine-Made Reinforced Thermosetting Resin Pipe.

V. ASTM D2466 - Socket-Type PVC Plastic Type Fittings, Schedule 40.

W. ASTM D2467 - Socket-Type PVC Plastic Type Fittings, Schedule 80.

X. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite-Sewer Piping.

Y. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

Z. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

AA. ASTM D2855 - Making Solvent-Cemented Joints with PVC Pipe and Fittings.

BB. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.05 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9.

1.06 QUALITY ASSURANCE

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

B. Welding Materials and Procedures: Conform to ANSI/ASME SEC. 9, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/AWS D1.1.

1.07 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00.

B. Include data on pipe materials, pipe fittings, valves, and accessories.

C. Include welders certification of compliance with ANSI/AWS D1.1.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 WALL, FLOOR AND CEILING PLATES:

A. See Section 23 05 29.

2.02 SLEEVES, INSERTS, AND FASTENINGS:

A. See Section 23 05 29.

2.05 CHILLED WATER PIPING - ABOVE GROUND:

A. See Section 23 20 00.A and 23 06 20.

1. All piping shall be Standard Weight-black steel pipe.

2. All unions: Class 300.

3. Low Zone (0' to 150' elevation)
a. Fittings on piping 2-1/2" and larger shall be standard weight butt welding type. Flanges shall be 150# welding neck type. Standard weight Weld-O-Lets, Thread-O-Lets, and shaped nipples may be used only when take-off is 1/3 or less nominal size of main. Bushings shall not be used.

b. Fittings on piping 2" and smaller shall be Class 150 black malleable iron screw fittings. (Class 300 for unions.)

c. Valves and strainers: Class 150.

2.04 EQUIPMENT DRAIN PIPING:

A. All factory fabricated or field erected air conditioning units with drain pans, all centrifugal water pumps and all other items or equipment or apparatus that require drains shall be connected with drain line run with adequate slope to a floor drain or other point of discharge as shown on the Drawings. On A.C. units the drain line shall include a properly sized water-sealed trap.

B. All drain piping shall be one inch (1") size minimum or larger as may be indicated on the Drawings. Such piping shall be Type L hard copper tube. The drain piping shall be assembled with adapter tees at each change in direction. Install screw plugs in unused openings for access to rod and clean.

PART 3 EXECUTION

3.01 PREPARATION

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

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

C. Prepare piping connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems. Refer to Section 22 13 16.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

E. Provide clearance for installation of insulation, and access to valves and fittings.

F. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to weld area.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 91 00.

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

K. Piping taps shall be made off of the top half of the pipe. Either off of the top or at a 45 degree angle up..

3.03 FABRICATION OF PIPE:

A. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage.

B. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site.

C. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

D. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.

E. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from laying on the ground shall be removed.

F. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

G. Procedure for Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.

3.04 APPLICATION

A. Roll grooved mechanical couplings and fasteners may be used only for pump fit-up assemblies.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

D. Install butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Install butterfly valves for throttling, bypass, or manual flow control services.

F. Provide spring loaded check valves on discharge of condenser water pumps.

G. Use gas plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

H. Use butterfly valves in heating, chilled and condenser water systems.

I. Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.

J. Use lug end butterfly valves to isolate equipment.

K. Provide 3/4 inch (20 mm) ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest drain.

3.05 PIPE PRESSURE TESTS:

A. See Section 23 00 00.

3.06 CLEANING AND FLUSHING OF WATER SYSTEMS

A. Water circulating Systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, any and all other material foreign to water being circulated.

B. Extreme care shall be exercised during construction to prevent dirt and other foreign matter from entering the pipe or other parts of systems. Pipe stored on the project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and dirt removed.

C. At pipe end locations a temporary bypass will be installed. Bypass shall be *same* size as the supply and return pipe. Prior to flushing the distribution system, the Contractor shall install the temporary bypass and a temporary line size strainer between the supply and return pipes. Contractor shall verify that the isolation valves are open.

D. After the temporary bypasses are installed, the Contractor shall provide and operate one pump which will cause a velocity of 10 feet per second in the main piping. This pump will be provided with a shot chemical feeder and a strainer assembly. Pump shall be connected to system at the point where piping goes into the building from the tunnel. If the pump is electric driven, rather than engine driven, the Contractor shall provide all temporary electrical disconnects, wiring, fuses, and other electrical devices that are required for safe operation.

E. Circulation will be started using the temporary pump. A nonhazardous cleaning compound (Entec 324 or approved equal) shall be added using the shot feeder until the concentration level of 20 parts per million is reached. Once this 20 parts per million concentration is reached, circulation will be maintained for 48 hours. After this period of time, the cleaning water shall be dumped to the sanitary sewer.

F. The distribution system will then be refilled with city water and circulated with continual bleed and make-up until the water is certified clean by the water treatment consultant, and accepted by the Owner. At the completion of this step an inhibitor shall be introduced. All waste water shall be dumped into the sanitary sewer system.

G. After the system is certified as clean, the Contractor shall close the valves. The bypass piping shall be removed as final connections to the building are accomplished.

H. During the flushing procedure, strainers shall be cleaned as often as necessary to remove debris and, in any event, all strainers shall be cleaned by physically removing the strainer screen from the body of the strainer at the end of flushing. Replace strainer basket and gasket. Contractor shall not flush through control valves, coils, etc. Contractor shall provide temporary bypasses at coils and spool pieces at control valves.

Flush the coils individually wasting water to sanitary sewer. Connect coils and install control valves after flushing.

I. Test samples shall be taken at all bypass locations and all tests shall indicate that the entire system has reached a PH, conductivity, and chemical concentration 1evel as approved by the Owner to match present systems. Contractor shall purchase needed chemicals from Owner's chemical treatment supplier.

J. Contractor shall provide a smaller assembly to clean and flush any miscellaneous piping that can not be included in the initial system flush. All other criteria shall remain the same.

K. Contractor shall add inhibitor to the cleaning and flushing chemicals if, once the system is approved as clean, there is any delay in connecting the new system to the existing system. This is to prevent any corrosion after the new pipe is clean.

END OF SECTION

SECTION 23 22 00
STEAM AND STEAM CONDENSATE PIPING

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED

A. Pipe and pipe fittings.

B. Valves.

C. Steam piping system.

D. Steam condensate piping system.

1.02 RELATED WORK

A. Section 08 31 13 - Access Doors.

B. Section 09 91 00 - Painting.

C. Section 23 00 00 - Basic Mechanical Requirements

D. Section 23 20 00.A - Piping, Valves and Fittings

F. Section 21 05 29 - Supports and Anchors.

G. Section 23 05 53 - Mechanical Identification.

H. Section 23 05 48 - Vibration Isolation.

I. Section 23 07 19 - Piping Insulation.

J. Section 23 22 00.A - Steam and Steam Condensate Specialties.

1.03 REFERENCES

A. ANSI/ASME SEC 9 - Welding and Brazing Qualifications.

B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.

C. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

E. ANSI/ASME B31.1 - Code for Power Piping.

F. ANSI/ASME B31.9 - Building Services Piping.

G. ANSI/AWS A5.8 - Brazing Filler Metal.

H. ANSI/AWS D1.1 - Structural Welding Code.

I. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

J. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

K. ASTM B32 - Solder Metal.

L. ASTM B88 - Seamless Copper Water Tube.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9, and ANSI/ASME B31.1.

1.05 QUALITY ASSURANCE

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

B. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/AWS D1.1.

1.06 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00.

B. Include data on pipe materials, pipe fittings, valves and accessories.

C. Include welder’s certification of compliance with ANSI/AWS D1.1.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 PIPING AND FITTINGS: (See also Section 23 20 00.A)

A. Piping systems shall conform to the following requirements.

B. Piping systems designed for steam pressure below 15 psig are low pressure steam systems. Piping systems designed for steam pressures from 15 psig up to and including 125 psig are medium pressure steam.

C. Condensate Return and Pumped Condensate Return Piping:

1. All piping shall be Schedule 80 black steel piping.

2. Fittings on piping 2-1/2" and larger shall be extra heavy butt welding type. Flanges shall be 150# welding neck type. Extra strong Weld-O-Lets, Thread-O-Lets, or shaped nipples may be used only when take-off is 1/3 or less nominal size of main.

3. Screwed fittings around traps and for piping 2" and smaller shall be 125# black cast iron. (300# for unions). At contractor's option, socket weld fittings may be used.

D. Low and Medium Pressure Steam Piping:

1. All piping shall be Schedule 40 black steel piping, except sizes 1" and smaller shall be Schedule 80.

2. Fittings on piping 2-1/2" and larger shall be standard weight butt welding type. Flanges shall be 150# welding neck type. Standard weight Weld-O-Lets, Thread-O-Lets, and shaped nipples may be used only when take-off is 1/3 or less nominal size of main. Bushings shall not be used.

3. Screwed fittings around traps and for piping 2" and smaller shall be 125 lb. black cast iron. (250 lb. for unions.) At contractor's option, socket weld fittings may be used.

F. Weld Fittings, Flanges and Unions:

1. Refer to Section 23 20 00.A.

G. Piping Materials:

1. Sizes shown on the Drawings are nominal pipe sizes unless otherwise indicated.

2.02 VALVES:

A. See Section 23 20 00.A.

2.03 STRAINERS:

A. See Section 23 06 20.

2.04 UNIONS:

A. See Section 23 20 00.A.

PART 3 EXECUTION

3.01 PREPARATION

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

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

C. Prepare piping connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space and not interfere with use of space, other work, or equipment.

C. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

D. Provide clearance for installation of insulation and access to valves and fittings.

E. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with the General Contractor.

F. Slope steam piping one inch in 40 feet (0.25 percent) in direction of flow. Use eccentric reducers to maintain bottom of pipe level.

G. Slope steam condensate piping one inch in 40 feet (0.25 percent). Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 91 00.

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

3.03 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections. Install dielectric unions where joining dissimilar materials.

B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

C. Install valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install valves for throttling, bypass, or manual flow control services.

E. All high pressure steam valves 12" and larger shall be piped with an equalizing bypass valve assembly.

3.04 CLEANING AND FLUSHING OF STEAM SYSTEMS:

A. Steam and condensate systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, any and all other material foreign to water being circulated.

B. Extreme care shall be exercised during construction to prevent dirt and other foreign matter from entering the pipe or other parts of systems. Pipe stored on the project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and dirt removed.

C. Chemicals, feeding devices, and water technician services shall be furnished by a single reputable manufacturer who will be responsible for the complete cleaning and flushing of the systems.

1. Add a temporary line with drain and isolate the building steam and condensate piping from the campus distribution piping to allow for proper circulation and cleaning of the new piping in the new tunnel and/or in the new or modified building piping system(s).

D. Systems shall be cleaned with a chemical compound specifically formulated for the purposes of removing the above listed foreign matter. These chemicals shall be injected to the systems, circulated and completely flushed out. Repeat the process if required. After each flushing, remove and thoroughly clean all strainers.

E. Final connection is not to be made to the campus loop system until the Chemical Contractor has filed with the Owner's representatives, a report stating that the systems are clean.

3.05 PIPE PRESSURE TESTS:

A. See Section 23 00 00.

END OF SECTION

SECTION 23 22 00.A
STEAM AND STEAM CONDENSTATE SPECIALTIES

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED

A. Steam traps.

B. Flash tanks.

C. Condensate return pumping units.

D. Steam pressure reducing valves.

E. Steam relief valves.

F. Steam safety valve discharge elbows.

G. Steam pipe guides.

H. Drip traps.

I. Sediment strainers.

J. Gauges and gauge connections.

K. Thermometer and thermometer wells.

L. Steam integrating (condensate) meters.

1.02 RELATED WORK

B. Section 23 05 13 - Motors.

C. Section 23 07 19 - Piping Insulation.

D. Section 23 07 16 - Equipment Insulation.

E. Section 23 06 20 - Hydronic Specialties

F. Section 23 22 00 - Steam and Steam Condensate Piping.

1.03 REFERENCES

A. ANSI/ASTM - Boilers and Pressure Vessels Code.

B. ASTM A105 - Forgings, Carbon Steel, for Piping Components.

C. ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

D. ASTM A216 - Steel Casings, Carbon, Suitable for Fusion Welding, for High Temperature Service.

E. ASTM A395 - Ferric Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

F. ASME B31.9 - Building Services Piping.

1.04 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 - Building Services Piping.

1.05 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.06 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00 and 01 33 23.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project.

C. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.

D. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.

E. Submit manufacturer's installation instructions under provisions of the Owner’s Special Instructions.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of the Owner’s Special Instructions..

1.08 EXTRA STOCK

A. Provide two service kits for each size and type of steam trap under provisions of the Owner’s Special Instructions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - STEAM TRAPS

A. Armstrong

B. Spirax/Sarco

C. Shipco.

D. Substitutions: Under provisions of Section 23 00 00.

2.02 INVERTED BUCKET TRAPS

A. Cast iron or semi-steel body and bolted cover for 250 psig WSP; provide access to internal parts without disturbing piping; with top test plug and bottom drain plugs, brass or stainless steel bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces, integral inlet strainer of monel or stainless steel.

2.03 FLOAT AND THERMOSTATIC TRAPS

A. ASTM A126, cast iron or semi-steel body and bolted cover for 250 psig WSP; provide access to internal parts without disturbing piping; with bottom drain plug, stainless steel or bronze bellows type air vent, stainless steel or copper float, stainless steel lever and valve assembly.

2.04 THERMOSTATIC TRAPS

A. Pressure balanced type with ASTM A216 WCB cast steel body and bolted or screwed cover, and integral ball joint union, for 300 psig WSP; monel or stainless steel bellows, stainless steel valve and seat; integral stainless steel strainer.

B. Freeze proof type with cast iron body for 300 psig WSP, bronze bellows, stainless steel valve and seat, external adjustment.

C. Bi-metallic type with ASTM A105 forged steel body and cover, for 300 psig WSP, bi-metal element with stainless steel components, integral Type 304 stainless steel strainer screen, 1/4 inch blow down valve.

2.05 STEAM PRESSURE REDUCING VALVES:

A. All pressure reducing valves shall be capable of maintaining the set pressure from zero to the maximum steam flow within reasonable limits when subjected to usual steam pressure fluctuations. They shall be single seated valves with stainless steel trim, with renewable valve, lugs and seats. Valve bodies shall be cast steel for high pressure service and cast iron for medium and low pressure service. These valves shall be self contained type with upstream and downstream pressure gauges and shall be installed as per manufacturer's recommendations. Valve capacities are scheduled on the drawings. Pressure reduction is one stage (125 to 25 psig). Station shall consist of two PRV's sized 1/3 and 2/3 capacity. Discharge pressure shall be adjustable to any value between 10 psig and 75% of the supply pressure.

B. All pressure regulators 2-1/2" and larger shall have flanged connections and those 2" and smaller may have screwed connections. Unions shall be installed on each side of any screwed pattern regulators installed.

C. Each reducing valve shall be preceded by a sediment strainer complete with a full-sized blow off valve with threaded end for hose connection.

D. These valves shall be Leslie, Spence (delete Spence on Austin projects, list first on Galveston projects), Spirax Sarco, Fisher, Mason Neilan or approved equal, with suitable automatic controllers.

2.06 STEAM RELIEF VALVES:

A. Relief valves 2" and smaller shall have brass bodies and arranged for screwed connections. Such relief valves shall be Crane No. 2501 or Spirax Sarco 6010 Brass Safety Valves for steam or approved equal. Bushings shall not be used.

B. Relief valves 2-1/2" and larger shall in the case of all medium and low pressure steam piping systems be arranged for flanged inlet and screwed outlet connections. Such relief valves shall be Consolidated Type 1511 or Spirax Sarco 252, ASME Standard Cast Iron Safety Valves, or approved equal.

C. The pressure at which each relief valve shall open is designated on the Drawings. When such valves are ordered by the Contractor, he shall definitely specify the pressure at which each relief valve is to be set. Each valve shall have a metal tag attached stamped with the valve identification plus the pressure setting.

2.07 STEAM SAFETY VALVE DISCHARGE ELBOWS:

A. All vent lines from safety valves shall be provided with safety valve discharge elbows at the point at which such lines rise to an elevation higher than that of the safety valve. The nature and design of the piping systems involved shall be such as to drain effectively all condensate from the discharge side of all relief valves. These safety valve discharge elbows shall be Grinnell Company's Safety Valve Drip Pan Elbows Figure No. 1538F, Spirax Sarco No. 299, or approved equal. No force shall be exerted on the safety valve by the discharge piping.

2.08 STEAM PIPE GUIDES:

A. All steam piping systems shall be properly guided as shown on the Drawings.

2.09 DRIP TRAPS:

A. High pressure drip trap assemblies shall be provided wherever called for on the Drawings and where required to keep such piping systems completely drained of condensate. Traps used in assemblies shall be 3/4" traps unless specifically shown to the contrary, i.e., they shall have 3/4" inlet and outlet connections. They shall have semi-steel bodies and the internal operating mechanisms shall be made of heat treated chrome steel. The caps shall be bolted to the bodies by the use of alloy steel heat treated machine bolts. These No. 213 Armstrong Traps, manufactured by Armstrong Machine Works, or approved equal, shall have a capacity for discharging at least 3,500 pounds of condensate per hour when operating at a pressure of 250 pounds per square inch. Where drip traps are installed in conjunction with 3" and larger steam lines, a drip pocket of the nature detailed on the Drawings shall be provided where a natural pocket does not exist. The piping and valves in trap assemblies shall be arranged as detailed on the Drawings; extra strong pipes shall be used on both sides of the trap.

B. All drip traps used in medium pressure steam piping systems where automatic steam control valves are not employed shall be arranged as shown on the Drawings. They shall be 3/4" Armstrong No. 811 Inverted Bucket Traps, or approved equal, with cast iron bodies, vacuum breakers and stainless steel trim. Each trap shall be provided with a valved test line and shall be preceded by a sediment strainer.

C. Condensate from coils, converters, hot water generators, low pressure drips and from all other devices where modulating steam valves are employed shall be of the float and thermostatic type. These traps shall be sized to handle 200% of the load with an inlet pressure drop of 0.5 psig and shall be equal to Armstrong "A" or "B" series, with vacuum breaker suitable for the system pressures. Installed traps with less than 12" of height between equipment outlet and trap inlet shall be sized for not less than 300 percent of the load. Each trap shall be provided with a 1/2" valve test line and shall be preceded by a sediment strainer. Under no circumstances shall a float and thermostatic trap be installed in a manner to lift condensate up in a return line.

D. Shop Drawing submittal of traps shall contain an itemized list with a tabulation of the load, trap type, and trap size.

2.10 SEDIMENT STRAINERS:

A. Each drip trap assembly, each control valve, for steam and each pressure reducing valve assembly regardless of its size shall be preceded by a sediment strainer. The arrangement of these sediment strainers shall be such that the screens may be removed for cleaning with ease through a gasketed plug.

B. Sediment strainers shall be placed in steam piping systems wherever shown on the Drawings and at such other points as may be required for the removal of foreign material from the piping systems.

C. Strainers in high pressure steam piping shall be cast steel sediment strainers and shall be suitable for working steam pressures as high as 300 pounds per square inch and temperatures not in excess of 750 degrees F. These strainers shall be the size designated on the Drawings. In the case of pipe sizes 2-1/2" and larger, flanged pattern sediment strainers shall be used. In the case of pipe smaller than 2-1/2", screwed pattern shall be used. Such strainers shall be Yarway No. 821 or 822 strainers manufactured by Yarnall Waring Company, or approved equal. The flanges of flanged strainers shall be dimensioned, faced, drilled, and spot faced to conform to the 300 pound American Standard for Steel Pipe Flanges and Flanged Fittings (B16e-1939).

D. Strainers in low and medium pressure steam piping systems 2-1/2" and larger shall be flanged iron body strainers having bolted covers. These strainers shall be suitable for operating pressures as high as 125 psig. They shall be Crane Company No. 989-1/2 Sediment Separators, or approved equal.

E. Sediment strainers in low and medium pressure steam piping systems 2" and smaller shall be arranged for screwed pipe connections. They shall be Crane No. 988-1/2 Sediment Separators, or approved equal.

F. Full sized blow off valves shall be installed on all strainers in steam, condensate, chilled and hot water lines and a drain shall be installed from each valve to the nearest floor drain.

2.11 GAUGES AND GAUGE CONNECTIONS:

A. See Section 23 05 19.

B. Furnish and install, where noted or indicated on the accompanying Drawings or called for elsewhere in these Specifications, gauge connections complete with Ashcroft No. 1095 lever handle union shutoff cocks, or approved equal. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.

2.12 THERMOMETER AND THERMOMETER WELLS:

A. See Section 23 21 00.A.

B. Thermometer wells and thermometers shall be located where noted on the accompanying Drawings and where called for in other sections of the Specifications. Thermometer test wells only shall be installed in a vertical position in horizontal lines and at 45 degrees, in vertical lines to hold a fluid in the well.

PART 3 EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions.

B. Install thermostatic steam traps to drain condensate from steam radiation units, convectors, and other similar terminal heating units.

C. Install float and thermostatic traps to drain condensate from unit heaters, converters, heating coils, steam separators, flash tanks, steam jacketed equipment, and direct steam injected equipment.

D. Install inverted bucket steam traps to drain condensate from steam main headers and branch lines.

E. Size steam traps to handle minimum of two times maximum condensate load of apparatus served.

F. Traps used on steam mains and branches shall be minimum 3/4 inch (20 mm) size.

G. Install steam traps with union or flanged connections at both ends.

H. Provide gate valve and strainer at inlet, and gate valve [and check valve] at discharge of steam traps.

I. Provide minimum 10 inch (250 mm) long dirt pocket of same pipe sizes as apparatus return connection between apparatus and steam trap.

J. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

K. Provide pressure reducing stations with pressure reducing valve, valved bypass, strainer and pressure gage on upstream side, relief valve and pressure gage on downstream side of pressure reducing valve.

L. Pressure reducing station shall be one or two stages as indicated, to produce flat reduced pressure curve over range of capacity.

M. Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.

N. Terminate relief valves to outdoors. Provide drip pan elbow with drain connection to nearest floor drain.

O. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.

END OF SECTION

SECTION 23 29 23

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Variable Frequency Drives

1.02 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 05 13 - Motors.

C. Section 23 05 48 - Vibration Isolation.

D. Section 23 34 16 - Fans.

E. Section 23 73 23 – Air Handling Units
F. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt.

G. Section 26 27 26 - Wiring Devices and Floor Boxes.

1.02 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. AMCA 99 - Standards Handbook.

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices.

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.

G. NEMA MG1 - Motors and Generators.

H. NFPA 70 - National Electrical Code.

I. IEEE - 112B, 587 and 519

1.03 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Product Data:

1. Provide literature which indicates dimensions, weights, capacities, ratings, performance, gages and finishes of materials, and electrical characteristics and connection requirements.

2. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

D. Manufacturer's Installation Instructions.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for routine service, spare parts lists, and wiring diagrams.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.07 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB

Substitutions: Under provisions of Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.02 GENERAL

A. Furnish and install complete Pulse Width Modulation (PWM) or 6-step variable voltage, variable frequency (VVD) speed controllers, as specified herein. All of the variable speed controllers shall be supplied by one manufacturer for this project. Motors must have a "bypass" switch as specified herein, to allow them to run if the controller malfunctions. All safety devices shall be energized. If an equal is proposed and accepted, Contractor must include installation and start-up by manufacturer's authorized personnel.

B. The Contractor shall furnish and install Variable Frequency Drive (VFD) motor controllers to vary the speed of the supply, return and relief air fans and pumps as shown in the fan and pump schedules on the Drawings. One controller shall control the speed of one motor only. See schedules and Drawings for quantity of controllers required.

C. The variable frequency drive shall produce an adjustable AC voltage and frequency output for complete motor control using solid state technology. The VFD shall be automatically controlled by a grounded electronic (4-20 ma) control signal. The drive shall produce an output volts/Hertz pattern to produce adequate starting torque under all conditions and operate smoothly at all operating speeds on variable torque load. The VFD shall be self-contained totally enclosed in NEMA 1 ventilated cabinet and capable of operation between 0 degrees and 40 degrees Celsius.

D. VFD's shall be ETL or UL listed. All components used on option units shall be ETL or UL listed. VFD's shall be designed to meet IEEE-587 and shall comply with all applicable provisions of the latest revision of the National Electric Code. The VFD shall comply with IEEE-519 with respect to the line noise generation.

E. The controllers shall be suitable for use with both standard and high efficiency 3-phase, squirrel cage, induction motors.

F. The service factor of the controller shall be equal to 0.95 with a power unit rating basis of 100 percent rated current continuous. **Rated continuous current of the** VFD **shall be equal to 110% of driven motor's FLA rating.**

G. Each controller shall consist of a converter, D.C. link filter or supply power backfeed RF (radio frequency) filter, and an inverter section with each section modularized for ease of troubleshooting. PWM controllers shall also have output line filters for motor noise reduction. All components shall be factory mounted and wired on a dead-front, grounded, freestanding or wall mounted minimum NEMA 1 enclosure arranged for top or bottom conduit entry.

C. The controller enclosure shall be provided with the manufacturer's illustrated operating instructions and parts list mounted inside the enclosure door, manual

speed control potentiometer, three position mode selector switch ("manual - off - auto", or equivalent), "power on" light, auxiliary relays and contacts for interlock and control wiring.

D. The 6-step VFD shall convert 460 volt, three phase 60 Hertz utility power to variable voltage and frequency, three phase, AC power. Both 6-step and PWM shall be designed to provide stepless motor control from 20 percent to 100 percent of base speed.

J. Each VFD shall be matched and coordinated with the motor that it is operating. Direct-drive equipment shall have VFDs selected so that the motor shall not over-amp when the VFD is in bypass.

2.03 FEATURES

The VFD shall incorporate the following minimum features:

A. Input power: 460 V/3 phase/60 Hz.

B. Input fused disconnect switch.

C. Input line filter capable of protecting the electronics against transient voltage spikes or notches, as well as backfeed of RF (Radio Frequency) interference, into the incoming power supply.

D. Fuseless electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause fuses to open.

E. The following door mounted devices:

1. "Power on" light

2. Hand/off/auto (or equivalent) selector switch

3. Manual speed potentiometer (1000 ohms) and ammeter

4. Digital display unit

5. Status, frequency/percent speed and fault diagnostics

F. Minimum/maximum adjustable speeds

G. Disconnect switch and thermal motor overloads.

H. Manual speed control during manual control mode.

I. A thermally protected transfer switch for manual bypass of the VFD.

J. The VFD shall have auto-restart after power failure, power surge, undercurrent and overcurrent. Overcurrent restart shall be limited to a maximum of five attempts.

K. Electronic and control follower board.

L. External signal shutdown feature (i.e. fire/smoke, freeze, operable and normal bypass mode).

M. Output terminal for remote frequency and current meters (4 to 20 ma).

N. Trip relay for remote fault indication.

O. A door interlock, designed to cut power to the unit when the door is opened.

P. Instantaneous overcurrent trip.

Q. Unit over temperature protection.

R. A bypass switch which shall simultaneously isolate the VFD from input and output power, and provide line power directly to the motor. The bypass switch shall also have the capability of starting and stopping the motor. The switch shall consist of an enclosure separate from the VFD.. The following shall be mounted on the enclosure door:

1. Door interlocked main input disconnect switch

2. Power on light.

3. "Drive-off-bypass" manual mode selector switch

4. A "normal operation-off-test" selector to facilitate static testing of the drive at startup or while the motor is operating in the bypass mode.

5. Speed lockout circuitry to allow the lockout or bypass of at least three speed ranges within the full range of the controller.

2.04 DISCONNECT AND INTERFACE

The following shall be mounted within the enclosure:

A. Line, load and bypass contactors capable of interrupting the locked rotor rating of the driven motor. Bypass and load contactors must be mechanically interlocked to prevent simultaneous closure.

B. Overload relay

C. A dedicated terminal strip to allow the controller to be interconnected with external shutdown contacts from smoke detectors, fire detectors, damper interlocks, freeze-stats, time clocks, remote master on-off switch, energy management and control system (FCMS) and input signals. The system must be capable of shutdown whether in the drive or in the bypass mode by remote detectors.

2.05 FAULT DETECTION DEVICES

A. A diagnostic fault detection center shall be integral to each VFD, providing an indication of the following fault conditions:

B. External fault

C. Processor line fault

D. Low AC line voltage

E. High AC line voltage

F. Current overload

G. High DC buss voltage

H. VFD output fault

2.06 CONTROL

A. All control adjustments shall be made without the necessity of an extender board of specialized meters, but rather from front access adjustable potentiometers.

B. Low voltage logic and 115 V control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded.

C. The VFD shall include a power ride-through feature to allow continuous operation through up to a three to five cycle line loss.

D. Electronic output overload protection shall be provided to eliminate the use of bimetallic overloads. The drive shall not be phase sequence sensitive.

E. The VFD shall have independently adjustable acceleration and deceleration circuits of 5 to 120 seconds. Extended time periods are also acceptable.

F. The VFD shall have full function output current limit adjustable from 10 to 100 percent.

2.07 SYSTEM OPERATION

A. Selector switch in the "off" position - the controller run circuit shall be open and the system shall not operate.

B. Selector switch in the "manual" position - the speeds of the motors shall be controlled by the manual speed potentiometer.

C. Selector switch in the "auto" position - operation shall be via the input 0 to 10 VDC signal with the output speed proportional to the input signal. If required for incorporation into the controls scenario, the VFD manufacturer shall furnish a pressure transducer mounted in the drive enclosure to convert a 3 to 15 psi pressure signal to a 0 to 10 VDC signal.

D. The bypass switch shall provide the ability to service the control in bypass operation while not de-energizing the motor. It shall also allow for start/stop functions for the motor.

E. In case of an output ground fault or similar abnormal output condition, any VFD serving multiple units shall be able to automatically alternate its output to either the duty device or the standby device. The VFD shall be fully operational after an output ground fault condition.

PART 3 EXECUTION

3.01 As part of the purchase price and agreement, a full, unconditional, one (1) year warranty on all parts and labor shall be provided. The warranty shall include all parts, labor, shipping, field service or technician time, labor or travel expenses and verbal or written correspondence with the VFD manufacturer or his representatives, including that which might be incidental to the proper installation and operation of the equipment.

3.02 The manufacturer's representative shall provide a list of recommended spare parts.

3.03 The manufacturer's representative shall provide terminal block to terminal block wiring diagrams coordinated with the owner to provide a complete and functional operating system. Furnish detailed drawings showing construction, dimensions, wiring diagrams and installation procedures for engineer's approval.

3.04 The manufacturer shall provide a factory trained technician to start the VFD and place it into operation.

3.05 The successful vendor shall provide for and present to the owner, at no cost to the owner, a training and troubleshooting course at the owner's location. This course shall be comprised of a minimum of two (2) days of classroom instruction for a minimum of four (4) hours per day complete with visual aids, documentation, circuit diagrams and hands-on training for a group of approximately 6 people. This course is not to be construed as a sale meeting, but rather as a school to familiarize the owner with the care, troubleshooting and servicing of the VFD.

3.06 VFD's shall be wall hung units. Contractor shall provide unistrut mounting bracket for drives. Contractor shall reinforce the wall studs with bracing as required to adequately support the drive. Installation of the VFD shall allow for clearance in front of the drive as required by the latest revision of the National Electric Code for an electrical panel.

3.07 TESTING

A. Components shall be pretested and complete VSD shall have full burn-in under full load for a minimum of 12 hours with the driven device and motor to be furnished for this project. VSD's shall be shipped to the air handling unit, pump or fan manufacturer for testing. The units shall be operated over the full speed range to certify noise and vibration limits are met.

1. Vibration shall be measured at each bearing in all three places and shall not exceed 1.0 mils in any plane.

2. Ambient noise generated by the VSD shall be limited to an amount equal to the system noise level as designated by the latest ASHRAE

noise level guidelines for such equipment. Noise level criteria at different octave bands and mid-frequencies shall be furnished with the submittal data.

B. Up to two of the three lock-out ranges can be used to avoid out of tolerance noise or vibration conditions. Maximum range of any lock-out range shall be limited to 50 RPM.

END OF SECTION

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SECTION 23 31 00
DUCTWORK

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED

A. Low pressure ducts.

B. Medium and high pressure ductwork.

C. Casings.

D. Duct cleaning.

1.02 RELATED WORK

A. Section 09 91 00 - Painting: Weld priming, weather resistant, paint or coating.

B. Section 23 00 00 - Basic Mechanical Requirements.

C. Section 23 05 29 - Sleeves, Flashings, Supports and Anchors.

E. Section 23 07 13 - Duct Insulation.

F. Section 23 33 00 - Ductwork Accessories.

G. Section 23 05 93.A - Testing, Adjusting and Balancing.

1.03 REFERENCES

A. ASHRAE - Handbook of Fundamentals; Duct Design.

B. ASHRAE - Handbook of Equipment; Duct Construction.

C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

D. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

E. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

F. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

G. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.

H. ASTM C 14 - Concrete Sewer, Storm Drain, and Culvert Pipe.

I. ASTM C 443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

J. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

K. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

L. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.

M. SMACNA - Low Pressure Duct Construction Standards.

N. SMACNA - High Pressure Duct Construction Standards.

O. UL 181 - Factory-Made Air Ducts and Connectors.

1.04 REFERENCES

A. Fundamentals Handbook, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

B. Equipment Handbook, ASHRAE.

C. HVAC Duct Construction Standards, Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

D. HVAC Duct System Design, SMACNA.

E. Round Industrial Duct Construction Standards, SMACNA.

F. Engineering Design Manual for Air Handling Systems, United McGill Corporation (UMC).

G. Assembly and Installation of Spiral Duct and Fittings, UMC.

H. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.

1.05 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: 2 inch WG positive or negative static pressure and velocities less than 1,500 fpm.

C. Medium Pressure: 6 inch WG positive static pressure and velocities greater than 1,500 fpm.

1.06 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.07 SUBMITTALS

A. Shop Drawings shall be submitted on all items of sheet metal work specified herein. Shop Drawings of ductwork at air units shall be submitted at a minimum scale of 3/8" equal to one foot.

B. Shop Drawings shall be submitted on all other ductwork per Section 23 00 00. Shop Drawings shall indicate location of all supply, return, exhaust and light fixtures from the approved reflected ceiling plans.

C. Submit shop drawings and product data under provisions of Section 23 00 00.

D. Submit samples under provisions of Section 23 00 00.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

PART 2 PRODUCTS

2.01 DUCTWORK GENERAL:

A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA Duct Manuals where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein. All exhaust ductwork including toilet room exhausts shall be constructed and leak tested as specified for medium pressure supply ducts at negative pressure.

B. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Architect.

C. All duct sizes shown on the Drawings are air stream sizes. Allowance shall be made for internal lining where required, to provide the required cross sectional area.

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

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

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

2.02 DUCTWORK LOW PRESSURE:

A. The scope of low pressure ductwork is defined as all ductwork downstream of terminal units and all return air boots (as defined as ducts transferring open plenums between walls to deck). Construction of all low pressure duct shall be in accordance with Low Velocity Duct

Construction Standards as published by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and shall be sealed and tested at 3" static with the same test procedures as medium pressure ductwork.

B. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.

C. The metal gauges listed in the 1985 SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct are the minimum which shall be used for this project if not otherwise specified herein. It shall be noted that the Contractor is responsible that the metal gauge selected is heavy enough to withstand the physical abuse of the installation.

D. Elbows shall be radius type and have a centerline radius of 1-1/2 times the duct diameter or width. Elbows in round ducts may be smooth radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.

E. SEALANT: All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Hardcast “Flex-Grip 550 (spray applied to 20 mil thickness), or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Weather" (United McGill Corp.) neoprene based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0. At contractor’s option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

2.03 DUCTWORK MEDIUM PRESSURE: (Includes all plenums on the roof unless otherwise noted on the drawings).

A. The scope of medium pressure ductwork is defined as all outside air ductwork, ductwork downstream of all air handlers, up to and including terminal units, plus all exhaust air ductwork as well as return air ductwork connected to the air handling unit. Construction of all ducts shall be in accordance with High Velocity Construction Standards as published by SMACNA if not otherwise specified herein. All round and rectangular duct construction, duct fittings, dampers, etc., are covered in this manual and it is to be adhered to.

1. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company, Mason Road Sheetmetal or approved equal.

2. The metal gauges are listed herein for round duct and for rectangular duct.

B. All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Hardcast “Flex-Grip” 550 (spray applied to 20 mil thickness), or "United Duct Sealer" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Weather" (United McGill Corp.) solvent based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. At contractor’s option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

C. Oval ducts shall be spiral flat oval or welded flat oval equal to those of United McGill Sheet Metal Company with gauges and reinforcing as recommended by the manufacturer for medium pressure or the ducts may be Shop fabricated of completely welded construction of the following gauge:

Major Axis 12 to 20	No. 24 gauge
Major Axis 20 to 30	No. 22 gauge
Major Axis 30 to 46	No. 20 gauge
Major Axis 46 to 50	No. 18 gauge
Major Axis 50 and Up	No. 16 gauge

D. Oval fittings shall be equal to those of United McGill Sheet Metal Company with requirements, sealing, etc., similar to that specified for round medium pressure work.

E. Oval duct reinforcing methods shall be submitted as Shop Drawings for approval. Reinforcing galvanized angles shall be of sizes specified for same size rectangular ducts. Galvanized angles shall be used where standing seams are specified for rectangular ducts. Attaching methods shall be shown on Shop Drawings and submitted for approval.

F. Testing of Medium Pressure Ductwork: (Includes from fan discharge through to the discharge of terminal units.)

1. All medium pressure ducts shall be pressure tested according to SMACNA Chapter 10 test procedures. Design pressure for testing ductwork shall be six inches (6") of water. Total allowable leakage shall not exceed 1% of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all Sections shall not exceed the total allowable leakage.

2. The entire system of medium pressure ductwork shall be tested, excluding the VAV/Constant Volume Terminal Units (i.e. The ductwork shall be capped between the Terminal Units and the medium pressure duct, and tested as described above). After testing has proven that the ductwork is installed and performs as specified, the terminal units shall be connected to the ductwork and the connections sealed with extra care. The contractor shall inform the project inspector when the joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage in the terminal unit connections/joints after the systems have been put into service, the leaks shall be repaired by: 1) complete removal of the sealing materials, 2) thorough cleaning of the joint surfaces, and 3) installation of multiple layers of sealing materials.

G. All exhaust ductwork, including toilet room exhausts, shall be constructed as for medium pressure ducts and shall be tested for leaks in the same manner as for medium pressure supply ducts. Testing may exclude any zoning valves as well. The duct shall be capped upstream and downstream of the valves and tested on both sides. The total leakage for both upstream and downstream shall be no more than 1% of the total design cfm.

H. DUCTMATE or Ward coupling system may be used on rectangular ductwork. Contractor may (where space permits) use rectangular ductwork with DUCTMATE or Ward system in lieu of oval ductwork. Joints shall be assembled with pre-formed isobutyene gasket (min. 3/16" thick x 5/8" wide), equal to Ductmate 440 tape or McGill "Uni-Butyl" tape. After assembly, entire joint shall be coated with 20 mil thickness of Hardcast "Flex-Grip" 550. <u>No other flange-type duct joining systems may be used.</u> Duct gauges shall be as specified herein.

I. Rectangular 90 degree elbows shall be constructed with single thickness turning vanes and shall be used only when lack of space prevents the use of radius ells. Radius type

rectangular elbows shall have a centerline radius of 1-1/2 times the duct diameter or width. Contractor shall have the option to substitute short radius vaned elbows, but shall request the substitution at the time of submittal of Shop Drawings, and shall request the substitution as required in Section 23 00 00. Elbows in round or oval ducts may be smooth long radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.

J. Plenums location on the roof shall be sloped to the edges so that water does not pond on the top.

2.06 ELBOWS:

A. Where rectangular elbows are shown, or are required for good air flow, contractor shall provide and install turning vanes. Job fabricated turning vanes, if used, shall be fabricated of the same gauge and type of material as the duct in which they are installed. Vanes must be fabricated for same angle as duct offset. Radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width. Submit Shop Drawings on factory fabricated and job fabricated turning vanes. Provide turning vanes in all rectangular radius elbows and offsets.

B. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.

C. Where turning vanes are to be provided and installed as required above. Only single thickness turning vanes shall be used.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Obtain manufacturer's inspection and acceptance of fabrication and installation of fiberglass ductwork prior to beginning of installation.

C. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

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

E. Slope underground ducts to plenums or low pump out points at 1:500. Provide access doors for inspection.

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

G. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.02 LOW PRESSURE DUCT SUPPORTS:

A. See Section 23 05 29.

3.03 MEDIUM PRESSURE DUCT SUPPORTS:

A. See Section 21 05 29.

3.04 DUCTWORK APPLICATION SCHEDULE

AIR SYSTEM	MATERIAL (2)	MINIMUM PRESSURE CLASSIFICATION
Supply and Return Systems:		
Untreated Outside Air Intake (Louver) to AHU Plenum	304L Stainless Steel	Medium Pressure
Treated Outside Air from OAHU to AHU & Plenums on Roof	Galvanized Steel	Medium Pressure

Notes to Table:

(1) Air device connections may be made with insulated flexible duct as specified herein. Provide hard connections where specifically shown on the drawings.

(2) Any duct exposed within occupied spaces (excluding mechanical rooms) shall be stainless.

3.05 CLEANING OF SYSTEMS:

A. Before turning the installation over to the Owner, all ducts should be cleaned and wiped down of all dust and dirt that has collected in the ducts.

END OF SECTION

SECTION 23 33 00
DUCTWORK ACCESSORIES

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED

A. Volume control dampers.

B. Fire dampers.

C. Combination fire and smoke dampers.

D. Backdraft dampers.

E. Air turning devices.

F. Flexible duct connections.

G. Duct access doors.

H. Duct test holes.

1.02 RELATED WORK

A. Section 23 05 48 - Vibration Isolation.

B. Section 23 31 00 - Ductwork.

1.03 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

B. SMACNA - Low Pressure Duct Construction Standards.

C. UL 33 - Heat Responsive Links for Fire-Protection Service.

D. UL 555 - Fire Dampers and Ceiling Dampers.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.

B. Provide shop drawings for shop fabricated assemblies indicated, including volume control dampers duct access doors duct test holes. Provide product data for hardware used.

C. Submit manufacturer's installation instructions under provisions of Section 23 00 00 for fire dampers and combination fire and smoke dampers.

PART 2 PRODUCTS

2.01 DAMPERS:

A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of the air flow, including all supply, return and exhaust branches, "division" in main supply, return and exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, the Contractor shall be responsible for the proper location of the access doors.

B. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, No. 644 on exposed externally insulated ductwork and No. 677 (2-5/8" diameter) chromium plated cover plate for concealed ductwork not above lay-in accessible ceilings. Furnish and install end bearings for the damper rods on the end opposite the quadrant when No. 555 or No. 644 regulators are used, and on both ends when No. 677 regulators are used.

C. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.

D. Dampers larger than three (3) square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and with end bearings supporting the axle.

E. Volume dampers shall be equal to those of Greenheck, Ruskin, Pottorff or substitute approved by Owner. Blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16 gauge galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.

F. Install all dampers furnished by the Temperature Control Manufacturer's in strict accordance with the manufacturer's recommendations and requirements of these Specifications.

G. All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equal, elevated dial operators. Insulation shall extend under the elevated dial. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635, or equal, dial operators. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.

2.02 FIRE AND FIRE/SMOKE DAMPERS:

A. <u>Fire Dampers</u>

1. Furnish and install where shown on the drawings or required by the Specifications, fire dampers meeting the following requirements.

2. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555. All dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural drawings) protection rating, 165 or 212 degree F fusible link, and shall bear a U.L. label in accordance with Underwriters' Laboratories labeling procedures. Fire dampers shall be constructed such that the damper frame material and the curtain material shall be galvanized.

3. Fire dampers shall be curtain blade or multi-blade type and the damper shall be so constructed that the blades are either out of the air stream or installed in an oversized sleeve to provide a 100 percent free area of the duct in which the damper is housed.

4. The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500 Standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05 inch water gauge.

5. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations shown in the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles and other material and practices required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be a minimum of 1 1/2 inch by 1 1/2 inch by 14 gauge and bolted, tack welded or screwed to the sleeve at maximum spacings of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the gauge of the duct defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 4" water gauge static pressure.

6. The damper installation shall be in accordance with the damper manufacturer's instructions.

7. All fire dampers shall comply with the specification as written above and shall be Ruskin Model IBD2 (Style C, CR or CO), Greenheck Model FD-150 (Type C, CR or CO), or Prefco Model 5500 (E6-M, CR, or CO).

8. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape so as to allow for expansion and contraction of the sleeve and damper assembly.

9. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 4” wg for air flow in either direction.

B. Combination Fire/Smoke Dampers

1. Furnish and install where shown on the Drawings, or as required by the Specifications, combination fire/smoke dampers meeting the following requirements.

2. Each combination fire/smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gage pressure and 8 cfm per square foot at 4 inches water gage pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gage at the design air quantity. (Note that this may require a larger damper than the connected duct size.)

3. The damper frame shall be a minimum of 20 gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be either parallel or opposed blade type. The blades shall be constructed with a minimum of 14 gauge equivalent thickness. The blade edge seal material shall be able to withstand 450 degrees F. The jamb seals shall be flexible stainless steel compression type or lap seal type.

4. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 250 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and operators. The manufacturer shall provide a factory assembled sleeve. The sleeve shall be a minimum of either 20 gauge for dampers where neither width nor height exceeds 48 inches or 16 gauge where either dimension equals or exceeds 48 inches.

5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gage in the closed position, and 2500 fpm air velocity in the open position.

6. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat/releasing device. The firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The Firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.

7. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.

8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.

9. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or

rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 4" W.G. static pressure.

10. All combination fire/smoke dampers shall comply with the specification as written above and shall be Ruskin Model FSD-60, Greenheck Model FSD-33, or Prefco Model 5020-1 (or Model 5010 for manual reset dampers).

11. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape so as to allow for expansion and contraction of the sleeve and damper assembly.

12. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 4” wg for air flow in either direction.

C. Submittal and Installation

1. The air quantity and free area through each fire and combination fire and smoke damper has been noted on the drawing adjacent to the duct size or wall opening size where such damper is required.

2. Submittal(s) for fire and combination fire/smoke dampers shall include the following:

   a. Assign identification numbers for each damper with corresponding number noted on the drawings.

   b. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper.

   c. Provide manufacturer's data of damper and its accessories or options.

3. One sample 18" x 12" damper shall be furnished for the purpose of illustrating damper operation to the owner's operating and maintenance personnel.

4. Access doors as specified elsewhere shall be provided to make all parts of the damper accessible. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.

5. Contractor shall install each damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555.

6. After each fire damper and combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to the installation of the ceilings, the Contractor shall, as directed by the Construction Inspector, activate part or all the dampers as required to verify "first-time" closure. Activation of the damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fusible link of the fire damper, and manually operating the fire/smoke damper through the pneumatic or electronic controls as appropriate. Failure of the damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.

2.03 FLEXIBLE CONNECTIONS:

A. Where ducts connect to fans, including roof exhausters, flexible connections shall be made using "Ventglas" fabric that is fire-resistant, waterproof, mildew resistant and practically air tight, and shall weigh approximately thirty ounces (30 oz.) per square yard. There shall be a minimum of one-half inch (1/2") slack in the connections, and a minimum of two and one-half inches (2-1/2") distance between the edges of the ducts. This does not apply to Air Handling Units with internal isolation.

2.04 ACCESS DOORS:

A. Furnish and install in the ductwork, hinged rectangular or round "spin-in" access doors to provide access to all fire dampers mixed air plenums, upstream of steam reheat coils, automatic dampers, etc. Where the ducts are insulated, the access doors shall be double skin doors with one inch (1") of insulation in the door. Where the size of the duct permits, the doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors). Latches for rectangular doors smaller than 18" x 16" shall be Ventlok No. 100 or 140. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10" x 12", complete with latch and two (2) hinges, or twelve inches (12") in diameter. Round access doors shall be "Inspector Series" spin-in type door as manufactured by Flexmaster USA, or approved equal. Doors for personnel access to ductwork shall be nominal twenty-four inches (24") in diameter.

B. Provide access panels as shown on the drawings, as noted above and in locations where motorized dampers are unviewable (such as fan isolation dampers and riser pressure control dampers) so that they may be visually inspected for linkage failure.

C. Where these access doors are above a suspended ceiling, this Contractor shall be responsible for the proper location of the ceiling access doors.

2.05 SCREENS:

A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are, outdoors. Screens shall be No. 16 gauge, one-half inch (1/2") mesh in removable galvanized steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.06 TEST OPENINGS:

A. Furnish and install in the return air duct and in the discharge duct of each fan unit Ventlok No. 699 instrument test holes. The test holes shall be installed in locations as required to measure pressure drops across each item in the system, e.g., O.A. louvers, filters, fans, coils, intermediate points in duct runs, etc.

2.07 DUCT LOW PRESSURE TAPS (Conical Bell Mouth Fittings)

A. All duct taps shall be made with low-loss taps, conical taps or full-sized bellmouth taps.

B. Conical fittings may be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles) even though a volume damper is specified for the air device. (This does not apply to medium pressure duct.) Spin-in fittings shall be sealed at the duct tap with a gasket, or compression fit, or sealed with sealant specified for medium pressure ductwork. The location of spin-in fittings in the ducts shall be determined after dual

or single duct terminal units are hung or the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends.

C. The conical fitting shall be made of at least 26 gage galvanized sheet metal. The construction to be a two-piece fitting with a minimum overall length of 6 inches and shall be factory sealed for high pressure requirements. Average loss coefficient for sizes 6, 8, and 10 shall be less than 0.055.

D. Each to be provided with minimum 24 gage damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.

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

F. The conical bellmouth fitting shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc., or Buckley Air Products, Inc., 'AIR-TITE'.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions.

B. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers only where indicated.

C. Provide balancing dampers on medium pressure systems where indicated.

D. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

E. Demonstrate re-setting of fire dampers to Owner's representative.

F. Provide backdraft or motorized dampers on exhaust fans or exhaust ducts where indicated.

G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps.

H. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated.

I. Provide duct test holes where indicated and where required for testing and balancing purposes. Refer also to Section 23 05 93.

END OF SECTION

SECTION 23 29 23 – FANS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Inline Centrifugal Fans

B. Plenum Fans

C. Drives

D. Fan Accessories

1.3 RELATED WORK

A. Section 23 05 13 - Motors

B. Section 23 05 48 - Vibration Isolation

C. Section 23 07 13 - Ductwork Insulation

D. Section 23 29 23 – Variable Speed Drives

E. Section 23 31 00 - Ductwork

F. Section 23 33 00 - Ductwork Accessories: Backdraft Dampers

G. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

H. Section 26 27 26 - Wiring Devices and Floor Boxes

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data

F. NEMA MG1 - Motors and Generators

G. NFPA 70 - National Electrical Code

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate assembly of fans and accessories including dimensions, installation and mounting details, weights, service clearances, connection locations and types, and electrical connection requirements.

C. Product Data: Submittal data for approval for all fans of every description furnished under this section of these Specifications shall include the following:

1. Manufacturers software selection output that includes:

   a. fan curve with specified operating point clearly plotted Brake horsepower, motor horsepower and fan static efficiency

   b. System effect allowance (where applicable)

   c. Fan and motor RPM

   d. Clearly plotted “do not select left of this curve”

2. For fans above 10 horsepower, provide selections for the same fan (motor may vary) at TSP equal to scheduled TSP plus 0.5” wg.

3. Sound power levels for both fan inlet and outlet at rated capacity. Include breakout sound power levels for cabinet mounted fans.

4. Materials of construction

5. Electrical characteristics and connection requirements.

6. All data on fan accessories.

D. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

1.9 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two sets of belts for each belt drive fan, not including the set installed on the fans. Tag sets to identify fan.

PART 2 - PRODUCTS

2.1 GENERAL

A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Conform to AMCA 99.

D. Performance Base: Sea level conditions.

E. Temperature Limit: Maximum 300 degrees F.

F. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

G. Selection Restrictions:

1. Direct drive fans may not be selected to operate at higher RPM than the driving motor nominal RPM rating.

2. Fans furnished with VFDs may not be selected to operate with an input frequency greater than 60 hz and must be selected to not overload the motor when put into bypass mode.

3. Fans may not be selected to operate in the service factor of the motor.

4. Fans may not be selected to operate in an unstable region of the fan curve ("left of the do not select" curve)

5. Fans may not be selected with a brake horsepower greater than 5% of the scheduled brake horsepower

6. Scheduled fan static pressure is external to the specified product. Fans that include integral backdraft dampers, plenums, energy recovery coils, attenuators, etc must add the pressure drop associated with those accessories to the scheduled static pressure to obtain the total static pressure for fan selection.

2.2 EXHAUST FANS:

A. Centrifugal exhaust fans shall be Cook, Twin Cities, American Coolaire, or approved equal, single inlet, single width belted vent fans conforming to the following requirements.

1. Fans, as shown on the Drawings and having the capacities, characteristics and starting equipment shown in the schedule, shall be belt driven (as scheduled) and of the centrifugal type, especially selected for ventilating work. The fans shall run in perfect balance at all speeds, up to a 15% increase above the speeds indicated in the schedule, without noise or excessive vibration in fan or motor. Fan wheels shall be made with backward pitched blades. Blades shall be die-formed, true in shape and held in place by rivets or weld.

2. Fans shall be provided with antifriction bearing of the types specified herein. Shafts shall be made of the best quality steel, turned and ground to close tolerance and shall run true and in perfect balance.

3. Fans shall be arranged for multiple V-belt drives and shall be furnished complete with Vari-Pitch sheaves for single or two belt drives and fixed sheaves for three or more belt

drives. Provide a second fixed sheave for final balancing of size as determined after job operating conditions are known.

B. Inline exhaust fans shall be Cook, American Coolaire, or Twin Cities, in-line centrifugal or vane axial as approved. Capacity ratings shall be based upon tests performed in accordance with AMCA Standard 210. Each fan shall carry near the unit nameplate the AMCA seal indicating that capacity ratings are certified. Housings for all inline fans shall be of 14-gauge steel minimum and shall have square mounting frame of heavy steel angle to provide for mounting of fan. The fan housing will provide for slip joint duct connection. Fan wheels shall be axial flow type with cast aluminum blades or tubular centrifugal type constructed of welded steel and have airfoil shaped blades. The fan shall be dynamically balanced for smooth operation. The fan shaft shall be solid be solid steel AISI-C1040 keyed to the fan wheel. Grease lubricated bearings shall be selected for a minimum average life in excess of B-10, minimum life 40,000 hours at maximum catalogued operating conditions. Fans shall be provided with factory mounted inlet and outlet sound attenuators when required to meet the scheduled sound power levels. .

2.3 RETURN AIR FANS:

A. Centrifugal return air fans shall be Cook, American Coolaire, Twin Cities, or approved equal, DWDI and Class II or above as scheduled; belt drive fans (as scheduled) conforming to the following requirements.

1. Fans, as shown on the Drawings and having the capacities, characteristics and starting equipment shown on the schedule, shall be belt driven and of the centrifugal type, especially selected for ventilating work. Fan wheels shall be made with FC, BI or airfoil blades. Blades shall be die-formed, true to shape and held in place by rivets or welds. Fan shaft shall not reduce in diameter at the outboard bearing (opposite of drive end).

2. Fans shall be provided with antifriction bearing of the types specified herein. Shafts shall be made of the best quality steel, turned and ground to close tolerance and shall run true and in perfect balance.

3. Fans shall be provided with quick opening access doors in the fan scroll.

4. Belt driven fans shall be arranged for multiple V-belt drive and shall be furnished complete with Vari-Pitch sheaves for single or two belt drives and fixed sheaves for three or more belt drives. Furnish a second fixed sheave for final balancing of size as determined after job operating conditions are known.

5. Fans and motors shall be mounted on a common pad. See Vibration Isolation Specification, Section 23 05 48.

6. Fan belt guards shall be constructed with heavy steel angle frames and wire mesh panels. Guard shall be removable (four bolt max., or equivalent secure quick dismount) for easy access to belts and pulleys.

2.4 V-BELT DRIVES:

A. All v-belt drives shall be designed for a minimum of 50% overload. Where more than one belt is required, matched sets shall be used. All belt drives shall be furnished with belt guards.

2.5 FAN ACCESSORIES:

A. Inlet bell air flow measurement: Where scheduled or called for in the fan specifications, furnish an inlet cone air flow measurement system per the following requirements

1. Flow monitoring station shall not use air restricting probes that reduce fan performance or create additional fan sound.

2. Flow monitoring station shall accurately measure the pressure differential to within +/- 3% from scheduled air flow to 30% of scheduled air flow.

3. Flow monitoring station to be installed by the fan manufacturer as part of the standard fan assembly.

2.6 MOTORS:

A. Refer to Section 23 05 13 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install flexible connections specified in Section 23 33 00 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one-inch flex between ductwork and fan while running.

C. Provide fixed sheaves required for final air balance.

D. Provide safety screen or cage where inlet or outlet is exposed. Plug fans inside walk-in casings shall be provided with hinged safety cage.

E. Pipe scroll drains over to nearest floor or roof drain.

F. Provide motorized dampers on discharge of exhaust fans where indicated. Refer to Section 23 33 00.

G. Unless specified elsewhere, the fan manufacturer shall dynamically balance the fan with the fan set in place, leveled, and ductwork attached, to a vibration velocity less than or equal to 0.200 inches (0.100 inches for direct-drive applications) per second measured on horizontal, vertical, and axial planes at each bearing pad. Vibration amplitudes are in inches/second peak velocity. All values recorded are to be filter-in at the fan speed. Confirm the fan/motor vibration velocity limit over the following operating speed range: Fans with VFDs shall be checked from 15 to 110% of rated fan speed. Constant speed fans shall be checked at 100% of rated fan speed. ‘Lock-out’ ranges may be used to correct up to two ranges of excess vibration. The span of each ‘lock-out’ range shall be limited to an effective fan speed of 50 RPM. Any ‘lock-out’ range used shall be clearly identified in the test report and shall be prominently displayed on a typed, laminated legend mounted inside the VFD controller cabinet. This testing shall be witnessed by a representative of the Owner’s Test and Balance Consultant.

H. Failure to confirm vibration velocity limit shall require re-balancing and re-testing until criteria is met. Contractor shall bear all costs involved in the modifications, balancing, and re-testing, including travel and hourly costs associated with the Owner’s Test and Balance firm’s consultant.

END OF SECTION 23 34 16

SECTION 23 41 00
FILTERS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Filters.

B. Housings and frames.

C. Filter gauges.

1.02 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 05 13 - Motors.

C. Section 23 07 13 - Ductwork Insulation.

D. Section 23 31 00 - Ductwork.

E. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt.

F. Section 26 27 26 - Wiring Devices and Floor Boxes.

1.03 REFERENCES

A. AMCA 99 - Standards Handbook.

B. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.

C. NFPA 70 - National Electrical Code.

D. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

E. ANST/UL-900 - Test Performance of Air Filter Units.

F. ANSI/UL 586 - Test Performance of High Efficiency Porticalate, Air Filter Units.

G. ASHRAE 52 - Method of Testing Air Cleaning Devices.

1.04 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Product Data:

1. Provide literature which indicates dimensions, weights, capacities, ratings, performance, gauges and finishes of materials, and electrical characteristics and connection requirements.

2. Provide data of media, performance data, assembly, and frames.

3. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

D. Manufacturer's Installation Instructions.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.09 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two sets for each unit of filters. Tag to identify associated unit.

1.10 SCHEDULES ON DRAWINGS:

A. In general, all capacities and characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings,

the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Type "C": Replaceable Dry type, Moderate Efficiency

1. Farr 30/30

B. Type "D": Replaceable Dry Type Medium and/or High Efficiency

1. American Air Filter
2. Cambridge
3. Farr RIGA-FLO

C. Side Access Housings

1. Farr (4P) (3P) Universal Glide Pack
2. American Air Filter

D. Frames

1. American Air Filter
2. Farr Type 8

E. Filter Gauges

1. Dwyer "Magnehelic"
2. Dwyer #25 Manometer

F. Substitutions: Under provisions of Section 23 00 00. The equipment or material supplied by any of these acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.02 GENERAL DESCRIPTION

A. Configuration: Fabricate with fan(s), coils, etc. plus accessories, including:

1. Filters.

2. Filter Housings and Frames.

3. Filter Gauges.

B. Performance Base: Sea level conditions.

C. Fabrication: Conform to AMCA 99 and ARI 430.

D. Performance: Refer to schedules.

2.03 FILTERS:

A. All air filters shall be listed as (Class 1, Class 2) in accordance with Underwriters' Laboratories, Inc., Building Materials Director requirements, except ultrahigh efficiency filters (HEPA or ULPA) shall be manufactured of materials that are so listed by UL. All filters other

than the ultrahigh efficiency type are to be rated in accordance with ASHRAE Test Standard 52-76 and performance characteristics are to be published in the manufacturer's literature. When specified performance characteristics are not published in the manufacturer's literature, the submittal data shall include certified documentation of performance by an approved independent test laboratory.

B. Type "C": Replaceable, Dry Type, Moderate Efficiency: Filters shall be of the pleated media, disposable type, 2" (two inches) deep in direction of air flow. Each filter cell shall utilize a nonwoven, lofted cotton media with a net effective area of not less than 4.6square feet of media per 1.0 square feet of filter face area, a media support grid, and enclosing high wet strength cell sides. The 96% free area welded wire support grid shall be continuously bonded to the leaving air face of the media to properly support the radially tapered, pleated media in the air stream through the life span of the filter. The media itself shall be cemented to the inside perimeter of the cell sides to prevent bypass of unfiltered air. Filter efficiency shall average not less than 25 to 30% when tested in accordance with ASHRAE Test Standard 52-76. Initial clean resistance to air flow shall not exceed 0.30" w.g. at 500 fpm filter face velocity. The 24" x 24" size shall be certified to have a dust holding capacity of not less than 200 grams of ASHRAE Test Dust when operated at 500 fpm to a final resistance of 1.0" w.g.

C. Type "D": Replaceable, Dry Type, Medium and/or High Efficiency: Filters shall be 12" deep of the extended surface, supported pleat type. Each filter shall consist of high density, microfine glass fiber media, media support grid, contour stabilizers, and enclosing galvanized steel frame. Media shall be laminated to a nonwoven synthetic backing to form a lofted surface for maximum dust holding capacity. The edges of the media shall be continuously bonded to the internal surfaces of the galvanized steel frame to prevent bypass of unfiltered air. Filter efficiency shall average not less than 80 to 85% when tested in accordance with ASHRAE Test Standard 52-76. Filters shall be 24" x 24" x 12" deep with an initial clean resistance not to exceed 0.50 inches w.g. at 500 fpm face velocity. The filters shall be certified to have a dust holding capacity of not less than 235 grams of ASHRAE Test Dust when operated at 500 fpm face velocity to a final resistance of 1" w.g.

2.04 HOUSINGS AND FRAMES

A. Side access housings shall be fabricated of not less than 16 gauge galvanized steel. Housings shall each be equipped with hinged access doors at both ends, provision for receiving filters of any manufacturer without alteration to the housings, and extruded aluminum channels capable of receiving both the after filters and 2" deep panel type prefilters. The housings shall incorporate a permanent provision for sealing the filters against leakage around the entire perimeter of each filter, eliminating the need to purchase replacement filters with factory applied gasket strips. Replaceable woven pile seals shall be an integral component of the downstream flange of each extrusion so that the seals are compressed by the pressure drop across the filters, preventing bypass of unfiltered air. Side access housing shall not exceed (12) (21) inches in direction of air flow and shall be of all welded construction with factory prepunched standing flanges for ease of attachment to adjacent equipment and/or ductwork. Doors are to be fitted with positive sealing, heavy duty multiple latches and with sponge neoprene gaskets.

B. Unitary front access holding frames shall be fabricated of not less than 16 gauge galvanized steel with holes prepunched for convenient assembly into banks. Frames shall be a minimum of 2-5/8" deep for maximum structural strength and resistance to racking. All joints in the field assembled banks of frames shall be thoroughly caulked to prevent bypass of unfiltered air between frames and surrounding ductwork or plenum chambers. Frames shall each be fitted with polyurethane foam gaskets, held in place by long lasting adhesive, and with a minimum of four heavy duty spring type fasteners. Fasteners shall attach to the frames without requiring tools and shall be capable of withstanding 25 pounds of pressure without deflection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

1. Type "C" - Replaceable, Dry Type, Moderate Efficiency: Install 2" deep fiberglass throwaway filters at startup. Replace throwaway filters as required prior to final acceptance. At final acceptance, remove and discard the partially used throwaway filters and install a set of moderate efficiency filters. Furnish Owner with an additional set of unused moderate efficiency filters.

2. Types "D" - Replaceable, Dry Type, Medium and/or High Efficiency: Install 2" (two inch) deep fiberglass throwaway filters at startup. Replace throwaway filters as required prior to final acceptance. At final acceptance, remove and dispose of the used throwaway filters. Install first set of medium and/or high efficiency filters and, where called for, required prefilters. Furnish Owner with an additional set of unused medium and/or high efficiency filters.

B. Install in conformance with UL 900.

C. Assemble high pressure units by bolting sections together.

END OF SECTION

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SECTION 23 73 23

AIR HANDLING UNITS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Packaged air handling units.

B. Factory installed fans.

C. Dampers.

D. Filters.

E. Coils.

F. Drives.

1.02 RELATED SECTIONS

A. Section 23 00 00- Basic Mechanical Requirements.

B. Section 23 05 13 - Motors.

C. Section 21 05 48 - Vibration Isolation.

D. Section 23 07 13 - Ductwork Insulation.

E. Section 23 82 16 - Air Coils.

F. Section 23 41 00 - Filters.

G. Section 23 31 00 - Ductwork.

H. Section 23 33 00 - Ductwork Accessories: Flexible duct connections.

1.03 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. AMCA 99 - Standards Handbook.

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices.

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.

G. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.

H. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

I. ARI 435 - Application of Central-Station Air-Handling Units.

J. ARI 610 - Central System Humidifiers.

K. NEMA MG1 - Motors and Generators.

L. NFPA 70 - National Electrical Code.

M. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

N. UL 900 - Test Performance of Air Filter Units.

1.04 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Include with the initial submittal a letter signed by the manufacturer's national sales manager (or any corporate officer) and the production manager, acknowledging that this equipment is intended for a University of Texas facility and that all specification requirements shall be complied with. Submit copy of letter to OFPC engineer/UTHSC-H Construction manager.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics, connection requirements, and .

D. Product Data:

1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics and connection requirements.

2. Provide data of filter media, filter performance data, filter assembly, and filter frames as tested and certified per ASHRAE standards.

3. Provide fan curves with specified operating point clearly plotted, as tested and certified per AMCA standards. Ratings to include system effects. Bare fan ratings will not satisfy this requirement, but shall be submitted for comparison purposes.

4. Submit sound power level data for both fan outlet and casing radiation at rated capacity, as tested and certified per AMCA standards.

5. Provide data on all coils as tested and certified per ARI standards.

6. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

7. All materials shall have NFPA-90 rating of 25/50 or better.

E. Manufacturer's Installation Instructions.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. For panelized units, components may come palletized, in crates or on skids. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation of the Owner’s RCM.

1.09 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide one year of filters for each unit (start-up filters, plus 4 additional sets of MERV 8 for change-out each 3 months, and one additional set of MERV 13 for change-out one year from turn-over). One set of filters is to be installed when unit is started up, and shall be protected from construction debris with additional media either at the first bank of filters, or covering each air intake (outside air and return air). The other sets shall be scheduled for delivery at the times noted for change-out, one MERV 8 at 3 months from start-up, one MERV 8 at 6 months from start-up, one MERV 8 at 9 months from start-up and a MERV 8 and MERV 13 at 12 months from start-up. Coordinate exact delivery date with UTHSC-H personnel.

1.11 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information.

The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Insofar as is possible, all items of the same type (i.e., pumps, fans, etc.) shall be by the same manufacturer. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is installed.

1.12 WARRANTY:

A. Unit shall have a 5-year warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Laboratory Units:
   a. Climate Craft only per UTHSC-H Agreement. Price shall be submitted as a separate price from the base bid.

B. Office Units – These units shall also be provided as a separate price from the base bid:
   a. Climate Craft
   b. Temtrol
   c. Thermal
   d. JCI
   e. Trane

B. **NOTE**: Units must meet the size restrictions. In addition, each manufacturer must verify the shipping and delivery sizes of the components and coordinate exactly how the units will get to the building's penthouse and ultimately get to the location of the replacement.

C. Substitutions: Under provisions of Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.02 GENERAL DESCRIPTION

A. Configuration: Fabricate with fan and coil sections as scheduled plus accessories, including sections as detailed per unit.

B. Performance Base: Sea level conditions.

C. Fabrication: Conform to AMCA 99 and ARI 430 in the absence of direction in this specification.

D. Performance: Refer to schedule in drawings.

2.03 AIR HANDLER CASING AND GENERAL CONSTRUCTION:

A. Unit casing exterior (walls and roof) shall be a minimum 18-gauge thickness galvanized steel insulated internally, throughout (double wall construction with no thru metal). Internal insulation shall have an R-value of at least 10, with foil facing, neoprene or anti-microbial hardcoat protected unless specifically noted otherwise, and shall be fire and fungus proof.

Foam may be used as an alternate as long as it is also anti-microbial protected andfire and fungus proof. All internal insulation shall be protected with solid galvanized sheet metal, of a minimum of 20-gauge thickness. All sheet metal joints throughout the air handler, and between panelized sections, shall be gasketed with closed cell, soft rubber gaskets, fabricated from neoprene, EPDM, or other approved sealant material. Internal walls and roof outside shall be sealed such that there is no passage of air from inside the unit to the outer casing.

B. Individual panels of the fan section shall be removable without compromising the integrity of the unit. Casing assembly shall be configured to eliminate all thru-metal in portions of the unit subject to below ambient temperatures. Where fasteners are used in the assembly of the unit components, they shall not extend from the outside of the unit into the air stream. If all components of the fan section can be removed through the door, removable panels will not be necessary.

C. Drain pan liners shall be constructed of No. 16-gauge 316-L-L stainless steel or heavier as standard with the manufacturer, and shall be non-skid or be provided with protective grating. Drain pan shall be non-skid and extend up to the fan section on draw-thru units. Entire drain pan, and shall be insulated with R-8 rigid insulation. Drain pans shall be sloped to the outside edge of the unit. On units over six feet wide, slope to each side of the unit. The insulation shall be installed and sealed as is appropriate for the equipment construction.

D. Unit shall have a complete perimeter channel base of at least 6" galvanized steel, 8” tube steel or 6" carbon steel with marine quality primer. The unit manufacturer shall provide a condensate drain trap calculation that ensures there will be ample trapping height when the unit is sitting on a 5-1/2” concrete pad. Base channels shall be sized no less than 6”, but shall be extended to provide proper trapping. All floors shall be insulated with R-10 insulation with 14-gauge non-skid galvanized floor (or equivalent aluminum). An 18-gauge galvanized sheet shall enclose and form a vapor barrier for the insulation on the bottom of the unit. If a foamed-in-place closed cell insulation is used, the lower metal enclosure may be eliminated. All points of contact between the floor, vapor barrier and structure shall be thermally isolated with gasketing of closed cell soft rubber or EPDM.

1. Provide Alternate D2 for lighter base channel with description and cut-sheets.

E. Access doors shall be provided to allow access to both sides (upstream and downstream) of the filter racks, into the fan section, and both sides of all coils. Access doors shall be double wall, insulated the same as wall panels, and the opening framed with thermal break construction. Door size shall be at least 18” wide and full height of the panel up to 5’ 0” tall. The construction of the access doors shall equal or exceed the quality and quantity of the air handler casing materials as specified herein. Each door shall have a minimum of an 8-inch by 6-inch double-glazed view window, capable of withstanding the total developed pressure of the unit. The doors shall be hinged using either heavy-duty stainless butt hinges, adjustable cast aluminum hinges, or a continuous stainless steel piano hinge, extending along the entire edge of the door, except for a maximum of two inches at each end. If butt hinges are used, provide two per door for up to 36” high doors and three per door for longer doors. There shall be a minimum of two latches on doors longer than 18,” and three latches in doors over 36” long. Latches shall be Ventlok 310, heavy-duty latch, or approved equal. All access doors shall open against air pressure.

F. Coils in the air-handling units shall be individually removable from within the unit so that they may be removed through the access doors without removing any unit panels or piping exterior to the unit and shall not be used to provide structural stability for the casing. All coils shall be arranged for and piped to provide counterflow operation. The coils shall be

completely enclosed within the coil housing of the air unit casing. All penetrations of the air handler casing shall be neatly sealed using a resilient sealant. Hinged gasketed quick access doors of adequate size for a man to enter shall be provided for each space between coils, filters and other components. Stacked coils shall have intermediate drain pans with at least 1" rigid drain piping and pipe supports to main drain pan.

G. Panels shall be reinforced with sufficient internal bracing to prevent excessive deflection of the panels. Maximum deflection at any joint on the unit casing shall be limited to L /250th of the overall panel width or height.

H. Panel construction shall provide the following acoustical performance.

a. Sound Transmission Loss (dB) per ASTM E-90 & E-413

Octave	2	3	4	5	6	7	STC+
Coated Liner	22	26	37	44	53	55	39
Solid Liner	22	38	49	50	57	62	42

b. Sound Absorption Coefficients per ASTM C-423 & E-795

Octave	2	3	4	5	6	7	NRC+
No liner	.26	.71	1.09	1.02	.96	.83	.95
Coated Liner	.25	.79	1.06	1.06	1.04	.78	1.00

The above ratings represent minimum performance. Unit manufacturer shall submit full sound performance data to the project sound consultant for evaluation.

I. Provide a unit housing, including joints, seams, and access doors, that will not condense moisture on the external surfaces of this housing when subjected to a surrounding ambient environment of 82ºF dry-bulb/75ºF dew-point temperature air.

J. Equivalent aluminum material may be used where galvanized steel panel components are called for.

K. Provide sealable test ports on either side of each filter bank and each coil section, in inlet plenum and discharge plenum, and suction and discharge side of all fans. Ports shall be equal to Ventfabrics test port Model 699-2.

2.04 FANS:

A. Shall be both dynamically and statically balanced. Housed fans shall be equipped with quick opening access doors in the fan scroll. Motors shall be high efficiency type per Section 23 05 13. The motor mounting for each unit shall be an integral part of the fan support frame. The fan/motor unit shall be mounted on spring isolators within the air handler casing. Housed fans shall have an appropriately designed fabric duct vibration isolator installed within the air handler casing. The unit shall be supplied with a factory installed and sealed flange for connection to ductwork. Units shall be direct drive only.

B. The fan unit bearings shall be of the antifriction type, either ball or roller, lubricated at the factory, and shall be equipped with means for lubrication with a grease fitting on the outside

of the bearing housing. Both inboard and outboard bearings shall be the same, identical size. The bearings shall be a catalogued type as manufactured by Fafnir, SKF, Sealmaster, or approved equal, and stocked locally. Bearings shall have an L-10 minimum life of 200,000 hours. Intermediate bearings will not be acceptable. Grease fittings for bearings shall be remotely mounted within line of sight of the bearing, where possible. Where it is not possible, then the fitting shall be mounted where it is most easily accessible for service. The tubing used for remoting the fitting shall be stainless steel. Provide AEGIS bearing protection on all shafts.

C. After assembly, the unit manufacturer shall balance the fan (per ANSI/AMCA 204-96 fan application category BV-3) at design fan speed with belts and drives in place to a vibration velocity less than or equal to 0.157 inches (0.100 inches for direct-drive applications) per second measured on horizontal, vertical, and axial planes at each bearing pad. Vibration amplitudes are in inches/second peak velocity. All values recorded are to be filter-in at the fan speed.

D Plug fans installed in walk-in units shall be provided with a safety cage around the wheel or with a fan shut down switch in the access door. Cage shall be large enough to allow working room for wheel and bearing service and shall have removable sections to allow wheel removal.

E. Direct drive fans shall have fan wheels cut to provide proper matching of the motor and fan rpm.

F. Multiple Fan/Motor VFD Control: The fan array shall consist of multiple fan and motor "cubes", spaced in the air way tunnel cross section to provide uniform airflow and velocity profile across the entire airway tunnel section and components contained therein. Each fan cube shall be individually wired to a control panel containing power lock-disconnects for individual motors and a single VFD controlling all fan motors in the fan array. Refer to Specifications Section 23 2923 – "Variable Frequency Drives" for requirements. Controls on laboratory units (AHU-L1, 2, 3 &4) shall allow the unit to reduce to no less than 15% of the design flow and remain stable. This shall be provided by the balance stream option. Office units (AHU-O1, 2, 3, 4, 5, 6, 7 & 8) shall allow the unit to reduce to no less than 30% of design flow and remain stable.

2.05 DAMPERS

A. Damper Leakage: Section with factory built, factory mounted outside and return air dampers of galvanized steel and edge seals in galvanized frame, with galvanized steel axles in self-lubricating nylon bearings, in opposed blade arrangement with damper blades positioned across short air opening dimension. Maximum 4 CFM/Sq. Ft. at 4 inch WG differential pressure. Dampers shall be sized for 2000 fpm maximum face velocity.

B. Isolation Dampers: Factory mounted isolation dampers downstream or backdraft dampers upstream of the fan section shall be governed by the low-leakage damper specification in section 23 33 00.

C. Face and Bypass Dampers (Heat Recovery Units): Factory mounted in casing field mounted with access doors, of galvanized steel blades, and edge seals, galvanized steel frame, and axles in self-lubricating nylon bearings, arranged to match coil face with bypass, blank-off

and division sheets, external linkage, access doors, and adjustable resistance plate. Dampers shall be low-leakage type.

2.06 DRIVES:

B. Variable speed drives: See Section 23 29 23. Drive shall be supplied by the VFD manufacturer and shall be connected in the field. The AHU manufacturer shall coordinate with the drive manufacturer to ensure the motor will not over-amp in bypass mode.

2.07 COILS:

G. Refer to Section 23 82 16 - Air Coils, and Unit Schedules for requirements.

2.08 FILTERS:

A. Units shall have a MERV 8 and MERV 13 filter bank. Refer to Section 23 41 00 - Filters, and Unit Schedules for requirements.

2.10 ELECTRICAL

A. Fan motors shall be factory mounted and wired to an external disconnect switch adjacent to the motor access door. Fan motors shall be interlocked with fan access door to shut down when door is opened. For units with one VFD, the disconnects shall be in the fan array overload panels.

B. Vapor proof lights (mounted at 88” above floor or as high as possible for units shorter than 88”) shall be provided in each compartment. Lights shall have a switch at each door into the compartment with access doors. Provide two GFI convenience outlets evenly spaced on the long dimension of the unit. Wire lights and outlets to two external 120v, 20a power connections (one for each service) for connection by Division 26.

C. UV lights shall be provided in each outside air cooling coil compartment downstream of the coil. This includes all cooling coils on laboratory units and only the pretreated outside air path in the office units. Lights shall have a switch at each door into the compartment with access doors along with an automatic door switch that will shut off the UV lights when the access door is open. Provide warning stickers for the doors. The lights shall provide a minimum of 5W/sqft of the coil. Wire lights and outlets to external 120v, 20a power connections for connection by Division 26. Provide a comprehensive wiring diagram for the light fixtures showing number of 20A circuits required, how the door switches are to be wired and verify the door switch is installed in such a way as to not exceed the switch’s rated amperage.

D. All wiring shall be 600v rated type MTW/THWN stranded copper in EMT or LiquidTite conduit (max 3 feet). All junction boxes shall be UL approved and gasketed.

E. Motors – Motors shall be provided to match the direct-drive requirements of the AHU without overamping in bypass mode. See Section 23 05 13 for additional requirements.

F. Motor/VFD/Fan – The fan wheel shall be cut so that maximum motor/fan rpm does not exceed the motor rated horsepower when the variable frequency drive is placed into bypass.

2.11 FINISH

A. All external parts of the unit shall be Brite G-90 galvanized. No painting will be required.

PART 3 EXECUTION

3.01 INSTALLATION

A. Field assembly of the unit shall be the responsibility of the contractor and shall be supervised by the manufacturer.

B. Install in conformance with ARI 435.

C. Assemble high pressure units by bolting sections together.

3.02 TESTING

A. Units with cabinet mounted fans shall be tested and certified at rated conditions using AMCA 210 and AMCA 300 test procedures with fan mounted in the cabinet. Bare fan data will not be accepted.

B. Casing Deflection Test

1. Deflection limit of L/250 shall be demonstrated in the field after installation and witnessed by a representative of the Owner's Test and Balance Consultant.

2. 'L' is defined as the height of the largest panel on the sides, width across the top of the largest panel on the unit, and the smaller of width or height of the largest panel for the ends. These are known as the governing panels.

3. That portion of the unit after the fan discharge shall be tested at positive pressure. The remainder of the unit shall be tested at negative pressure.

4. Measurements shall be taken at mid point of 'L' using dial indicators reading in 1/1000ths. Mounting of dial indicators shall be independent of the unit casing. Multiple measurements shall be made. Dial indicator shall be mounted at mid point of 'L'. Measurements shall then be spaced along the sides, ends and top at mid point and quarter points of the negative section and the positive section. Spacing shall be adjusted to fall on nearest flange or panel joint. Any section of less than five feet shall require only one measurement at the center.

5. Unit shall be furnished with proper blank offs to facilitate the pressure testing.

6. In order to reduce the number of pressure cycles, it is recommended that multiple dial indicators be used at the measurement points. Separate set-ups will be required for the positive pressure tests and the negative pressure tests.

C. Casing Leakage Test. With unit set in place, leveled and ready to receive duct work connections, unit shall be tested for casing leakage by sealing all openings and pressurizing to 2.5 times rated pressure (defined as total static pressure of unit) or 10" WG, whichever is smaller. Maximum allowable leakage rate is 1.5% of rated unit flow. Test is to be performed by the manufacturer using flow measurement devices and shall be witnessed by a representative of the Owner's Test & Balance firm.

D. Fan/Motor Vibration Test. With the unit set in place, leveled, and ductwork attached, the manufacturer shall perform a final dynamic vibration trim balance to verify the fan/motor vibration velocity limit over the following operating speed range: Fans with VFDs shall be checked from 40 to 110% of the rated fan speed. Constant speed fans shall be checked at 100% of rated fan speed. 'Lock-out' ranges may be used to correct up to two ranges of excess vibration. The span of each 'lock-out' range shall be limited to an effective fan speed of 50 RPM. Any 'lock-out' range used shall be clearly identified in the test report and shall be prominently displayed on a typed, laminated legend mounted inside the VFD controller cabinet. This testing shall be witnessed by a representative of the Owner's Test and Balance firm.

E. Failure of the leakage and/or deflection test shall require sealing and bracing of the unit and retesting until criteria is met. Failure of the trim balance to confirm vibration limit shall require rebalancing and re-testing until criteria is met. Contractor shall bear all costs involved in the modifications, balancing, and re-testing, including travel and hourly costs associated with the representatives of the Owner's Test and Balance firm.

END OF SECTION
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SECTION 23 82 16

AIR COILS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Water coils.

B. Refrigerant coils.

1.02 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 07 19 - Piping Insulation.

C. Section 23 06 20.13 - Hydronic Specialties.

D. Section 23 22 00.A - Steam and Steam Condensate Specialties.

E. Section 23 31 00 - Ductwork: Installation of duct coils.

F. Section 23 09 23 - Direct Digital Control Systems.

1.03 REFERENCES

A. ANSI/ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

B. ANSI/NFPA 70 - National Electrical Code.

C. ANSI/UL 1096 - Electric Central Air Heating Equipment.

D. SMACNA - HVAC Duct Construction Standards, Metal and Flexible.

1.04 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

C. Submit product data under provisions of Section 23 00 00.

D. Submit product data indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

E. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

F. Submit manufacturer's certificate under provisions of Section 23 00 00 that coils are tested and rated in accordance with ANSI/ARI 410.

1.05 QUALIFICATIONS

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.

D. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 PRODUCTS

2.01 CHILLED WATER COILS:

A. Water coil capacities, pressure drops and selection procedures shall be certified for the capacity scheduled in accordance with ARI Standard 410-87. Non-certified coils will not be accepted.

B. Chilled water and heating water coils shall be of the extended surface type meeting all conditions and having the minimum face area and pressure drops scheduled on the Drawings, and shall have same-end supply and return connections unless otherwise indicated. Coils shall be constructed of copper tubes 5/8" O.D. with .035" thick minimum wall thickness and copper fins permanently bonded to the tubes by mechanical expansion. Coils shall have a maximum of 8 fins per inch, and a maximum of 6 rows. If additional cooling capacity is necessary, the additional capacity shall be provided by an additional coil, with an additional access section between the coils, and the coils shall be piped in series, counterflow to the direction of air flow. Copper fins on plate coils shall be .006" thick. Heating coil construction shall be similar, except fins may be aluminum material.

C. All coil headers and connections shall be of I.P.S. brass or heavy gauge seamless hard drawn copper tubing with penetrations for connection of core tubing by die-formed intrusion process with resulting contact depth between the header wall and core tubing of not less than .090". Joints between core tubing and header shall be of recess swage design to allow a large mating area for build up of brazing materials to give increased strength to the joint. Supply and return connection of brass or copper shall be terminated with National Pipe Threads with wrench flats.

D. Coils shall be designed and certified by the manufacturer to operate to scheduled face velocity plus 10% without moisture carry over. Each cooling, and heating coil section shall be provided with a 304 Stainless Steel frame/casing, including tube sheets, no lighter than 16 gauge. Frame members shall extend over the ends and edges of the coils and shall be constructed with formed holes for tubes, permitting free expansion and contraction of coil sections while supported by an extended surface of the frame. Intermediate tube support

sheets of 316-L stainless steel shall be provided in all coils having tube lengths in excess of 48": on long coil sections the spacing of coil supports shall not exceed 48". All intermediate supports shall be welded to coil frame members and fabricated with formed tube holes to support the penetrating tubes. Heating coil construction shall be similar, except casting frame and intermediate supports may be G90 galvanized material.

E. Condensate from chilled water coils shall be piped to the nearest convenient floor drain. The pipe size shall be the full size of the connection or 1" minimum diameter whichever is larger, insulated as specified for chilled water piping. A trap of a minimum depth of 6 inches, or as noted on the drawings, shall be provided in this drain line to prevent the escape or entry of air through the drain piping.

G. Pressure test all coils to 350 psi under water.

2.02 STEAM COILS:

A. All steam coils shall be 5/8" or 1” O.D. seamless copper tubes having 0.035" minimum wall thickness. Coil shall have 0.008" thick aluminum fins suitable for use with steam at a maximum temperature of 300 degrees F. and a maximum pressure of 200 psig. Coils shall vertical or horizontal tube type. Coil headers shall be cast iron or I.P.S. brass or as specified hereinafter for chilled water coils. Coils shall have one row, and a maximum of 8 fins per inch. Frames and rails shall be 304 stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

C. Support coil sections independent of piping on steel channel or double angle frames and secure to casings. Provide frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Provide airtight seal between coil and duct or casing.

D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

E. Make connections to coils with unions and flanges.

F. On water coils, provide shut-off valve on supply line and lock shield balancing valve on return line. Locate water supply at bottom of supply header and return water connection at top. Provide float operated automatic air vents at high points complete with stopvalve. Ensure water coils are drainable and provide drain connection at low points.

G. On water heating coils, and chilled water cooling coils, connect water supply to leaving air side of coil (counterflow arrangement).

H. For cooling coils where air velocity exceeds 500 ft/min (2.5 m/sec), provide three break moisture eliminators of 24 gage (0.60 mm) copper.

I. Provide drain pan and drain connection for cooling coils. Fabricate drain pan from minimum 18 gage 316L stainless steel. Extend 18 inches from face of coil leaving air side or through to the fan section on coils directly in front of the fan. Pipe drain pans individually to floor drain with water seal trap.

J. In steam coils, install vacuum breaker in steam line at header. Install steam traps with outlet minimum 12 inches below coil return connection.

K. Insulate headers located outside air flow as specified for piping. Refer to Section 23 07 19.

END OF SECTION

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SECTION 26 00 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General Requirements specifically applicable to Division 26.

B. The Contractor shall be responsible for:

1. The work included consists of furnishing all materials, supplies, equipment and tools, and performing all labor and services necessary for installation of a completely functional power, lighting, fire alarm and signaling systems. Complete systems in accordance with the intent of Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions, which affect the work covered under this Division.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

4. Temporary power service and lighting for construction. Coordinating all shutdown dates and schedules with Owner's Representative and obtain all work-permits required by Owner.

C. Intent of Drawings:

1. The Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every device or raceway in its exact location, unless specifically dimensioned. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceway, subject to prior review by the Owner and Engineer. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

2. The intent of the Drawings is to establish the type of systems and functions, but not to set forth each item essential to the functioning of the system. The drawings and specifications are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Review pertinent drawings and adjust the work to conditions shown. In case of doubt as to work intended, or where discrepancies occur between drawings, specifications, and actual conditions, immediately notify the Architect/Engineer and the Owner's representative, and propose a resolution.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total general requirements for the project electrical systems and equipment.

1. Division 01 Sections included in the project specifications.
2. The contract.

1.3 DESIGN CRITERIA

A. Equipment and devices to be installed outdoors or in enclosures where the temperatures are not controlled shall be capable of continuous operation under such conditions per manufacturer's requirements.

B. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically and

electrically suited to meet operating guarantees at the specified service conditions.

C. Electrical components shall be UL listed and labeled.

1.4 REFERENCE CODES AND STANDARDS, REGULATORY REQUIREMENTS

A. Standards of the following organizations as well as those listed in Division 01, may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

1. Association of Edison Illuminating Companies (AEIC)
2. American National Standards Institute (ANSI)
3. Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. National Electrical Code (NEC)
6. National Electrical Manufacturers Association (NEMA)
7. Electrical Safety in the Workplace
8. National Fire Protection Association (NFPA)
9. Underwriter's Laboratories (UL)
10. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

B. Work, materials and equipment must comply with the latest rules and regulations of the following.

1. National Electrical Code (NEC)
2. Electrical Safety in the Workplace
3. Occupational Safety and Health Act (OSHA)
4. American with Disability Act (ADA)
5. American Society for Testing and Materials (ASTM)
6. University of Texas (UT) System
7. Applicable state and federal codes, ordinances and regulations

C. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified shown.

D. Contractor shall obtain permits and arrange inspections required by codes applicable to this Section and shall submit written evidence to the Owner and Engineer that the required permits, inspections and code requirements have been secured.

1.5 SUBMITTALS

A. Submit the following in addition to and in accordance with the requirements of Division 01 for submittal requirement.

1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of it are clearly indicated and non-applicable portions clearly deleted or crossed out.

3. All schematic, connection and/or interconnection diagrams in accordance with the latest edition of NEMA.
4. Provide submittals as required by individual specification Section.

B. Provide the following with each submittal:

1. Catalog cuts with manufacturer's name clearly indicated. Applicable portions shall be circled and non-applicable portions shall be crossed out.
2. Line-by-line specification review by equipment manufacturer and contractor with any exceptions explicitly defined.

C. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads should be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.

D. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.

1. Itemize equipment and material by specification Section number; include manufacturer and identifying model or catalog numbers.
2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
3. If a satisfactory replacement is not submitted within a two-week period, owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to owner.

E. As-Built Record Drawings: The Contractor shall maintain a master set of As-Built Record Drawings that show changes and any other deviations from the drawings. The markups must be made as the changes are done. At the conclusion of the job, these As-Built Record Drawings shall be transferred to AutoCad electronic files, in a format acceptable to the Owner, and shall be complete and delivered to the Owner's Representative prior to final acceptance. Refer to 01210 Project Administration for other requirements.

1.6 SAFETY

A. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of Project Safety Manual (PSM).

1. The Contractors shall be responsible for training all personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.
2. The Contractor shall secure all electrical rooms, to limit access, prior to energizing any high voltage (480V or higher) equipment and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is on going near energized equipment. The Contractor shall cover all energized live parts when work is not being done in the equipment. This includes lunch and breaks.
3. The Contractor shall strictly enforce OSHA lock out/tag out procedures. Initial infractions shall result in a warning; a second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

1.7 SHORING AND EQUIPMENT SUPPORTS

A. The Contractor shall provide all permanent and temporary shoring, anchoring, and bracing required to make all parts absolutely stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.

B. The Contractor shall adequately support all freestanding panels, motor control centers, enclosures, and other equipment. This shall include bolting to the floor or solid structural steel to prevent tipping. Install free-standing electrical equipment on 4" thick concrete housekeeping pads

that are provided by others. Under no condition shall equipment be fastened to non-rigid building steel (i.e., removable platform steel gratings, handrails, etc.).

C. The Contractor shall provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. At no time shall the Contractor mount or suspend equipment from other disciplines' supports.

1.8 TEMPORARY POWER REQUIREMENTS

A. Provide power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15 and 20 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.

B. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.

C. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate equipment grounding conductor.

D. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.

E. Provide temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels and submit plan for approval by the owner.

F. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.

G. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.

1.9 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

A. Refer to Uniform General Conditions and Supplementary General Conditions for substitution of materials and equipment.

B. The intent of the Drawings and/or Specifications is neither to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

C. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.

D. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

E. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

F. All equipment installed on this project shall have local representation; local factory authorized service, and a local stock of repair parts.

G. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

H. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

I. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

J. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Materials shall be of a standard industrial quality if no specifications or specific model numbers are given.

B. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

C. All materials shall be new and unused.

D. Provide non-metallic material in corrosive areas or as otherwise specified.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Install work in compliance with NEC latest edition.

B. Install material and equipment in accordance with manufacturers' instructions. Provide calibrated torque wrenches and screwdrivers and tighten all terminals, lugs, and bus joints using it.

C. Comply with startup procedures as defined by Construction Manager and Owner.

D. Arrange electrical work in a neat, well-organized manner. Do not block future connection points of electrical service. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.

E. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.

F. Make opening through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.

3.2 SERVICE CONTINUITY

A. Maintain continuity of electric service to all functioning portions of process or buildings during the hours of normal use. Phase construction work to accommodate Owner's occupancy requirements.

B. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.

C. All service outages shall be requested in writing a minimum of two weeks prior to the date. Owner reserves the right to postpone shutdowns up to 24 hours prior to the shutdown at no additional cost. Outage requests shall include a schedule of the work to be performed and the time requirements.

D. The Contractor shall obtain all appropriate Owner permits for working in equipment.

3.3 HAZARDOUS LOCATIONS

A. Equipment, wiring, devices, and other components located within hazardous areas to be of appropriate type per NFPA requirements.

B. Ground exposed non-current carrying parts of entire electrical system in hazardous areas, in accordance with NEC and as instructed by Owner.

3.4 SLEEVES AND SEALS

A. Provide sealing and/or fire stopping where electrical equipment passes through walls, ceilings, and floors. Seals shall be watertight and/or fire rated as applicable.

3.5 CONSTRUCTION REVIEW

A. The Engineer or Owner's representative will review and observe installation work to insure compliance by the Contractor with requirements of the Contract Documents.

B. Review, observation, assistance, and actions by the Engineer or Owner's representative shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The review and observation activities shall not relieve the Contractor from the responsibilities of these Contract Documents.

C. The fact that the Engineer or Owner's representative do not make early discovery of faulty or omitted work shall not bar the Engineer or Owner's representative from subsequently rejecting this work and insisting that the Contractor make the necessary corrections.

D. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the Engineer or Owner's representative for an increase in the Contract price, or for any payment on account of increased cost, damage, or loss.

3.6 WARRANTY

A. Provide warranties in accordance with the requirements of Uniform General and Supplementary Conditions (UGC).

END OF SECTION

SECTION 26 00 00.01

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Electrical demolition for remodeling.

B. Electrical/control portion of HVAC work covered by Division 23 pertaining electrical demolition shall follow the requirement set forth by this specification.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for minor electrical demolition for remodeling.

1. Section 26 00 00 - Basic Electrical Requirements.

B. In the event of conflict regarding minor electrical demolition requirements between this Section and any other Section, the provisions of this Section shall govern.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: as specified in individual Sections.

B. Provide all materials necessary for work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. All demolitions or modifications to existing systems shall be coordinated through Owner's Representative. Demolition drawings are based on casual field observation and existing record documentations. Therefore the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and circuiting arrangements are as shown on Drawings and abandoned wiring and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to Engineer before disturbing existing installation.

B. Beginning of demolition means Contractor accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal. Provide temporary wiring and connections to maintain remaining systems in service during demolition and/or modification. Owner reserves the right up to 24 hours prior to any scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.

B. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. No work shall begin without proper permits and authorizations. Disable system only to make switchovers and connections. Obtain permission from Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

C. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Provisions for manual fire watch shall be provided in areas where services are interrupted. Make temporary connections to maintain service in areas adjacent to work area.

D. Existing Telephone System: Maintain existing system in service until new system is complete

and ready for service. Disable system only to make switchovers and connections. Notify Owner at least (2) weeks before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new plan drawings.

B. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes full length from source to device. Cut embedded or concealed conduit flush with walls and floors, and patch surfaces.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

D. Disconnect and remove abandoned panelboards and distribution equipment.

E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

G. Repair adjacent construction and finishes damaged during demolition and extension work.

H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

I. Extend existing installations using materials and methods compatible with existing electrical installation or as specified.

J. The level of completion shall be demonstrated to Owner’s Representative.

K. Where equipment is indicated to be demolished and returned to Owner, the Contractor shall include the delivery of this equipment to the Owner's site storage area. Remove with care all equipment to be relocated. Repair or replace of newly damaged equipment is the responsibility of the Contractor.

3.4 CLEANING AND REPAIR

A. The Contractor shall follow Owner’s clean work policy and shall include the removal of trash and demolished material from the building or work area at the end of the each day and removal from the site once a week.

B. The Contractor shall be responsible for repairing adjacent construction and finishes damaged during demolition and/or modification. The Contractor shall be responsible for the removal of ceiling tiles required in the demolition work. The Contractor shall be responsible for the replacement of damaged tiles and reinstallation of the ceiling prior to final acceptance.

C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.

3.5 DISPOSITION OF MATERIAL AND EQUIPMENT

A. Review with the Owner materials that have been removed and are no longer required, to determine any which the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner’s specified location.

B. For those materials not required by the Owner, dispose of them in accordance with applicable regulations.

END OF SECTION

SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Hinged cover enclosures and cabinets

B. Contactors

C. Control relays

D. Push buttons, and selector switches

E. Terminal blocks and accessories

F. Penetration sealing systems (fire stops)

G. Electrical/control portion of HVAC work covered by Division 23 pertaining basic electrical materials and methods shall follow the requirement set forth by this specification.

1.2 APPLICABLE CODES AND STANDARDS

A. NFPA 70, National Electrical Code (latest edition)

B. American National Standard, National Electrical Safety Code, (latest edition)

C. Applicable publications of NEMA, ANSI, IEEE, and ICEA

D. Underwriters Laboratories, Inc. Standards (UL)

E. Federal, city, state, and local codes and regulations having jurisdiction

F. OSHA requirements

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

H. NEMA WD 1 – General-Purpose Wiring Devices

I. UL 98 - Enclosed Switches

1.3 INTENT

A. This Section is not, and shall not be interpreted to be, a complete listing of all materials or equipment that is Contractor furnished and erected. It is intended to clarify and further define the Contractor scope of work, procurement, and responsibilities for those incidental materials that are not specified by other specifications, but important to a complete and operational system.

B. The Contractor shall furnish all equipment and materials, whether or not specified in other Sections of specification and on drawings, for installation and connection required to place equipment into satisfactory operating service. The Contractor shall review the Drawings and specifications for clarification of his responsibility in the handling and installation of equipment and material. Where applicable, and not in contradiction with the Drawings and specifications, the Contractor shall install and connect the equipment in accordance with the manufacturer's recommendations and instructions.

C. All materials and equipment shall be of types and manufacturer specified wherever practical. Should materials or equipment so specified be unattainable, the Contractor shall submit the description and manufacturer's literature, reason for substitution request and shall secure the approval of the Engineer before substitution of other material or equipment is purchased. This Section establishes performance requirements and the quality of equipment acceptable for use and shall in no way be construed to limit procurement from other manufacturer.

1.4 SUBMITTALS

A. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

B. Submit manufacturer's literature and specification data sheets for each type of basic material, which is applicable to the project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit. Damaged materials shall be removed from project site.

B. In their factory-furnished coverings, store materials in a clean, dry indoor space, which provides protection against the weather.

PART 2 - PRODUCTS

2.1 ENCLOSURES AND CABINETS

A. Enclosures and cabinets for all Contractor furnished electrical equipment and devices shall be suitable for the location and environmental conditions and shall be of the NEMA type as shown in Table 26 05 00-1. Exceptions shall be specifically designated on the Drawings.

Table 26 05 00-1
Enclosures

Location	Environment	Enclosure Type
Indoor Utility	Dry, subject to dust, falling dirt and dripping non-corrosive liquids	NEMA 12
Indoor	Clean, Dry	NEMA 1
Outdoor	Subject to windblown dust and rain, splashing water, and hose-directed water	NEMA 4
Indoor	Wet, subject to hose-directed water	NEMA 4
Outdoor	Subject to falling rain, sleet, and external ice formation	NEMA 3R
Indoor or Outdoor	Subject to corrosion, windblown dust and rain, splashing water and hose-directed water	NEMA 4X

B. Enclosures shall have the following properties:

1. Hinged Cover Enclosures: NEMA 250.

a. Type 1: Steel.

b. Type 4: Steel with gasket door, rain tight.

c. Type 4X: Stainless steel, (polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas).

d. Type 12: Steel with gasketed door, dust-tight.

C. Finish: Exterior, manufacturer's standard gray enamel finish; interior, white enamel finish.

D. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock. Where required for NEMA ratings, gaskets shall be neoprene rubber.

E. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14-gauge steel, white enamel finish.

F. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

G. Forced Ventilation: Where indicated, provide 115V single-phase fan motor, filtered with air plenum, finger guard, and stainless steel grille. Washable aluminum filter, accessible for cleaning from outside the enclosure; 20,000-hour continuous operation without lubrication or service. Provide matching exhaust grille assembly. Mount fan in lower side corner, exhaust grille in opposite upper side corner.

2.2 CONTACTORS

A. Acceptable Manufacturers

1. General Electric Company

2. Square D Company

3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. Contactors: NEMA ICS 2; electrically held or mechanically held as indicated on Drawings. Two-wire control for electrically held contactors and three-wire control for mechanically held contactors.

C. Enclosure: NEMA 1 unless indicated otherwise on Drawings.

D. Control Transformer: Provide when indicated on Drawings. Minimum capacity shall be 100 VA. Provide primary and secondary fuse protection.

E. Coil operating voltage; 110 volts, 60 Hz or as per drawings.

F. Size: NEMA ICS 2; size as indicated on Drawings.

G. Contacts: As indicated on Drawings; 600 Volts, 60 Hz.

H. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

2.3 CONTROL RELAYS

A. Acceptable Manufacturers

1. General Electric Type CR120A

2. Cutler-Hammer Type M-300

3. Square D Company

4. Allen-Bradley

5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. Provide magnetic control relays, NEMA Class A: A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.

C. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a solid-state timer attachment adjustable from 0.2 to 60 seconds (minimum) or with range as indicated. Provide with field convertible from ON delay to OFF delay and vice versa.

D. Where latching (mechanically held) relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

2.4 PUSH BUTTONS, AND SELECTOR SWITCHES

A. Acceptable Manufacturers

1. Allen-Bradley

2. Square D
3. Cutler Hammer
4. Seimens
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. For non-hazardous, indoor, dry locations, including control panels, and individual stations, provide heavy duty, NEMA 13, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices.

C. For non hazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, NEMA 4, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4 watertight enclosures. Provide special gasketing required to make complete station watertight.

D. For hazardous locations, provide control station listed by UL for Class I, Divisions 01 and 02, Groups C and D; Class II, Division 01 and 02, Groups E, F, and G. Specific type shall be in accordance with area classification as indicated on the Drawings.

E. For corrosive locations, provide nonmetallic components and enclosures meeting NEMA Type 4X.

F. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide push-button stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Nameplates shall be as specified in Section 26 05 53.

G. Utilize selector switches having standard operating levers. All indicating lights shall be LED type, push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.5 TERMINAL BLOCKS AND ACCESSORIES

A. Signal And Control Terminals

1. Acceptable Manufacturers

a. Phoenix Contact

b. Buchanan

c. Weidmüller

d. Entrelec

e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 23 00 00 and Division 01 for substitution requirement.

2. Signal and Control Terminals: Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24-inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.

B. Power Terminals

1. Acceptable Manufacturers

a. Buchanan

b. Ilsco

c. Square D Company

d. Burndy

e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

2. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals.

2.6 PENETRATION SEALING SYSTEMS (FIRE STOPS)

A. Provide penetration sealing where conduit, cable tray, etc. pass through rated walls, ceilings, and floors. See Section 07840, Fire Stopping, and Section 07900, Joint Sealants, for sealing requirements and systems.

2.7 UL LISTING

A. All equipment and materials shall be new and conform to the requirements of this Section. All equipment and materials shall be UL listed, and shall bear their label whenever standards have been established and level service is regularly furnished. All equipment and materials shall be of the best grade of their respective kind for the purpose.

PART 3 - EXECUTION

3.1 FABRICATION - CONTROL ENCLOSURES AND CABINETS

A. Shop assembles enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

3.2 INSTALLATION - ENCLOSURES AND CABINETS

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.

B. Provide accessory feet for freestanding equipment enclosures.

C. Install trim plumb.

3.3 ERECTION OF EQUIPMENT

A. Manufacturer's Installation Instructions: Where furnished or called for by the manufacturer equipment manufacturer's installation instructions shall be considered a part of this specification and fully complied with. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.

B. Mounting Heights: Individual safety switches and buttons and devices shall normally be installed at the following mounting heights, when not specified on the Drawings.

1. Safety Switches: 6 feet 0 inches (to top).

2. Pushbuttons: 4 feet 0 inches (to center).

3. Control Panels: 6 feet 0 inches (to top).

C. Mounting: Equipment and control devices shall be supported independent of conduit connections. Panels or cabinets shall be mounted on metal frame supports independently of equipment. Control devices and metal enclosures shall be bolted or welded to steel channel or steel plate. All electrical equipment and devices not covered by the above, such as miscellaneous switches, thermostats, duct switches, temperature switches, floats, photoelectrical devices, and similar electrical devices shall be located and set as suitable for the application. Where control panels are provided as part of the equipment racks mounted on the floor, they shall be provided to support conduits and flexible connections to control panels.

3.4 COORDINATION

A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified by Engineer's field representative prior to installation.

END OF SECTION

SECTION 26 05 19

CABLE, WIRE AND CONNECTORS, 600 VOLT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Building wire.

1. Power distribution circuitry.
2. Control system circuitry.
3. Lighting circuitry.
4. Appliance and equipment circuitry.
5. Motor-branch circuitry.
6. Other systems circuitry as designated.

B. Cable.

C. Wiring connections and terminations.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining 600 volt cable, wire and connectors shall follow the requirement set forth by this specification.

1.2 REFERENCES

A. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

B. ANSI/UL 83 – Thermoplastic-Insulated Wire and Cables

C. NFPA 70 – National Electrical Code, latest edition

D. NEFA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. Where application of National Electrical Code, trade association standards or publications appears to be in conflict with the requirements of this Section, the Architect/Engineer shall be asked for an interpretation.

1.3 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

B. Submit manufacturer's literature and specification data sheets for each item of cable, wire connectors.

C. Qualification of cable and wire manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years experience.

1.4 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from project site.

B. Store cable, wire and connectors in a clean, dry indoor space in their factory-furnished coverings, which provides protection against the weather.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Generally, cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information.

B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper with insulation as noted below. Minimum size for control shall be #14 copper.

C. The conductors of wires and cables shall be of copper (tinned where specified), and have conductivity in accordance with the standardization rules of the IEEE. The conductor and each strand shall be round and free of kinks and defects.

D. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.

E. Use crimp type compression lugs for all wiring termination's, except on breakers or terminal strips in panel boards.

2.2 BUILDING WIRE

A. Thermoplastic-insulated Building Wire: NEMA WC 5.

B. Rubber-insulated Building Wire: NEMA WC 3.

C. Feeders and Branch Circuits, all sizes: 98% conductivity copper, soft-drawn, stranded conductor, 600 volt insulation, THHN/THWN-2 Use XHHW-2 conductors where installed in conduit underground. Use of aluminum conductors is acceptable for conductors #1/0 and above. All conductor sizes shown on plans are based on copper cable. If aluminum conductor is selected, the contractor is responsible for sizing the conductor to match or exceed the equivalent capacity of the copper conductor. Conduit size shall also be adjusted to suit the aluminum conductors.

2.3 REMOTE CONTROL AND SIGNAL CABLE

A. 600 Volt Insulation Control Cable for Class 1 Remote Control and Signal Circuits, Type TC:

1. Individual Conductors: 14 AWG, stranded copper, XHHW insulation. Rated 90 degrees C dry, 75 degrees C wet, color-coded per ICEA Method 1 plus one green equipment grounding conductor.

2. Assembly: Bundle wrapped with cable tape and covered with an overall PVC jacket. Cable shall pass IEEE-1202 vertical tray ribbon-burner flame test (210,000 BTU) VW-1.

B. Instrumentation Cable

1. 300 Volt Instrumentation Cable, Multiple Pairs, Overall Shield, Type PLTC:

a. Individual Conductors: 18 AWG, stranded, tinned copper, flame retardant polyethylene or PVC insulated, rated 105 degrees C, black and white numerically printed and coded pairs.

b. Assembly: Individual twisted pairs having a 100 percent coverage aluminum-polyester shield and 20 AWG stranded tinned copper drain wire. Conductor bundle shall be shielded with 100 percent coverage overall aluminum-polyester shield complete with 20 AWG drain wire. All group shields completely isolated from each other. Bundle wrapped with cable tape and covered with an overall flame retardant PVC jacket. Cable shall pass IEEE-383 vertical tray flame test (70,000 BTU) UL1581.

C. Life Safety Systems Cable

1. All life safety system wiring shall be installed in dedicated conduit or raceway with adequate separation/shielding from all other systems.

2. Life safety systems wiring shall be as specified in the Section 28 31 00 - Fire Alarm and Smoke Detection Systems.

D. Security/Access Control/CCTV Cable

1. All security/access control wiring shall be installed in dedicated conduits.

2. Security/access control wiring shall be rated and as specified below:

Circuit Type	No. of Conductors	Conductor Specifications	Cable Specifications
20 mA Current Loop	2	18-gauge, stranded copper	2 cables, 1 twisted pair each required
Card Reader Coaxial	--	18-gauge, solid copper, center conductor	Schlage Model No. SE9284PL or Anicom 5910PL
Contact Circuits	2	18-gauge, stranded copper	Nonshielded, twisted
CCTV Coaxial	--	--	Belden 89259 plenum rated, or approved equal

3. All security/access control power circuit wiring shall comply with paragraph 2.2. Building Wire of this Section.

D. Plenum Cable for Class 3 Remote Control and Signal Circuits: 98% conductivity copper conductor, 300 volt insulation, rated 60 degree C, UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.4 WIRING CONNECTIONS AND TERMINATIONS

A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. Select from only following types, classes, kinds and styles.

1. Type:

a. Solderless pressure connectors

b. Crimp.

c. Threaded.

d. Insulated spring wire connectors with plastic caps for 10 AWG and smaller.

2. Class: Insulated.

3. Material: Copper (for CU to CU connection).

4. Style:

a. Insulated terminals. Use ring-terminal for control wiring. Use flange (fork) spade compression terminal for termination of stranded conductors at wiring devices, including ground connection.

b. Split bolt-parallel connector.

c. Pigtail connector.

d. Pre-insulated multi-tap connector.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer must examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 GENERAL WIRING METHODS

A. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.

B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Do not install the conductors until raceway system is complete and properly cleaned.

C. Cables shall be selected on the basis of their purpose and UL listing. Generally, use Types THWN-2 and THHN-2 in building interiors and other dry locations. Outdoors and underground in raceways, use Type XHHW-2. Conductors subject to abrasion, such as in lighting poles, shall be Type XHHW-2.

D. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 50' in length (100' for 277 volt) no conductor smaller than a No. 10 wire shall be used. The sizing of all wire except remote control wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions. Separate neutral conductors shall be provided for each phase of the same size for 120V/277V single-phase application for heavy electrical loads, computer loads, loads fed from isolated transformers, lab equipment, clinic equipment, dedicated circuits, unless noted otherwise on drawings. Voltage drop on feeders and branch circuits shall not exceed NEC requirement.

E. Remote control wires shall be no smaller than No. 14 conductors. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code requires the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner's duly authorized representative.

F. Splice branch circuits only in accessible junction or outlet boxes. Control cable shall never be spliced except the final connection to field devices. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.

G. Wiring Within An Enclosure: Contractor shall bundle ac and dc wiring separately within an enclosure. The Contractor shall utilize panel wire-ways when they are provided. Where wireways are not provided the Contractor shall neatly tag, bundle wires and secure to sub-panel at a minimum of every three inches with T&B Type TC5355 heavy duty mounting bases.

H. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

3.3 WIRING INSTALLATION IN RACEWAYS

A. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer’s recommended values for maximum pulling tension.

B. Pull conductors together where more than one is being installed in a raceway.

C. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

D. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.

E. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

F. Place an equal number of conductors for each phase of a circuit in same raceway.

G. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.

H. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

3.4 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage during construction. Do not install cable before the completion of raceway system.

B. Cable above ceilings shall be in conduit or raceways. Cables, conduits and raceways shall not be laid on ceiling tiles or strapped to ceiling wire.

C. Use suitable cable fittings and connectors.

D. It shall be the Contractor's responsibility to accurately measure all cable runs before the cable is cut. The Contractor shall furnish all tools and equipment, have sufficient properly trained personnel and shall exercise necessary care to ensure that the cable is not damaged during installation. Cable found to be damaged before installation shall not be installed. Cable damage during installation shall be removed and replaced. Repairs to cables can only be done with written permission from the Owner's Representative and only under special circumstances.

E. Care shall be exercised with cables entering or leaving cable trays that all cable bend radii shall not be less than the recommended minimum and that cables are not left to rest unprotected on any sharp edge or corner.

F. PVC jacketed cable shall not be installed or worked in any way at temperatures below 32 degrees F, unless cable has been previously stored in a heated area 48 hours prior to being pulled and transported to a heated pulling area.

G. Each cable entering an enclosure shall have its conductors bundled together and identified with the cable number. All groups of conductors within an enclosure shall be shaped and formed to provide a neat appearance to facilitate future additions or rework. All control conductors shall be numbered and shall be labeled at each termination with this number, using markers designed for the application.

H. Multi-Conductor Cable Installation: Fire alarm cable shall be routed in a separate conduit only.

I. Instrument Cable: Instrument cable shall, when conduit installation is required be installed in rigid steel conduit. They shall not be spliced at any point. The shields and drain wires of shielded signal cables shall be grounded only at one point as indicated on the Drawings.

3.5 WIRING CONNECTIONS AND TERMINATIONS

A. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

B. Keep conductor splices and taps accessible and to a minimum, and in junction boxes only. Control circuit conductors shall terminate at terminal blocks only. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotchcast.

C. Use splice, tap and termination connectors, which are compatible with the conductor material.

D. Thoroughly clean wires before installing lugs and connectors.

E. Terminate spare conductors with electrical tape and label as spare.

F. Power and Lighting Circuits: Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.

G. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

H. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then two layers of No. 33 half-lapped.

I. Identify conductors per Section 26 05 53 - Electrical Identification.

3.6 FIELD QUALITY CONTROL

A. Torque test conductor connections and terminations to manufacturer's recommended values.

B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

C. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

D. Conductors may be run in parallel on sizes 1/0 to 500 MCM inclusive provided all paralleled conductors are the same size, length, and type of insulation. Except as otherwise shown on drawings, no more than three conductors may be run in parallel, and they shall be so arranged and terminated as to insure equal division of the total current between all conductors involved. Where parallel connection is contemplated, approval of the Owner's representative must be obtained before installation is made.

3.7 TESTING AND ACCEPTANCE

A. Before final acceptance, the Contractor shall make voltage, insulation, and load tests, necessary to demonstrate to the Owner's representative the satisfactory installation and proper performance of all circuits.

B. Test feeder conductors clear of faults. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems. Test results below 50 megohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductor.

C. At the completion of this project, the Contractor shall provide for the Owner three (3) complete and finally corrected sets of working drawings. These sets of working drawings shall be new, unused and in good condition, and shall include the nature, destination, path, size and type of wire and all other characteristics for complete identification of each and every conduit and circuit.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Power system grounding.

B. Electrical equipment and raceway grounding and bonding.

1.2 RELATED WORK

A. Lightning protection.

1.3 REFERENCES

A. NFPA 70 – National Electrical Code, latest edition

B. ANSI/UL 467 – Electrical Grounding and Bonding Equipment

C. ANSI/IEEE STD 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems

D. IEEE 81 – Guide for Measuring Earth Receptivity, Ground Impedance and earth Surface Potential of a ground System

E. IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

F. ANSI/TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

1.4 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Concrete encased electrodes shall be connected as the most effective grounding electrodes. Provide a completely grounded system in accordance with Article 250 of the NEC.

B. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformer, UPS systems, power conditioners, inverters, or other power supplies are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.

C. Refer to telecom plans for grounding requirements for telecom systems.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metal underground water pipe.

E. Bonding jumpers shall be installed around non-metal fittings or insulating joints to ensure electrical continuity. Bonding shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

1.4 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Grounding system components shall be as required to comply with the design and construction of the system indicated. Components shall be as indicated in manufacturer's submittal data.

B. Ground conductors shall be stranded tinned, annealed copper cable of the sizes indicated on drawings. Bond grounding conductors at both ends of metallic conduit.

C. Grounding clips shall be Steel City Type G, or equal.

D. Ground Rods shall be copper-encased steel, 3/4" diameter, minimum length 10 feet.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install ground system as indicated, in accordance with the applicable requirements of the National Electrical Code and the National Electrical Contractors Association's "Standard of Installation".

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Install test wells as required per drawings.

C. In feeder and branch circuits, provide a separate, insulated equipment grounding conductor. Terminate each end on a grounding lug, bus, or bushing.

D. Connect grounding electrode conductors to metal water pipe where metal pipe is available and accessible using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

E. Install fusion welded ground connectors where they are concealed or inaccessible.

F. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate; or by the use of an approved grounding yoke type receptacle.

G. No strap grounding clamps shall be used; connections requiring bolting shall be made up with monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.

H. Install external ground wire on liquid tight flexible metal conduit with grounding bushings.

I. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors. .

J. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device.

3.2 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION

SECTION 26 05 29

SECURING AND SUPPORTING METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Raceway, cable tray, and equipment supports

B. Fastening hardware

C. Coordinate location of concrete equipment pads

1.2 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry. Support systems shall be sized adequately to support an additional 25% for future loads

1.3 COORDINATION

A. Coordinate with other trades where conduit and cable tray supports are in the same location as piping, ductwork, and work of other trades and where supports are furnished and installed under other Divisions. Supporting from the work or supports of other Contractors shall not be allowed except by express, written permission of the Owner.

1.4 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Support Channel:

1. All non-corrosive locations: Hot-dip galvanized steel.

2. Corrosive locations: Nonmetallic fiberglass.

B. Hardware:

1. All non-corrosive locations: Hot-dip galvanized steel.

2. Corrosive locations: Stainless steel threaded rod, attachments and fasteners shall be used with fiberglass supports.

C. Threaded Rod: used for rack support from structure above; 3/8-inch minimum diameter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, or beam clamps. Do not use spring steel clips and clamps. Provide necessary calculations to select proper support materials for electrical equipment, raceway, and cable tray supports. Provide cable tray supports for cable tray filled to 125 percent capacity per NEC.

B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for installation of supporting devices. Install supports with spacing in compliance with NEC requirements.

C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors in solid masonry walls; or concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

E. Do not use powder actuated anchors without written permission from the Engineer.

F. Do not drill structural steel members without written permission from the Structural Engineer.

G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.

I. Install surface mounted cabinets and panelboards with a minimum of four anchors. Provide strut channel supports to stand cabinet 1-5/8 inches off wall. Utilize "Post Bases" where support channel is attached to structural floor.

J. Provide extra care in supporting PVC conduit to protect it from potential damage.

K. Use fiberglass for nonmetallic raceway systems supports in areas subject to corrosives.

L. All supports in contact with floor using stanchion type support shall be solidly bolted to the permanent structural floor.

M. Conduit supports shall have at a minimum, the bottom support member constructed of double strut. This horizontal member shall be double-nutted, and the supporting all-thread rod shall be trimmed to one inch below lowest nut.

N. Conduit entering/exiting cable tray shall be attached to the tray rail by means of unistrut bolted to the rail and standard manufacturer's accessories. Conduit shall only enter/exit tray horizontally supported within three feet of the tray, and extended into the tray two inches. Conduit shall be terminated with a grounding bushing, and bonded to the tray ground wire. (The attachment to the tray shall not be considered a support.)

O. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

P. Install freestanding electrical equipment on 4-inch concrete pads. Pad shall be a minimum four inches larger than equipment. No crevices shall be left around the pads. Equipment includes but not limited to the following:

1. Motor Control Centers
2. Static Transfer Switches
3. Floor mounted VFDs
4. Floor mounted transformers
5. Switchboards, 1200A and larger

Q. Do not anchor supports to columns. Where panelboards, cables, or conduits are routed on the face of a column provide “column hugging” channel supports.

3.2 TOUCH-UP

A. Touch-up all scratches on securing and supporting system, and paint the ends of channel after cutting with an approved zinc chromate or 90 percent zinc paint.

END OF SECTION

SECTION 26 05 33

RACEWAYS, CONDUITS AND BOXES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Raceways:
   1. Surface metal raceways.
   2. Multi-outlet assemblies.
   3. Wireways.
   4. Indoor service poles.

B. Conduit:
   1. Rigid metal conduit and fittings. (RGS)
   2. Intermediate metal conduit and fittings. (IMC)
   3. Electrical metallic tubing and fittings. (EMT)
   4. Flexible metal conduit and fittings.
   5. Liquid-tight flexible metal conduit and fittings.
   6. Non-metallic conduit and fittings. (underground use only)
   7. PVC coated rigid steel conduit.

C. Boxes:
   1. Wall and ceiling outlet boxes.
   2. Pull and junction boxes.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining raceway, conduit and boxes shall follow the requirement set forth by this specification.

1.2 REFERENCES

A. NFPA 70 – National Electrical Code, latest edition

B. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated

C. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated

B. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies

E. EMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

F. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

H. ANSI/NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

I. ANSI/UL 1 – Flexible Metal Conduit

J. ANSI/UL 5 – Surface Metal Raceways and Fittings

K. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit

L. ANSI/UL 467 – Electrical Grounding and Bonding Equipment

M. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit (underground use only)

N. ANSI/UL 797 – Electrical Metal Tubing

O. ANSI/UL 870 – Wireways, Auxiliary Gutters and Fittings

P. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated galvanized Rigid Steel Conduit and Intermediate Metal Conduit

Q. NEMA VE 1 – Metallic Cable Tray Systems

R. UL 6 – Rigid Metal Conduit

S. ANSI/UL 5C – Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits

T. ANSI/UL 498 – Attachment Plugs and Receptacles

U. ANSI/UL 943 – Ground Fault Circuit Interrupters

1.3 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Section 01330, Submittal Procedures.

B. Shop drawings consisting of a complete list of equipment and materials, which will be used for the project, including manufacturer's descriptive and technical literature, catalog cuts and installation instructions.

C. Sealing/fire stopping materials and details.

1.4 STORAGE AND HANDLING

A. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.

B. Store materials in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 SURFACE METAL RACEWAY

A. Surface metal raceway shall be factory pre-assembled galvanized steel complete including bases, removable covers, receptacles, end plates, elbows, connectors and fittings, to exact length to match the length of the cabinets, casework, utility chases, and shelving as indicated on laboratory and furniture shop drawings, and work bench details, as applicable.

B. Size shall be as shown on the Drawings. The length shown on electrical drawings is diagrammatic only and is not accurate for fabrication of raceway Sections. Refer to shop drawings, architectural plans, elevations, and details.

C. Finish shall be ANSI-61 gray enamel .

D. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.

E. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system per drawing as applicable. Provide divider with fittings that maintain the separation of the raceway wiring compartments.

F. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates.

G. Provide receptacles for the respective power systems as indicated on the drawings. Refer to Section 26 27 26 Wiring Devices for device specifications.

2.2 MULTI-OUTLET ASSEMBLY

A. Multi-outlet assembly shall be two-piece sheet metal channel with fitted, removable cover suitable for use as a multi-outlet assembly.

B. Size shall be as indicated on the Drawings.

C. Provide receptacles mounted as shown on Drawings.

D. Finish shall be ANSI-61 gray enamel.

E. Provide couplings, elbows, outlet and device boxes, and connectors designed for use with multi-outlet system.

2.3 WIREWAYS

A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.

B. Size shall be as indicated on Drawings.

C. Cover shall be hinged or screw applied as indicated on Drawings. Rain tight wireways shall be provided with full gasketing.

D. Fittings shall be so constructed to continue the "lay-in" feature through the entire installation.

E. Provide all sheet metal parts with a rust inhibiting phophatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

2.4 CONDUIT AND FITTINGS

A. Conduit and fittings for all electrical systems on this project shall include the following:

1. Electrical power and lighting feeders
2. Electrical power and lighting circuits
3. Telephone systems
4. Control systems (other than HVAC)
5. Fire alarm and signaling systems
6. Other electrical systems

B. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.

C. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by N.E.C. Article 250. Grounding bushings shall have insulated throats.

D. Rigid and intermediate metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type. Expansion fittings shall be OZ Type DX.

E. Electrical metallic tubing shall be galvanized. Fittings shall be all steel compression type. Expansion fittings shall be OZ Type TX.

F. Flexible metal conduit and fittings shall be zinc-coated steel.

G. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC). It shall be furnished with a sealing O-ring where entering an enclosure subject to moisture. Where O-Rings are used, ground type bushings shall be used in the box or enclosure.

H. Nonmetallic conduit and fittings shall be suitable for temperature rating of conductor but not less than 90°C. Nonmetallic conduit and fittings shall be molded of high impact PVC compound having noncombustible, nonmagnetic, non-corrosive and chemical resistant properties and shall be of the same manufacturer. Where located outdoors and above ground, the conduit and fittings shall be UV resistant. Solvent cement shall be of the same manufacturer as the conduit and shall

be of the brush-on type. Spray solvents are prohibited. PVC coated metallic fittings shall not be permitted for PVC conduit connections.

I. Crimp or set-screw type fittings are not acceptable.

J. Minimum conduit size shall be 3/4 inch, except 1/2 inch flexible metallic conduit may be used as fixture whips.

K. PVC coated rigid steel conduit shall be externally coated with a 40 mil PVC coating and internal phenolic coating over a galvanized surface.

2.5 WALL AND CEILING OUTLET BOXES

A. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Minimum box size shall be 4” square by 2 1/8” deep except boxes for light fixtures may be octagonal, 4” and 1 ½” deep.

B. Outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

C. Provide multi-gang outlets of single box design. Sectional boxes are not acceptable. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NEC, and not less than 1 ½ inch deep unless shallower boxes are required by structural conditions and are approved by the A/E.

D. Provide deep type FD cast metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with ¾” threaded conduit ends, cast aluminum face plate with spring-hinged waterproof cap for outdoor use.

E. Outlet boxes in poured concrete shall be plenum type without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

F. Provide 4-inch octagonal ceiling outlet boxes.

2.6 PULL AND JUNCTION BOXES

A. Boxes shall be galvanized sheet metal conforming to ANSI/NEMA OS 1 with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.

B. Boxes larger than 12 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.

C. Boxes shall be sized in accordance with NEC.

PART 3 - EXECUTION

3.1 INSTALLATION - CONDUIT

A. Install products as indicated, in accordance with the applicable requirements of NEC, NEMA and the National Electrical Contractors Association's "Standard of Installation".

B. Cut conduit square using a saw or pipe cutter. De-burr cut ends. Joints in steel conduit must be painted with T&B Kopr shield and drawn up tight. Threads for rigid metal conduit and IMC shall be deep and clean. Running threads shall not be used. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement with brush to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Spray type of cement is not acceptable. Install raceway and conduit system from point of origin in outlets shown, complete with support assemblies including all necessary hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, clips angles, through bolts, brackets, saddles, nuts, bolts, washers, offsets, pull boxes, junction boxes and fittings to ensure a complete functional raceway system. Where vertical drops of conduit are made to equipment in open space, the vertical conduit shall be rigidly supported

from racks supported on the floor.

C. Install rigid wall hot-dipped galvanized steel conduit or hot-dipped galvanized intermediate metal conduit for service entrance; feeders; wall or floor penetrations; mechanical rooms electrical rooms and exposed locations where there is a high potential subject to physical damage; exposed outdoor locations; damp locations or any location as per design drawing. The following exceptions permitted:

1. EMT

   a. In sizes up to and including 1-1/2 inch, may be used inside dry locations where not subject to mechanical damage. EMT may be used in air-conditioned spaces, such as accessible ceilings, dry wall partitions and exposed where 6 feet above the floor. EMT may not be used outside, in concrete, underground, in under floor spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation, or exposed within 6 feet of the floor. EMT shall not be used for medium voltage circuits.

   b. Where used for feeder circuits receptacle branch circuits and motor branch circuits EMT shall also contain a NEC grounding conductor.

   c. All conduits shall be concealed in walls or ceilings unless otherwise noted.

2. Liquid-tight

   a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install external ground wire on flexible conduit with grounding bushings. Maximum length shall be 6 feet minimum of 2 feet.

3. Flexible Metal Conduit

   a. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips or motor vibrations, with internal ground wire. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be 6 feet minimum of 3 feet; minimum size shall be 3/4**;** and minimum size shall be ½ inch for lay-in light fixture whips.

D. Install conduits parallel and supported on Unistrut, or equal, trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. No raceways or boxes shall be supported using wire. Arrange conduit to maintain headroom and present a neat appearance. Conduit routes shall follow the contour of the surface it is routed on. Route exposed conduit and tray above accessible ceilings parallel and perpendicular to walls and adjacent piping. Maintain 12-inch clearance between conduit and heat sources, such as flues, steam pipes, and heating appliances. Wire ties or “wrap lock” are not permitted to support or secure conduit system. Fasten conduit with the following material:

1. Wood screws on wood
2. Toggle bolts on hollow masonry
3. Bolts and expansion anchors in concrete or brick
4. Machine screws, threaded rods and clamps on steel
5. Conduit clips on steel joists.
6. 4 inch x 4 inch penta-treated pine installed in pitch pans on roof, spaced at intervals not to exceed 5 feet.

E. Install conduits outside of building lines at a minimum depth of 30 inches below finished grade. Maintain twelve inches earth or two inches concrete separation between electrical conduits and other services or utilities underground. Encase all plastic service entrance conduits with concrete unless otherwise specifically detailed or noted on the drawings.

F. Fittings shall be approved for grounding purposes or shall be jumpered with copper grounding

conductors of appropriate ampacity. Leave termination of such jumpers exposed.

G. Install expansion fittings in metal and PVC conduit as follows:

1. Conduit Crossing Building Expansion Joints:

   a. EMT all sizes

   b. IMC all sizes

   c. RMC all sizes

   d. PVC all sizes

2. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.

3. Unless expansion fitting has an integral bonding braid, as in Crouse-Hinds Type XC, a green insulated grounding conductor shall be pulled in the conduit. Both ends of this green grounding conductor shall be accessible for inspection.

H. Install conduit concealed in walls, partitions and above ceilings. Install conduit exposed in ceiling area (at structure) of boiler rooms, mechanical rooms and in other similar rooms where ceilings are not called for.

I. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

J. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture if cable or wire are not installed immediate after conduit run. Tape covering conduit ends is not acceptable.

K. Provide 200 lb. nylon cord full length in empty conduit.

L. Where conduit penetrates fire-rated walls and floors, provide pipe sleeve two sizes larger than conduit; pack void around conduit with oakum and fill ends of sleeve with fire-resistive compound or provide mechanical fire-stop fittings with UL listed fire-rating or seal opening around conduit with UL listed foamed silicone elastomer compound equal to fire-rating of floor or wall.

M. Install no more than the equivalent of three 90-degree bends between boxes. Where four 90 degree bends are required, prior approval by the Engineer is required. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bodies shall be readily accessible and sized for the cables installed. Running or rolling offsets are not approved. Use factory long radius elbows for bends in conduit larger than 2-inch size. All parallel bends shall be concentric.

N. Nylon pull string shall be provided full length in conduit designated for future use.

3.2 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET

A. Use flathead screws to fasten channel to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings on multi-outlet assembly.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path in accordance with the requirement of NEC.

3.3 INSTALLATION - WIREWAYS

A. Bolt wireways to steel channels fastened to the wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight wireway.

C. Mount rain tight wireway for exterior installation in horizontal position only.

3.4 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

C. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in.

D. Locate and install boxes to allow access, minimum 12 inches above ceiling except where space dimensions do not allow.

E. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation. Provide minimum 24-inch separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the two and pack openings with fiberglass.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Do not support junction boxes from the raceway systems. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.

G. Provide knockout plugs for unused openings.

H. Use multiple-gang boxes where more than one device is mounted together. Do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box.

K. Outlet boxes for switch shall not be used as junction boxes.

L. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

O. Set floor boxes level and flush with finish flooring material.

P. Provide tamper resistance receptacles in child care areas, psychiatric, and medical facilities.

3.5 WALL AND FLOOR PENETRATIONS:

A. Core drilling shall be approved in writing by the Structural Engineer prior to execution.

C. Provide a 4 inch curb around block outs through concrete floors. Fire-stop all openings per Architectural specification.

D. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. Coordinate roof penetrations with the roofing contractor.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Nameplates and tape labels

B. Wire and cable markers

C. Conduit color coding and labeling

1.2 REFERENCES

A. NFPA 70 – National Electrical Code (latest edition)

1.3 SUBMITTALS

A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

1. Furnish nameplate identification schedules listing equipment type and nameplate data with letter sizes and nameplate material.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Equipment Nameplates:

1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.

2. For emergency equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.

3. For UPS powered equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.

4. For fire alarm system provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.

B. Underground Warning Tape

1. Manufactured polyethylene material and unaffected by acids and alkalines.

2. 3.5 mils thick and 6 inches wide.

3. Tensile strength of 1,750 psi lengthwise.

4. Printing on tape shall include an identification note BURIED ELECTRIC LINE, and a caution note CAUTION. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.

C. Conductor Color Tape and Heat Shrink:

1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.

2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of wire or cables are not acceptable.

D. Conduit Labels (5 kV and 15 kV Conduits Only): 2-inch black letters on yellow background reading "DANGER - 12,470 VOLTS" or "DANGER - 4,160 VOLTS". Labels shall have adhesive

backing, and shall be installed at intervals not exceeding 50 feet and on all pull boxes located to be visible from floor.

E. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2" lettering.

F. Tape Labels: Embossed adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.

1. White letters on black background for normal power.
2. White letters on red background for emergency/standby power.
3. White letters on orange background for UPS power.

G. J-Box and Cover plate Voltage Labels: Black stenciled letters 1/4" high or permanent marker. Adhesive back tapes may be used if a clear tape is applied over the label for protection. Label legibly with circuitry number.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Degrease and clean surfaces to receive nameplates or tape labels.

B. Install nameplates parallel to equipment lines.

C. Secure plastic nameplates to equipment fronts using screws or rivets. Use of adhesives shall be per Owner's approval. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

3.2 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits. Label control wire with number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

B. Conductors for power circuits to be identified per the following schedule.

	System Voltage			
Conductor	480/277V	208/120V		
Phase A	Brown	Black		
Phase B	Purple	Red		
Phase C	Yellow	Blue		
Neutral	Gray	White		
Grounding IG	Green N/A	Green Green w/Yellow		

3.3 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.

B. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4-inch; identify source to device and the load it serves, including location.

C. Dry Type Transformers Not in Substations: 3/8-inch; identify equipment designation. 1/4-inch; identify primary and secondary voltages, primary source, and secondary load and location.

D. Automatic Transfer Switches: 3/8-inch; white letters and red background; identify equipment designation 1/4-inch; identify voltage rating, normal source, standby source and load served including location.

E. Panelboards: 3/8-inch; identify equipment designation. 1/4 -inch; identify source, voltage and bus rating.

3.4 ENCLOSURE COLOR CODING

A. The following systems shall have each junction and pull box cover completely painted per the following:

System	Color of Box Cover
Telecommunications	Brown
DDC	Green
Emergency Power	Red
Security	White
Fire Alarm	Yellow
UPS	Orange

END OF SECTION

SECTION 26 05 73

SHORT CIRCUIT ANALYSIS/COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, "Electrical General Provisions", govern this Section.

1. DESCRIPTION OF THE WORK:
   General:
   The Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Studies specified in this section shall be completed and submitted prior to submitting submittals for panelboards, enclosed circuit breakers and other electrical gear with short circuit or interrupting ratings.

2. The Electrical Contractor shall provide the Engineer with a Power System Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Study. These analysis's and studies shall include all power distribution systems, beginning at the electric service point from the Electric Utility Company to the secondary buses of each panelboard as described hereafter. A very recent study was conducted during the switchgear project. **UTHSC-H will make this study available for the contractor to expand the study for the new equipment.**

3. The Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Studies shall be prepared by and certified with a registration seal and signature of a Registered Professional Engineer. The Engineer shall be qualified by experience in preparation of studies having similar requirements and of similar magnitude to that specified in this section of the Specifications.

4. The Short Circuit Analysis shall terminate at each branch bus at the lowest utilization voltage secondary bus where the symmetrical short circuit RMS amperes, total source plus all motor contribution, is less than 10,000 amperes for 208/240 volts and 14,000 amperes for 480 volts. It is the intent of these Specifications to determine all locations in the entire electrical system where the symmetrical short circuit amperes meets or exceeds 10,000 amperes at 208 volts and 14,000 amperes at 480 volts. The short circuit analysis shall compare interrupting rating of all installed electrical protective devices connected to each bus included in the study with that of the available fault current at the load terminals of each protective device. Appropriate recommendations shall be made for corrective action in the conclusions of the report where the interrupting rating of electrical equipment is exceeded by the available fault current.

5. The Protective Device Coordination Study shall start at the electric service and include all electrical distribution equipment protective devices with adjustable trip units, relay settings or options for fuse types. The curves and settings for the Power Company protective devices shall be included in the scope of this study. The coordination plots shall terminate with the first non-adjustable overcurrent device or devices downstream of all protective devices with an adjustable trip unit, relay settings or options for fuse types. The protective device study shall include a separate analysis for phase and ground protection.

6. The Arc Flash and Electrical Hazard Study comply with applicable NEC and OSHA requirements and shall include calculating the Arc Flash and establishing the Electrical Hazard rating for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

7. The Contractor shall obtain all lengths of cable from the electrical drawings and, where not shown the entire length of the run, from Contractor estimated lengths. All other equipment ratings shall be obtained by the Contractor from the equipment manufacturer's and/or suppliers.

B. Short Circuit Analysis: The Analysis shall include the following:

1. A schematic one-line drawing of the entire electrical system included in the study, from the power company system including the point of delivery, to each primary transformer, and including all main secondary buses of each transformer included in the study. Secondary buses shall include multiple secondary transformations within the scope of the study. Each device shall be identified using project assigned identification labels. Each motor 10 hp and larger shall be shown and identified. Each bus shall be assigned an identification number.

2. Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on an assumed bolted 3 phase short circuit.

3. At each bus, including buses of all primary protective and switching devices, primary and secondary of all transformers, all secondary main and feeder breakers, and all secondary devices and panelboards within the scope of the study, the following shall be calculated for assumed bolted 3 phase short circuits.

   a. Symmetrical RMS short circuit amperes, calculated using total source and motor contribution reactance and resistance values.

   b. Asymmetrical average 3 phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.

   c. Reactance ("X") and Resistance ("R") in OHMS at the voltage of the device being examined, including both The Power Company source and all motor contributions.

4. Calculation sheets for cable sections shall indicate voltage, wire size, cable length, reactance and resistance of the section in OHMS and total "X" and "R" to the source.

5. Calculation sheets for transformer sections shall indicate transformer kVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total "X" and "R" value in OHMS at the secondary voltage to source, including The Power Company source impedance plus any primary motor contribution.

6. Calculation sheets for busway and miscellaneous devices shall provide all pertinent parameters including operating voltage, section "X" and "R" values in OHMS, and total "X" and "R" values in OHMS to the source, based on source impedance plus any motor contribution.

7. Bus summary sheets shall be provided giving consecutive bus numbers, description, voltage, "X" and "R" values in OHMS including The Power Company plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ration, and asymmetrical factor.

8. Motor summary sheets shall provide motor description and all pertinent motor data including subtransient reactance for each motor 10 hp and larger. Symmetrical short circuit amperes shall be given for each motor at the motor terminals.

9. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer. For this evaluation, circuit breakers shall all be fully rated.

10. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

C. Protective Device Coordination Study: The Study shall include the following:

1. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
2. The Power Company's relay, fuse, or protective device shall be plotted with all load protective devices at the same voltage.
3. Transformer primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the secondary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.
4. Low voltage circuit breakers shall have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.
5. The coordination plots shall include significant motor starting characteristics and large motor protective devices.
6. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used, with average 3 phase RMS asymmetrical amperes as 1/2 cycle calculated using actual resistance and reactance values of the source plus all motor contributions which exist at the load end of the feeder conductors. Conductor initial temperature and conductor maximum transient temperature for short circuits as recommended by ICEA shall be indicated.
7. High voltage relays shall have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.
8. A determination of settings or ratings for the overcurrent and ground fault protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with **[service continuity] [system protection]** considered more important than **[system protection] [service continuity]**. The time-current coordination analysis shall be performed with the aid appropriate software.
9. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.
10. An evaluation of the degree of system protection and service continuity possible with the overcurrent devices supplied.
11. When main breaker is provided with setback to reduce the arc fault level both settings shall be included in the study.
12. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.

D. Arc Flash & Electrical Hazard Analysis: The Analysis shall include the following:

1. The Arc-Flash & Electrical Hazard Analysis (AFEHA) shall be performed in accordance with the requirements of NFPA 70 Section 110.16, NESC ANSI C2-2007 Section 410.A.3, IEEE Std. 1584 and OSHA 29 CFR 1910.132(d) and 1910.335.
2. The AFEHA shall:

a. Calculate incident energy levels and flash protection boundaries at all relevant equipment busses based on available short-circuit current, protective device clearing time and other applicable one-line diagram information.

b. Calculate the Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm^2) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

c. Identify the Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

d. Identify the current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

e. Establish the Flash Protection Boundary (approach limit distance) as required by NFPA 70E for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

f. Provide equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.

g. Provide recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements

h. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

1.2 STUDY AND ANALYSIS SEQUENCE:

A. All studies and analysis specified herein shall be completed and submitted with electrical distribution equipment submittals to allow the Engineer to review submitted electrical distribution equipment for interrupting rating, coordination and arc flash related coordination.

1.3 QUALITY ASSURANCE:

A. The short circuit analysis/coordination study shall be performed by the Engineering Department of the electrical equipment supplied for the project or by a qualified engineering consultant approved in writing in advance by the Engineer.

1.4 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Four copies of the Short-Circuit Analysis including, but not limited to:

a. A printout of input data, calculated results and an explanation of how to interpret the data.

b. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.

c. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X over R ratio of that fault current.

d. A table of specified equipment short-circuit ratings versus calculated short-circuit current values with notations of locations where are specified equipment short-circuit ratings are less or greater than required at the point of application.

e. An analysis of the results in which any overrating or inadequacies shall be called to the attention of the Engineer and recommendations made for improvements.

2. Four copies of the Protective Device Coordination Study including, but not limited to:

a. Time-current characteristic curve drawings on log-log printouts which illustrate:

1) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.

2) The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the settings or ratings of the overcurrent protective devices supplied.

3) The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.

b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.

c. An analysis of the results in which any inadequacies related to selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.

3. Four copies of the arc-flash & electrical hazard analysis including, but not limited to:

a. Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm^2) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

b. Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

c. Current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

d. The Flash Protection Boundary (approach limit distance) as required by NFPA 70 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

e. Equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.

f. Recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements

4. Cut sheets and submittal information on the Arc Flash warning labels being provided.

5. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

PART 2 - PRODUCTS

2.1 ARC FLASH WARNING LABELS:

A. Labels: Seton Write-On Arc Flash Warning Labels or an approved equal labels with NEC and OSHA required warning information and with Arc Flash Hazard Category, minimum Personal Protection Equipment (PPE) required and Minimum Arc Rating (cal/cm^2) clearly indicated.

PART 3 - EXECUTION

3.1 PROTECTIVE DEVICE SELECTION AND SETTING:

A. Settings and Selection: Prior to project Substantial Completion, the Contractor shall set all relays, overcurrent devices and ground fault protection devices and confirm selection of fuse overcurrent devices as follows:

1. Relays: Reset all adjustable relay settings from the factory default settings to the settings recommended in the studies specified in this section.
2. Circuit Breakers: Reset all adjustable trip settings from the factory default settings to the settings recommended in the studies specified in this section.
3. Ground Fault Protection Devices: Reset all adjustable device settings from the factory default settings to the settings recommended in the studies specified in this section.
4. Fuses: Confirm that fuse types installed on the project are as recommended in the studies specified in this section.

B. Certification: Prior to project Substantial Completion, the Contractor shall submit 4 signed copies of a document certifying that the Contractor has completed the settings and selection scope specified in Paragraph 3.1 A. to the Engineer.

3.2 AVAILABLE FAULT CURRENT LABEL:

A. Building Service entrance equipment shall be provided with a permanently affixed label listing the maximum available fault current at the time of installation and the date the fault current calculation was performed, per NEC 110.24. The label shall be 2” x 3” in size and shall be blue lettering on a contrasting background.

3.3 ARC FLASH WARNING LABELS:

A. Installation: Arc Flash warning labels shall be securely affixed to each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch in a readily visible location in accordance with NEC and OSHA requirements. The actual calculated Minimum Arc Rating (cal/cm^2) for that individual piece of equipment along with the associated Arc Flash Hazard Category and minimum Personal Protection Equipment (PPE) required shall be clearly indicated on each warning label

END OF SECTION 26 05 73

SECTION 26 25 01

FEEDER AND PLUG-IN BUSWAY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide busway work as shown, scheduled, indicated, and as specified.

B. Types: The types of busway required for the project include, but are not limited to, the following:

1. Indoor plug-in busway.

1.3 STANDARDS:

A. Products and installation shall comply with applicable sections of the following standards:

1. NEC Article 368 - Busways.
2. Underwriters' Laboratories, Inc.
3. Federal Specification W-B-8116.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Busplug compatible with the existing busway – We believe it is GE. Verify prior to submitting and purchasing.

B. NEMA Compliance: Comply with National Electrical Manufacturers' Association (NEMA) Standards BU 1, "Busways", and BU 1.1, "General Instructions for Safe Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less".

C. UL Label: All components of the busway system shall be UL-labeled whenever possible.

1.5 SUBMITTALS:

A. Shop drawing submittals shall include, but not be limited to, the following:

1. Cut sheets of busway plugs with type, amperage, voltage, poles clearly indicated.
2. Busway fabrication drawings include dimensioned drawings of busway showing the accurately scaled duct and system layout, including, but not necessarily limited to, offsets, transitions, busway plugs, reducers, supports and transformer connections.
3. Additional information as required in Section 26 00 01, “Electrical General Provisions”..

1.6 STORAGE AND HANDLING:

A. Handle busways carefully to avoid damage, breaking, denting, and scoring. Damaged equipment or materials shall not be installed.

B. Store busways and accessories in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. Busway Plugs: Provide busway plugs, compatible with plug-in busway, in the sizes and ratings shown and as recommended by the busway manufacturer.

1. Busway plugs shall be molded case current limiting breakers rated for 200,000 (100,000 for 600 AF) AIC RMS symmetrical. Busway plugs shall be mechanically interlocked with the busway housing to prevent their installation or removal with the switch in the "ON" position. The busway plug shall include a defeatable interlock to prevent the cover from being opened while the switch is in the "ON" position and to prevent accidental closing of the breaker with the cover open. The busway plug shall have means for padlocking the cover closed and the breaker in the "OFF" position. The operating handle and mechanism shall remain in control of the breaker at all times. The handle shall be mountable on either the end or the side of the busway plug. The plug-in stubs shall be silver-plated. The enclosure of any busway plug shall make positive ground connection to the busway housing and ground bus before the stubs make contact with the busbars.
2. All plug-in units shall be manufactured specifically for the existing busway.
3. Provide a hook-stick of suitable length in each room that has plug-in busway plugs for operation of disconnecting switches which are mounted above 6’ in height.

PART 3 - EXECUTION

3.1 IDENTIFICATION:

A. General: Refer to Section 26 05 53, "Identification for Electrical Systems", for painting and identification of busways.

END OF SECTION 26 25 01

SECTION 26 27 26

WIRING DEVICES AND FLOOR BOXES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Wiring Devices:

1. Wall switches.
2. Receptacles.
3. Device plates and box covers.
4. Wall dimmers.
5. Occupant sensors.

B. Floor boxes.

C. Wring for HVAC in Division 23 shall meet the requirement of this specification.

1.2 REFERENCES

A. Americans with Disabilities Act (ADA)

B. ANSI/NEMA OS 1- Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

C. ANSI/UL 20 – General Use Snap Switches.

D. ANSI/UL 498 – Attachment Plugs and Receptacles.

E. ANSI/UL 943 – Ground Fault Circuit Interrupters.

F. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts maximum).

G. NEMA WD 1 – General-Purpose Wiring Devices.

H. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.

I. NEMA WD 5 - Specific-Purpose Wiring Devices.

J. Texas Accessibility Standards. (TAS)

1.3 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver wiring devices individually wrapped in factory-fabricated containers.

B. Handle wiring devices carefully to avoid damage, breaking and scoring.

C. Store in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide factory fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

B. Device color:

1. Switches, receptacles, and dimmers on normal power shall be white.

2. Switches, receptacles, and dimmers on emergency power shall be red.
3. Key operated switches shall be gray.
4. Provide receptacles in surface mounted raceways in colors the same as listed above.

2.2 WALL SWITCHES

A. Acceptable manufacturers

1. Arrow-Hart
2. Hubbell
3. General Electric
4. Leviton
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. Material

1. Wall switches for lighting circuits and motor loads under 1/3 hp shall be AC general use snap switch with toggle handle, 20 amperes and 120/277 volt AC with number of poles as required.
2. Pilot light type shall be equipped with red toggle handle (glow when on), 20 amperes and 120/277 volt AC with number of poles as required.
3. Key operated switches shall be Gray, 20 amperes and 120/277 volt AC with number of poles as required key all locks alike. Furnish keys compatible with key switch, quantity as directed by Owner, minimum of ten copies.
4. Illuminated Emergency-Power-Off switch shall be provided with button guard equal to Allen-Bradley #800T-QA10R or approved substitutions.
5. A listed manual switch having a horsepower rating not less than the rating of the motor and marked “Suitable as Motor Disconnect” shall be permitted to serve as disconnect means for stationary motor of 2 horsepower or less.
6. Switch terminal screws or connectors shall be designed to accommodate No. 10 solid conductor.

2.3 RECEPTACLES

A. Acceptable manufacturers

1. Arrow-Hart
2. Hubbell
3. General Electric
4. Leviton
5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

B. Material

1. Hospital grade receptacles shall be installed in clinic, patient care and other areas required by NFPA. Tamper proof in areas serving children.
2. Dedicated circuit and convenience duplex receptacles shall be rated 20 amperes, 125 volt AC.
3. GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter

4. Specific-use receptacles shall have volts, amps, poles and NEMA configuration as noted on drawings.

5. Heavy-duty lock-blade receptacles shall be NEMA WD5 heavy-duty specification grade.

6. Emergency receptacles shall be red plastic face.

7. Weatherproof receptacles as specified shall be mounted in a cast steel box. All weatherproof cover plates shall be UL listed. Use weatherproof aluminum or stainless steel lift up covers over receptacles located outdoors and in other locations as shown on the plans. Use In-use type clear weatherproof cover over selected receptacles as noted on the drawings. Cover shall be a Leviton 5976-CL or equal.

8. Designations: The following designations are for brown devices; provide devices in the color specified in Article 2.1B.

Type	Arrow-Hart	Hubble	GE	Leviton
5-20R	8300	8300	8300	8300
5-20R(single)	8310	8310	8310	8310
6-20R	8500	8400	8400	8400
14-20R	5759	8410	1420	--
15-20R	5781	8420	1520	--
5-30R	5716N	9308	4138-3	5371
6-30R	5700N	9330	4139-3	5372
14-30R	5744N	9430A	1439-3	278
15-30R	8430N	8430A	1530	8430-A
5-50R	5711N	9360	4140-3	5375
6-50R	5709N	9367	4141-3	5374
14-50R	5754N	9450A	4181-3	279
15-50R	8450N	8450A	1550	8450-A
GFCI	GF8300	GF8300	GFR 8300-1	6898-HG
Twist Lock	5708	5235	--	5361-CH

2.4 DEVICE PLATES

A. Acceptable manufacturers

1. Arrow-Hart
2. Hubbell
3. General Electric
4. Leviton
5. Crouse Hinds – Cast Metal Wall Plates
6. OZ Gedney – Cast Metal Wall Plates

B. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement and:

C. Material

1. Device plates in IT, mechanical and electrical rooms, loading dock, and other industrial areas shall be 302 stainless steel with cutouts as required for devices indicated on drawings, unless otherwise noted. Other wall plates shall be smooth plastic, 0.1 inch thick. Where switches or outlets are shown adjacent to each other, they shall be ganged with partitions between different type services and covered by a single custom wall plate.

2. Exposed boxes:

a. Dry interior spaces: Use cast metal plates with cast metal box. Use heavy cadmium-plated sheet steel plates with steel boxes and copper-free aluminum with aluminum

boxes. All screws shall be stainless steel. Edges of plates must be flush with edges of boxes.

b. Outdoor locations: Use weatherproof devices plates. Provide cast metal plates with gasketed spring door

3. Jumbo plates are not permitted.

4. Weatherproof cover plates shall be UL listed metal lift up type with sealing gaskets. Weatherproof plates shall be used in exterior locations as described above.

2.5 WALL DIMMERS

A. Acceptable manufacturers

1. Lutron

2. Leviton

3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

B. Material

1. Provide NEMA WD 2 solid-state wall-box dimmers, where indicated on drawings. Dimmers shall be complete, with linear slide-type solid-state dimming controls, and LED light level ON/OFF indicators. Dimmer shall produce IES square-law response from blackout to full brightness. Dimmer rise time shall be restricted to prevent interference with professional quality audio or video equipment. Dimmer shall be compatible with ballast per manufacturer's specification.

2. Device: White finish plastic with linear slide.

3. Voltage: As noted on drawings.

4. Power rating: Match load shown; 1000 watts minimum, larger size is required to accommodate connected loads greater than 1000 watts. Load to 80% of the dimmer capacity, maximum.

2.6 FLOOR MOUNTED SERVICE FITTINGS AND BOXES

A. Acceptable manufacturers

1. Steel City

2. Walker

3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

B. Material

1. Floor mounted service boxes shall be flush mounted brushed aluminum housing with poke-through assembly. Provide brass cover plate with two hinged lift lids where carpeting is installed.

2. Quantity of outlets for A/V and power per drawings.

2.7 OCCUPANT SENSORS

A. Acceptable manufacturers

1. Wattstopper

2. Pass & Seymour

3. Leviton

4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

B. Material

1. See plans for specification.

2.8 TAPE LABELS

A. Provide tape labels in accordance with Section 26 05 53, Electrical Identification, on all receptacles and switches indicating panelboard and circuit number. White tape with 3/16 inch black letters/numbers.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer must examine the areas and conditions under which wiring devices and floor boxes are to be installed and notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 DEVICE COORDINATION

A. Where items of equipment are provided under other sections of this specification or by the Owner, provide a compatible receptacle and/or device plate for the cap or plug, and cord of the equipment.

3.3 INSTALLATION

A. General:

1. Install wiring devices and floor boxes as indicated, in accordance with the applicable requirements of the latest release of NEC, NEMA, and ANSI.

2. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the drawings. These drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Constructor Inspector.

3. Where more than one device occurs in one outlet box, causing 300 volts or more voltage difference between them, a barrier must be provided for isolation to meet NEC Article 380.

B. Wall Switches and Dimmers:

1. Location:

a. Install wall switches and dimmers in suitable outlet box centered at the height of 48 inches above finished floor, OFF position down.

b. Where wainscot occurs at the 48" level, install device in the wall below the wainscot and as near the 48" level as possible to provide the most pleasing appearance, but in no case partially in the wainscot and partially in the wall.

c. Where shown near doors, install switches and dimmers not less than 2" and not more than 12" from door trim.

d. Verify all door swings before rough-in and locate switches and dimmers on strike side of door as finally installed.

2. Position:

a. Wall switches: Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the project, generally up or to the left for the ON position.

b. Wall dimmers: Install dimmers in a uniform position so the same direction of operation will brighten and dim the lights throughout the project, generally up for brightest position.

3. Wall Box Dimmers:

a. De-rate ganged dimmers as instructed by manufacturer. Do not use common neutral.

b. Compatibility: Where dimmers are connected to fluorescent lights, verify with ballast manufacturer and dimmer manufacturer the suitability of the ballast for dimming applications.

c. Test: Test dimmers per manufacturer's instructions. Demonstrate that unit's function as specified. Where remote dimmers are provided, demonstrate that unit's function properly as master and remote.

d. Burn-in: Where dimmers are connected to fluorescent fixtures, operate at full brightness for the full burn-in duration as specified or recommended by the lamp manufacturer.

C. Receptacles:

1. Location:

a. Install convenience outlets, telephone, data and TV outlets in suitable steel outlet boxes centered at the height of 18 inches above the finished floor, 6 inches above countertop or at the backsplash level, or as indicated on the drawings. Coordinate with equipment and architectural drawings.

b. Install receptacles generally where indicated on drawings. The Owner's representative reserves the right to make any reasonable changes in receptacle locations without change in the contract sum.

c. Install specific-use receptacles at heights shown on Drawings.

2. Position:

a. Install receptacles vertically with ground pole on bottom. Install receptacles horizontally, where field condition does not allow vertical installation, with ground pole on left.

3. All receptacles with 6 feet of a water source such as sinks shall be GFCI type. Arrange circuit wiring for last receptacle on circuit to be GFCI. Feed through to non-GFCI receptacles is not permitted.

D. Plates:

1. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the General Contractor to patch, paint, etc. around the opening to the satisfaction of the Owner's representative.

2. All devices and cover plates shall be plumb and parallel to adjacent surfaces or trim. Devices must be flush with the finished trim cover plates and plates must be tight to surfaces over which they are installed.

3. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, plates shall be labeled to identify items being controlled, or areas being lighted. Labeling shall be 3/16-inch Condensed Gothic and shall be filled with black enamel.

E. Floor Boxes:

1. Verify locations of all floor boxes with the Owner's representative before installation. Increase slab thickness at boxes if required to obtain a minimum of 1 inch of concrete below bottom of box.

2. Install floor boxes level and flush with finish flooring material. Completely envelope floor boxes in concrete except at the top.

3. Adjust covers flush with finished floor.

F. Occupant Sensors:

1. Flush mount occupant sensors through round hole cut in ceiling tile, positioning and placement per sensor manufacturer's recommendation.
2. It is the installer's responsibility to replace damaged ceiling tiles during his installation of sensor.
3. The low voltage control wiring installed above ceiling tiles shall be plenum rated or general building wiring installed in raceway system.

END OF SECTION

SECTION 26 51 00

INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Interior lighting fixtures and accessories

B. Emergency lighting units

C. Emergency exit signs

D. Emergency fluorescent lamp power supplies

E. Lamps

F. Ballasts

G. Lighting controls

1.2 REFERENCES

A. NEPA 101 - Code for Safety to Life from Fire in Buildings and Structures

B. NEMA WD1 - General-Purpose Wiring Devices

C. ANSI C82.1 - Specification for Fluorescent Lamp Ballasts

D. ANSI C82.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type)

E. NEMA LE - H-I-D Lighting System Noise Criterion (LS-NC) Ratings

F. UL 844 - Electric Lighting Fixtures for Use in hazardous (classified) Locations

G. UL 924 - Emergency Lighting and Power Equipment

H. UL 935 - Fluorescent-Lamp Ballasts

I. UL 1029 - High-Intensity-Discharge Lamp Ballasts

J. UL 1572 - High Intensity Discharge Lighting Fixtures

K. UL 1574 – Track Lighting Systems

L. IESNA – Lighting Handbook

M. NEMA WD 1 - General Color Requirements for Wiring devices

N. NEMA LE 5B – Procedure for Determine Luminaire Efficacy Ratings for High-Intensity Discharge Industrial Luminaires

O. NFPA 70 – National Electrical Code

P. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

Q. Standards For State-Funded Outdoor Lighting Fixture – Texas House Bill 916 (1999)

R. UT System OFPC – Security Planning and Design Guidelines (2002 release)

1.3 DESIGN CRITERIA

A. Lighting level design shall be per IESNA (Illuminating Engineering Society of North America) recommendation.

B. The power consumption for interior and exterior lighting shall not exceed power allowance as per ASHRAE 90.1 latest revision.

1.4 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 1 for submittal requirement.

B. Submit manufacturer's data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by luminaire "type" in alphabetical order, with the proposed fixture and accessories clearly labeled.

C. Submit dimensioned drawings and performance data including complete photometric test data for each luminaire, candlepower distribution curves in two or more planes, candlepower chart zero to 90 degrees, lumen output zonal summary chart, average and maximum brightness data, and coefficients of utilization for zonal cavity calculations, spacing to mounting height ratio, efficiency and visual comfort probability. Also provide luminaire weights, mounting data, and accessory information for each luminarie type.

D. Lamps: Catalog cuts showing voltages, colors, approximate hours life, approximate initial lumens, lumen maintenance curve, lamp type and base.

E. Ballasts: Catalog cuts showing type, wiring diagram, nominal watts, input voltage, starting current, input watts, sound rating, power factor and low temperature characteristics.

F. Controls: Catalog cuts and/or shop drawings showing dimensions, voltage capacity, contact ratings, wiring diagrams, operating levels, and temperature ratings.

G. Lighting design shall be in compliance with power allowance for lighting, which is stipulated by ASHRAE 90.1. Compliance forms along with engineering data associated with it shall be submitted for Owner’s review during design phase.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers. Parabolic louvers shall be shipped in thermally sealed polyethylene wrapper.

B. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store lighting fixtures in a clean, dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 GENERAL

A. Lighting fixtures and accessories shall comply with the design and function requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data.

B. Provide lighting fixtures of the size, type and rating as scheduled, complete with, but not limited to, lamps, lamp holders, reflectors, ballasts, poles and wiring.

2.2 LED FIXTURES

A. LED Light fixtures shall be provided as scheduled on the drawings complete with LED light sources and drivers of the type, color, wattage and size scheduled.

B. Ballast/Driver Manufacturers for LED lights:

1. Advance Transformer Company.
2. Universal Lighting Technology/Magnetek.
3. Osram/Sylvania.
4. Phillips.
5. Lutron.

C. All LED light sources and drivers shall be provided with a 5 year warranty.

D. Ballast, driver and lamp/light source product data shall accompany all fixture submittals along with LM-80 lumen depreciation test results and L70 rated life test results for each type of LED source package, array or module being submitted for this project.

E. Provide recessed LED fixtures with trim rings compatible with the ceiling material where fixture is to be installed. LED fixtures shall be prewired equipped with integral thermal protection. LED lighting fixtures shall be appropriately listed and labeled by Underwriters' Laboratories, Inc. for their final installation, i.e., damp or wet locations, etc.

F. LED Light Source Packages: LED light source packages, arrays and modules used in luminaires shall be tested in accordance with LM-80 lumen depreciation tests and shall have a L70 rated minimum life of 50,000 hours.

G. For instances where LED sources are mounted directly to architecture, such as installing a strip LED using an adhesive tape, the LED manufacture shall provide a recommended heat sink volume adequate to achieve rated L70 life.

H. Recessed fixtures shall be designed and installed to eliminate light leakage.

I. For recessed LED fixtures where junction box is required, shall be accessible when fixture is removed. Connect to conduit system with flexible conduit containing #14 (minimum) fixture wire.

J. Aluminum reflectors shall be Alzak (finish as selected) or as authorized and not less than 0.057" thick, unless specified otherwise.

K. All fixtures specified for recessing in ceilings shall be supplied with prewired junction boxes.

L. LED fixtures shall have a minimum 5 year warranty covering failure of all electrical components.

2.3 OTHER INTERIOR LIGHTING FIXTURES

A. Fluorescent Fixtures

1. See plans for light fixture schedule.

B. Incandescent fixtures shall be pre-wired equipped with integral thermal protection. Use incandescent only where aesthetics outweighs economic considerations.

C. Lighting track shall be surface mount or pendant mount per the requirement on drawings, by manufacturer of track mounted light fixtures.

D. High Bay, Low Bay HID Fixtures

1. Provide rugged, lightweight, cast aluminum ballast housing with a baked electro-coat paint finish.

2. Optic reflector shall be fully fluted, anodized aluminum providing high efficiency. Where enclosed and gasketed type fixtures are specified, provide luminaires designed for continuous operation in an ambient temperature of 55° C.

E. Lamp Holders or Sockets

1. Incandescent lamp holders shall be screw base and have porcelain insulating shells and be rated for heavy duty, 660W.

2. Fluorescent Sockets: Fluorescent lamp holders shall be heat-resistant porcelain or plastic, designed and rated for the lamp type specified. Lamp holders shall be designed to maintain solid electrical contact at all times. The detent position for bi-pin lamp holders shall be a positive lock so that mechanical effort shall be required to rotate the lamps. Lamp holder shall be specifically compatible with lamping.

3. HID Medium and Mogul Base Sockets: Provide glazed porcelain pulse-rated heavy duty sockets with silicone leads hard soldered to nickel plated brass screw shell. Lamp holders shall also employ a positive spring locking means to maintain good electrical contact at the center terminal of the lamp.

4. Lamp holders and sockets shall be provided with minimum 18 AWG wiring leads.

F. Reflector Finishes

1. Painted Finishes: Provide electro-statically applied dry polyester white powder coat finish with minimum reflectance of 88 percent on all light reflecting surfaces.

2. Specular/Semispecular Finishes: Provide Alzak-type anodized finish on aluminum louvers and reflectors as specified in Luminaire Schedule as shown on the drawings. Minimum reflectivity shall be:

a. Specular: 80 percent

b. Semi-specular: 75 percent

G. UL Listing

1. All Luminaries and components shall be UL tested, listed, and labeled.

2. Luminaries installed under canopies, roofs, or similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.

3. Recessed luminaries installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall be approved for the installation in a fire-rated ceiling.

2.4 EXIT SIGNS

A. See plans for light fixture schedule.

2.5 LAMPS

A. Acceptable Manufacturers

1. General Electric Company

2. Philip Lighting Company

3. Osram/Sylvania

4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 1 for substitution requirement.

B. General Requirements

1. Lamps including linear fluorescent, compact fluorescent, and HID shall be low mercury type and shall pass all federal TCLP (Toxicity Characteristic Leaching Procedure) test requirements in effect at the time of manufacture. All lamps shall be energy saving and rapid start type.

2. General use incandescent lamps shall be inside frosted type, 120 volts, 750 hour minimum.

3. Linear fluorescent lamps shall be T8 lamps. Compact lamps shall be twin or double twin tubes. All lamps for one project shall be provided by the same manufacturer with color temperature as indicated on drawings. Operation voltage and wattage shall be as indicated on drawings.

4. Mercury vapor HID lamps shall not be used.

5. Metal halide HID lamps shall be phosphor coated, suitable for the burning position required.

6. High-pressure sodium HID lamps shall be clear or diffuse coated.

7. Maintenance Stock: Furnish a stock of replacement lamps in the original cartons or packing sleeves, amounting to 10% (but not less than two lamps in each case) of each type and size lamp used in each fixture type. Deliver replacement stock as directed to Owner's storage space.

2.6 BALLASTS/DRIVERS

A. Acceptable Manufacturers

1. Valmont
2. Advance
3. Magnetek
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 1 for substitution requirement.

B. General Requirements

All ballasts shall be UL listed and have the UL symbol on the label.

1. Ballasts for fluorescent lamps

   a. Provide 277V ballasts for all operations except as indicated otherwise on plans. Ballasts shall be electronic type, instant start, less than 10% THD, and power factor of 95 percent or greater, suitable to operate at 60 Hz input frequency.

   b. Electronic ballasts shall comply with all FCC and NEMA limits governing EMI and RFI, and shall have Total Harmonic Distortion (THD) of less than 10 percent.

   c. Ballasts shall be Class P thermally protected.

   d. Sound level criteria

   1) Nominal 430 mA Lamps: Class A sound rated.
   2) Nominal 800 mA Lamps: Class B sound rated.
   3) Nominal 1500 mA Lamps: Class D sound rated. Provide isolation mounting and insulation to reduce sound transmission and radiation.

   e. Electronic Dimming Ballasts: Compatible with lamp and dimming system, labeled for use and listed as compatible by dimmer manufacturer with a minimum full-to-5 percent dimming range.

   f. Exterior Fluorescent Ballasts: Provide zero degree starting rating.

2. Ballasts for HID lamps

   a. HID ballast shall be multi-tap encased and potted thermally protected high power factor of 90 percent or greater, constant wattage regulating, and autotransformer type. Ballast ambient operating temperature range shall be -20 to +130 degrees F. Ballasts shall be compatible to the lamps chosen for specific burning position, and compensate for the loss in efficiency.

   b. Provide isolation mounting and insulation of HID ballasts to reduce sound transmission or radiation.

   c. Each HID ballast shall have a fast acting primary inline fuse built into the fixture assembly by the manufacturer.

3. LED Drivers: Non-dimming and dimming LED drivers shall operate LEDs within the current limit specifications of the LEDs being driven.

   a. All LED drivers shall have a Class A sound rating.
   b. LED drivers shall operate from a 60 Hz power source, have a power factor >90%, a minimum efficiency of 70% at the full rated load of the driver.
   c. LED drivers shall have integral short circuit and overload protection.
   d. LED drivers shall have a minimum starting temperature of 0 degrees F and a maximum case temperature of 70 degrees C.
   e. LED Driver output voltage shall be regulated to ±5% over the published driver load range.
   f. LED drivers shall comply with the requirements of Federal Communicartions Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.

g. Dimming drivers shall be 0-10 VDC or phase shift as noted or scheduled on the drawings. Dimming drivers shall allow light output to be maintained at the lowest control setting, prior to off, without dropping out.

2.7 LIGHTING CONTROL

A. Refer to Section 26 27 26 Wiring Devices and Floor Boxes for lighting switch, dimming control, and occupancy sensor.

B. Photocell shall be automatic dawn on, dusk off switching; moisture, temperature, and vibration-resistant die-cast aluminum housing; time delay feature to prevent false switching; field adjustable to control operating levels.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to order lighting fixture, check the building electrical system requirements, architectural finishes, and the type of ceilings that lighting fixture will be installed. Any discrepancies of compatibility pertaining trim, frames, color, mounting, ballast, voltage and etc. shall be brought to the attention of A/E by written notice. Do not proceed with procurement until discrepancies are resolved in a satisfactory manner.

B. Installer shall examine the areas and conditions that light fixtures are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LIGHTING FIXTURES

A. Install light fixtures in accordance with the manufacturer's written instructions, the applicable requirements of NEC and national and local code, standard, and regulations. Install lamps in accordance with manufacturer's instructions.

B. Install luminaries at locations as shown on the Drawings; install aligned, aimed, and leveled. Install fixtures in accordance with manufacturer's installation instructions complete with mounting accessories, trim and support materials. Fasten fixtures securely to structural support members of the building; solid pendant fixtures shall be plumb.

C. Coordinate with other crafts to avoid conflicts between luminaires, supports, fittings and mechanical equipment.

D. Incandescent Fixtures

1. Surface Mounted Incandescent Fixtures: Mount directly to outlet box equipped with fixture stud or mounting bar.

2. Recessed Incandescent Fixtures: Mount with support rails attached to ceiling suspension support system.

E. Surface Mounted Fluorescent Fixture:

1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.

2. Where ceiling system has not been certified to support weight of fixtures, fixtures shall be supported at four points near each corner of fixtures.

3. Provide a minimum 5/8" air space between the fixture and the ceiling.

F. Recessed Fluorescent Fixtures:

1. Handle specular/semi-specular louvers and down light cones using only new clean white cotton or silk gloves. Do not touch louvers or cones with bare hands. Leave luminaries clean and free of any visible dust, debris, or fingerprints with all lamps operational at time of acceptance of work.

2. All recessed fluorescent fixtures shall be supported from building structure above ceiling with galvanized steel wire at not less than 4 points near corners of fixture. Size of wire shall be capable of supporting weight of fixtures.

3. Recessed luminaries trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide feed-through junction boxes or provide separate junction boxes. All components shall be accessible through the ceiling opening.

4. Connect recessed luminaries to junction box with flexible steel conduit and fixture wire.

G. HID Fixtures

1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.

H. Lighting Fixtures Adjustment

1. Adjust to illuminate intended areas as directed.

2. Adjust exterior fixtures during hours of darkness.

I. Immediately before final observation, clean all fixtures, inside and out, including plastics and glassware, and adjust all trim to properly fit adjacent surface, replace broken or damaged parts, and lamp and test all fixtures for electrical as well as mechanical operation.

J. Protect installed fixtures from damage during the remainder of the construction period.

K. Upon completion of installation of interior lighting fixtures, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

L. Incandescent lamps shall be new at time of final acceptance. Fluorescent lamps may be used in the final finishing of the building. Those that have exceeded more than 1/3 of their rated life (as established by Construction Inspector records), or that have blackened ends or inoperable shall be replaced with new lamps before final acceptance.

M. Lamp Disposal

1. The procedure of disposal of lamps that are mercury containing shall follow the guideline set by EPA (definitions in Title 40 Code of Federal Regulations 261 Subpart C, January 2000).

END OF SECTION

SECTION 28 31 00 - ADDRESSABLE DEVICE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Division 1, “General Requirements” and Section 26 00 00, "Basic Electrical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:

A. General: The extent of fire alarm system work is as shown and scheduled and includes, but is not limited to, providing a system with the following functions and operations:

1. Provide new fire alarm devices fully installed wired and interfaced to the existing addressable device fire alarm system in the building. All devices, fire alarm system materials, wiring and installation methods shall match the existing fire alarm system installation in the building.
2. Provide labor and software programming to upgrade the graphic annunciation of UCT at the remote UTPD monitoring station. Coordinate integration of work with UTPD.
3. All fire alarm system final connections and interfaces to the existing fire alarm system shall be made by Grinnell, the building fire alarm system installer.
4. All smoke detectors need to be labeled with the point number on the exterior of the device.
5. All pullstations need to be keyed to CAT 30.
6. Upon completion of the fire alarm installation updated CAD files need to be submitted to the owner.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the latest edition of the following standards:

1. National Fire Protection Association Standards including NFPA 72-2002, as applicable.
2. Underwriters' Laboratories, Inc. Requirements and Listing for use in Fire Protective Signaling Systems as applicable.
3. The requirements of State Fire Marshal and local authorities having jurisdiction.
4. Comply with requirements of the Americans with Disabilities Act of 1990.

1.4 QUALITY ASSURANCE:

A. Manufacturers: All fire alarm system equipment shall match the original building fire alarm system manufacturer (Simplex Grinell) to assure compatibility.

B. UL and FM-listing: All fire alarm system components shall be UL and FM listed for fire alarm use. The UL listing shall be under category UOJZ to assure that the entire system has been tested as an integral life safety system.

C. All equipment furnished shall be the current standard products of a single manufacturer and shall bear the label of the Underwriters' Laboratories for use in fire alarm system designed in compliance with the requirements of NFPA codes. Raceways, wiring and terminations shall be accomplished in compliance with the requirements of the National Electric Code, Article 760, except that all wiring shall be in EMT or an approved raceway.

D. The system as installed shall, upon completion, be certified by a state licensed fire alarm installation superintendent to the Owner as being installed in compliance with the specification, the requirements of all state and local codes, and as being operational and free from defects.

E. All system equipment supplied shall be listed by the Underwriters' Laboratories for NFPA 72 system use, and all applicable NFPA Codes.

F. The installing contractor shall be authorized and designated representative of the fire alarm system manufacturer to sell, install and service the manufacturer's equipment and shall stock the required spare parts to keep the system in operation. The installing contractor shall maintain a staff of specialists for technical assistance and system maintenance.

G. The installing contractor must be licensed by the State Fire Marshal to sell, install, and service fire alarm system as required by Article 5.43-2 of the Texas Insurance Code.

H. The installing contractor shall have on his staff a minimum of five installation superintendents who are licensed by the State Fire Marshal's office for such purpose and under whose supervision installation, final connections and check out will take place, as required by the Texas Insurance Code.

I. The installing contractor or equipment supplier shall have a staff a minimum of one certified NICET Level II state licensed fire alarm planner under whose supervision system design shall take place. In lieu of a NICET-certified state licensed fire alarm planner, the contractor or supplier may provide design supervision with a graduate or professional electrical engineer.

J. The equipment supplier shall provide 24 hour, 365 days per year emergency service with qualified and state-licensed service technicians.

K. The installing contractor shall have been actively engaged in the business of selling, installing, and servicing microprocessor and multiplex fire alarm systems for at least 8 years and shall have proof of experience in the installation and maintenance of the type of fire alarm system specified herein.

L. The manufacturer or his representative shall maintain within 50 miles of the installation, a staff of factory trained, state licensed fire technicians, together with all support parts necessary for maintenance of the system.

M. Where approved in writing by the system manufacturer and installing contractor, the Electrical Contractor may install all conduit and boxes. The system wiring shall be pulled in by the installing contractor. All system connections, device installation, system start-up and testing shall be performed by the installing contractor. Rough-in by the electrical contractor shall not in any way affect the system manufacturer's and installing contractor's full responsibility for the installed fire alarm system.

N. The manufacturer shall submit legal documentation indicating that the purchased fire alarm equipment will be provided with parts, and support for 10 years after the acceptance by the Owner.

O. Plenum cables are not acceptable. All wiring shall be listed for limited energy fire alarm use and rated for 300 volts minimum and installed in a suitable conduit or raceway.

P. The complete combination fire alarm system shall comply with the requirements of the Texas State Fire Marshall. Modifications required to provide compliance shall be made at no cost to the Owner. Where Contract Document requirements are in excess of Code requirements are permitted under the Code, the Contract Documents shall govern.

1.5 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:

1. A block diagram showing system components, wire runs, wire counts and wire sizes.
2. Manufacturer's descriptive literature for all panels, modules and peripheral equipment describing size, color, finish, capacity and electrical characteristics.

3. Completely identified and marked catalog cuts of all associated equipment and devices, with all non applicable items crossed out, or applicable devices clearly highlighted and/or identified.
4. Complete and detailed point-to-point wiring diagrams for all devices in the system.
5. Complete Bill of Material for all equipment.
6. A copy of the form to be used for final tests, 100% audit and checkout shall be submitted for approval.
7. Additional information as required in Section 26 00 00.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver fire alarm system components in factory-fabricated containers.

B. Store in a clean, dry space and protect from the weather.

C. Handle fire alarm system components carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: Provide the required fire alarm system products in the sizes and capacities required or indicated, complying with the manufacturer's published product information of standard materials and components, designed and constructed for the applications indicated.

2.2 SYSTEM OPERATION:

A. General: System operation for new fire alarm devices shall match existing operation.

B. Smoke Detectors: Activation of an "intelligent" smoke detector shall cause the same operations as for similar existing devices connected to the fire alarm system.

C. Addressable Devices: Activation of any addressable manual pull station, sprinkler waterflow switch or "intelligent" heat detector shall cause the same operations as for similar existing devices connected to the fire alarm system.

D. Valve Supervisory Switches: Closure of a supervised OS&Y valve sensed via a supervisory switch or loss of supervisory air pressure in a dry-pipe sprinkler system, sensed via a pressure switch shall cause the following operations and indications:

1. The system common alarm LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LED to a steady state.
2. An alpha-numeric LCD Display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location, and time of alarm. Location and zoning messages shall be custom field-programmed to respective premises.
3. Appropriate status change message(s) shall be transmitted to all graphics terminals, CRT displays, and printers.

E. System Wiring Supervision: Supervision of new fire alarm wiring shall match existing fire alarm system wiring supervision.

2.3 SYSTEM DEVICES:

A. General: System devices shall be located as shown on the Drawings. The Contractor shall refer to all the drawings to determine where devices are to be located. All system devices shall be numbered with a unique number. The numbering system shall include the building area, type of

device, and device number. This numbering system shall be shown on each submitted floor plan drawing, fire alarm riser diagram and be tabulated. The tabulation shall be included in each O&M Manual submitted to the Owner.

2.4 SYSTEM ZONING:

A. General: The system shall employ "intelligent" smoke detectors and addressable interface devices capable of being recognized and annunciated at the main control panel and CRT terminals on an individual basis. All devices shall be field-programmed into software zones for the purpose of general area identification and annunciation. However, each device shall also be annunciate identified on an individual basis including exact location and device type. All zoning/device location information shall be totally field-programmable to exact job requirements. Devices shall be zoned as follows:

1. Area smoke detectors shall be zoned by floor.

B. Initiating and monitored devices shall include, but not be limited to, the following:

1. Ceiling smoke detectors.
2. Addressable manual pull stations with firefighters telephone jacks.
3. Addressable input/output devices.

C. The system shall utilize remote transponder panels for distributed voice communications, firefighters' telephone conventional zoned initialing circuits and auxiliary control output circuits. Remote transponder panels shall communicate with the main CPU via the SLC data loop and be capable of being intermixed on the same loop as intelligent heat and smoke detection and control modules.

D. Output devices shall include, but not be limited to, the following:

1. Wall and ceiling alarm speakers/visual signals.
2. Addressable interface relays.

2.5 FIRE ALARM SYSTEM CENTRAL EQUIPMENT:

A. General: The Fire Alarm Control Panel and equipment is existing and shall be reused.

2.6 REMOTE TRANSPONDER PANELS:

A. General: Provide new transponder panels as required to interface new initiating and output devices to the existing fire alarm system.

B. Remote transponder/control panels shall be distributed remotely throughout the facility as required and as indicated on the Drawings. Transponders shall provide input/output interface between all field devices/equipment and main system CPU.

C. All functions of the transponder unit(s) shall be field-programmable via the main system CPU and incorporate nonvolatile RAM memory. Each unit shall be capable of operating independently in default mode should communication with the main CPU be disrupted. Transponders shall be capable of operating on the system SLC intelligent loop in conjunction with intelligent field devices.

D. The transponder shall include a resident microprocessor based CPU control module interfacing the main system CPU with respective I/O modules served by the resident/local CPU. The local CPU shall provide each transponder with common status indicators, pilot/status LED, common alarm LED, and common trouble LED. Each CPU module shall include local silence, reset, trouble display, lamp test, and reset capability. Each control module shall provide dual FormÿC common alarm and trouble contacts as well as a local alarm/trouble Piezo sounder.

E. Each transponder shall be capable of providing audio power supervision/annunciation, power supply supervision/annunciation, and supervision of all associated I/O modules. Each transponder shall be field programmable for alarm verification. Selection of alarm verification shall provide each associated zone/ input module with the automatic ability to verify all smoke detector initiated alarm

signals before initiating any event initiated output functions. The system shall have the ability to electronically differentiate between smoke detector alarms and contact/shorting device alarms and will NOT allow the verification sequence to occur from signals initiated from pull stations, flow switches, heat sensors, etc.

F. All transponder mapping/addressing shall be accomplished via the transponder CPU module.

G. Transponders shall be provided with zone initiation input modules as required. Each module shall provide eight Style B or four Style D initiating zone circuits. Each zone shall be capable of intermixing two-wire smoke detectors and contact type devices on the same circuit. Each zone shall assume a designated and distinct address I.D. within the system. The transponder shall monitor the status of each zone module and zone circuit for normal, alarm and trouble, and report any status or change thereof to the main system control panel/CPU. Each zone shall be equipped with status and trouble LED indication. Each zone shall be field programmable for alarm, waterflow, supervisory, or non-alarm/status configuration. Each zone shall be capable of being programmed/mapped in software to activate selected output functions.

H. Transponders shall be provided with zone alarm output modules as required. Each module shall provide eight Style Y indicating appliance circuits. Each indicating circuit shall be capable of being field programmed as conventional alarm, audio, and/or telephone circuits. Output circuits shall be power limited. Each output zone shall assume a designated and distinct address I.D. within the system and be field programmable for control by event actuation. The transponder shall monitor the status of each alarm output module and each associated circuit for normal, activation, and trouble, and report any status or change thereof to the main system control panel/CPU. Each zone shall be equipped with a status and trouble LED indicator.

I. Each alarm output circuit/zone shall be field programmable for silenceable or non-silenceable operation. Specified control circuits shall be supervised via alarm output circuits and shall be programmed for non-silenceable operation.

J. Transponders shall be provided with auxiliary output/control relay modules as required. Each module shall provide eight SPDT (or four DPDT) field programmable output circuits. Output circuits shall be power limited. Each output shall be rated at 2 amps, 24 volts dc. Each circuit shall assume a designated and distinct address I.D. within the system and be field programmable for control by event actuation. Designated control circuits shall be provided with software assignable manual control switch as herein specified. The transponder shall monitor the status of each output module and associated circuit for normal, activated, and trouble conditions. Each circuit shall be equipped with an individual status LED indicator.

K. The power supply for the panel and all fire alarm peripherals shall be integral to the control panel. The power supply shall provide all control panel and peripheral power needs with filtered power as well as 3.5 amperes of unregulated 24 volt dc power for external audio/visual devices. The audio/visual power may be increased as needed by adding additional modular expansion power supplies. All power supplies shall be designed to meet UL and NFPA requirements for power-limited operation on all external signaling lines, including initiating circuits and indicating circuits. All circuitry shall be UL listed for power-limited application.

L. Input power shall be 120 volt ac, 60 Hz. The power supply shall provide internal supervised batteries and automatic charger. The power supply shall provide both positive and negative ground fault supervision, battery/charger fail condition, ac power fail indicators.

M. Transponder shall be housed in key-locked steel cabinet painted in baked enamel finish. Cabinet door shall provide transparent glass window for viewing transponder indicators and controls. The cabinets shall be no more than 5" deep and 24" wide to conserve space. Cabinets shall be provided with conduit knockouts on sides and top for versatility in installation. The cabinet(s) shall be capable of accommodating multiple transponder units in a single enclosure.

2.7 SMOKE SENSORS/DETECTORS:

A. Intelligent "Ceiling-mounted" Photoelectric Smoke Sensors: Autocall or approved equal analog photoelectric smoke sensors shall be provided where indicated on the Drawings.

1. The intelligent photoelectric smoke sensors shall connect via two wires to one of the intelligent control panel loops.
2. The sensors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
3. The sensors/control panel shall provide automatic sensitivity "drift" compensation to provide longer term stability and reliability. The sensor shall also provide a "maintenance alert" feature whereby the detector shall initiate a trouble condition should the units sensitivity approach the outside limits of the normal sensitivity window.
4. The sensor shall be provided with extensive RF and EMF noise reduction circuitry.
5. The sensor shall employ sophisticated self-compensating solid state LED light source and photosensitive circuitry.
6. The sensor/control panel shall provide a calibrated test method whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself, by activating a magnetic test switch, or may be activated remotely on command from the control panel.
7. The sensors shall provide address-setting means on the sensor head using rotary decimal switches. No binary coding shall be required. The sensors shall also store an internal identification code which the control panel shall use to identify the type of sensor.
8. The sensors shall provide dual alarm and power/status LEDs. Status LEDs shall flash under normal conditions, indicating that the sensor is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected and verified. An output connection shall be provided in the base for connecting an external remote alarm LED.
9. The sensor shall be semiflush ceiling-mounted and be provided with modular detector head with twist-lock base. Sensors shall also be suitable for surface-mounting below the raised floor or above the ceiling. Sensors shall be provided in smooth attractive white finish, and sealed against dirt, vermin, and back pressure. Sensors shall be provided with fine mesh insect/contaminate screen.
10. Sensors shall be UL listed with respective control panel.

2.8 MANUAL STATIONS:

A. Addressable Manual Stations : Thorn Autocall or approved equal manual stations with addressable interface module or an approved equal shall be provided where indicated on the Drawings.

1. Manual stations in stairwells and in unfinished area shall be constructed of white high impact molded Lexan with instructions for station operation in raised red letters. Stations shall have an integral firefighters' telephone jack installed in the side of the station. Stations shall be installed using standard semiflush mounting.
2. The manual station addressable module shall connect with two wires to one of the intelligent control panel loops.
3. The addressable module at the manual station shall, on command from the control panel, send data to the panel representing the state of the manual switch.
4. The manual station addressable module shall provide address-setting means using rotary decimal switches and shall also store an internal identification code which the control panel shall use to identify the type of device. No binary coding shall be required.

2.9 FIRE FIGHTER PHONE JACKS: Provide fire fighters phone jacks where shown on the drawings. Provide stainless with graphics to match existing building jacks.

2.10 INPUT/OUTPUT DEVICES:

A. Monitor Module (Addressable input Device): Thorn Autocall or approved equal addressable monitor modules shall be provided where required to interface to contact alarm devices.

1. The monitor module shall be used to connect a supervised zone of conventional initiating devices (any N.O. dry contact device, including 4ÿwire smoke detectors) to an intelligent loop.
2. The monitor module will mount in a 4" square electrical box.
3. The monitor module shall provide address-setting means using rotary decimal switches and shall also store an internal identification code which the control panel shall use to identify the type of device. No binary coding shall be required.

B. Control Module (Addressable Output Device): Thorn Autocall or approved equal control/relay modules shall be provided where required to provide audible alarm interface and/or relay control interface.

1. The control module shall be used to connect a supervised zone of conventional indicating devices (any 24 volt polarized audiovisual indicating appliance) to an intelligent loop. The zone may be wired Class A or Class B field-selected. The control module may be optionally-wired as dry contact (Form C) relay.
2. The control module will mount in a standard 4" electrical box.
3. Power for the relay actuation shall be provided by the intelligent detector loop to reduce wiring connection requirements. Audio/visual power shall be provided by a separate loop from the main control panel or from supervised remote power supplies.
4. The control module shall provide address-setting means using rotary decimal switches and shall also store an internal identification code which the control panel shall use to identify the type of device. No binary coding shall be required. A status LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and in regular communication with the control panel. The LED shall illuminate steady when the device is actuated via the Fire Alarm Control Panel.

C. Auxiliary Control Relays: Air Products, Thorn Autocall or approved equal relays shall be provided for control interface. Relays shall be heavy duty type and rated up to 20 amps at 120 volts ac, 60 Hz. Relays shall be provided with NEMA 1 dust cover assembly and be provided with DPDT contacts.

D. Sprinkler Waterflow and Pressure Switches: Switches shall be furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor.

E. Fire Protection OS&Y Valve Supervisory Switches: Switches shall be furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor. Switches shall activate a supervisory signal within two turns of the valve or more than 1/3 of the valve travel toward the closed position.

F. Dry-pipe and Pre-action Sprinkler Low Air Pressure Trouble Signals: Low pressure switches and system trouble dry contacts shall be furnished and installed under Division 15, with wiring and addressable input device interface by this Contractor.

2.11 ALARM SIGNAL DEVICES:

A. Ceiling Mounted Fire Alarm Speakers: Wheelock "E" Series or equal flush mounted fire alarm speakers which match existing devices used in the building shall be provided. Ceiling mounted fire alarm speakers shall have a white finish.

B. Wall Mounted Fire Alarm Speakers/Visual Signals: Wheelock "E" Series or equal recess/surface mounted fire alarm speakers with integral visual signals which match existing devices used in the building shall be provided. Wall mounted fire alarm speaker/visual signals shall have a white finish. Visual signal candela ratings shall be in compliance with applicable codes and standards.

C. Wall Mounted Fire Alarm Visual Signals: Wheelock "E" Series or equal recess/surface mounted fire alarm visual signals which match existing devices used in the building shall be provided. Wall mounted fire alarm visual signals shall have a white finish. Visual signal candela ratings shall be in compliance with applicable codes and standards.

2.12 SYSTEM WIRING:

A. The equipment supplier shall furnish to the installing contractor a complete detailed point-to-point wiring diagram showing the system equipment and required number, type and sizes of conductors and conduit sizes. Where common devices which break the alarm circuit are installed on a common zone with shorting type device, the circuit breaking devices shall be wired electrically downstream of the shorting type devices.

B. All fire alarm system wiring shall be installed in an approved raceway.

C. All fire alarm system wiring shall be multiconductor, UL listed FPL for limited energy (300 volt) and fire alarm applications, and NEC approved fire alarm cable. Wiring shall be installed in accordance with NEC, Article 760 of NFPA Standard 70 and manufacturer's recommendations. All wiring shall be copper and installed in conduit sized in accordance with the National Electrical Code.

D. Fire alarm system wiring shall be color coded.

E. All fire alarm system junction boxes including covers, shall be secured, painted red and marked in white lettering as specified in Section 26 05 53.

F. Wire size shall be determined by calculated voltage drop and circuit loading. Minimum wire size shall be as follows:

1. #18 AWG twisted and shielded for data and communications circuits.
2. #18 AWG for non-data and communications initiating and low voltage auxiliary control circuits.
3. #16 AWG twisted for alarm circuits.
4. #14 AWG for all power circuits.

PART 3 - EXECUTION

3.1 GENERAL:

A. Inspection: Installer shall examine the areas and conditions under which the fire alarm system is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. NECA: All fire alarm installations shall be in accordance with NECA 305-2001, Standard for Fire Alarm System Job Practices.

3.2 SYSTEM DESIGN:

A. General: The basic equipment and device locations have been shown on the contract drawings. Specific wiring between equipment/devices has not been shown. It is the contractors responsibility to submit for approval the COMPLETE ENGINEERED system configuration and layout showing all devices, wiring, conduit, and locations along with other required information as specified herein.

3.3 PROGRAMMING:

A. General: The fire alarm system installer shall provide programming to interface new fire alarm devices as required.

3.4 INSTALLATION:

A. General: Install system and materials in accordance with manufacturer's instructions, roughing-in drawings, and details on the Drawings. Install electrical work and use electrical products complying with the requirements of the applicable Division 26 sections of these Specifications. Mount manual stations and alarm devices at heights specified in Section 26 05 00, "Basic Electrical Material and Method".

B. Wiring: All wiring shall be in accordance with NFPA 72, the National Electrical Code, Local Codes, and Article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.

1. Install fire alarm system line voltage and low-voltage wiring in a suitable raceway. Conceal fire alarm system conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.

2. All wiring shall be run in a supervised fashion (i.e. no branch wiring or dog-legged wiring) per NFPA requirements such that any wiring disarrangement will initiate the appropriate trouble signals via the main control panel per NFPA and UL requirements. Intelligent SLC loops may be T-tapped/branch wired due to inherent dynamic supervision.

3. Wiring splices shall be kept to a minimum with required splices to be made in designated terminal boxes or at field device junction boxes. Transposing or color code changes of wiring will not be permitted. End-of-line supervisory devices shall be installed with the last device on the respective circuit. Said device shall be appropriately marked designating it as the terminating device on the respective circuit.

4. No AC wiring or any other wiring shall be run in the same conduit as fire alarm wiring.

5. Number code and color code conductors appropriately and permanently for future identification and servicing of the system.

C. Conduit/Raceway: All wire shall be installed in an approved conduit/raceway system. Maximum conduit "fill" shall not exceed 40% per NEC.

1. Conduit and raceway system shall be installed as specified other Sections of the Specifications.

2. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.

Conduit and raceway system shall be installed as specified under the general electrical sections of the specifications and per NEC. Maximum conduit "fill" shall not exceed 40% per NEC.

D. Labeling: All system controls, indicators and other devices shall be labeled with names, designations and operating instructions as applicable. Labels shall be either engraved nameplates or covered printed labels and shall be approved by the Engineer. All water flow switches which are hidden shall have identification points. These identification points shall be red tags with white lettering indicating location of the water flow switch. Tag location will be visible from corridors.

E. Checkout: Check wiring to ensure that wiring is in accordance with the system manufacturer's wiring diagrams and that the system is free of open circuits, short circuits, and grounds.

F. Identification: Refer to Section 26 05 53 for additional requirements concerning painting, nameplates, and labeling.

3.5 COORDINATION:

A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the fire alarm system with all trades. Adequate coordination shall be provided to ensure proper installation and interface to all peripheral items required to interact with the fire alarm to provide a complete and functional life safety system.

B. The installing contractor shall be fully responsible for coordinating all system and device messages and system operation with the Owner's Representatives and Operating Personnel.

3.6 SYSTEM CHECKOUT AND TEST:

A. All final control panel connections shall be made by a state licensed, factory-trained technical representative of the manufacturer and who shall supervise a System Checkout and Test to demonstrate and confirm to the Engineer, Owner's Representative and the fire department, that the fire alarm system is 100% operational upon completion of the installation, and that it complies with all local code requirements and these specifications. It is intended that the System Checkout and Test be followed by a continuing program of inspection testing and maintenance. The Contractor shall provide a proposal to the Owner for a Maintenance, Inspection and Quarterly Testing Contract in compliance with NFPA 72H, upon completion and system checkout.

B. The System Checkout and Test shall be performed within 30 days after the fire alarm installation and all peripheral systems are completed. The System Checkout and Test shall be performed by a minimum of two licensed fire alarm system technicians, one of which is licensed by the State of Texas, and acceptable to the Engineer and the authority having jurisdiction. The test shall be performed in two parts and two-way radios for use by the test observers shall be provided. The first part shall be a full dry-run test with all subcontractors present, but without the Owner's Representative or fire department present. After the dry-run test is successfully completed, then the final test with the Owner's Representative and fire department present shall be performed.

C. This Contractor shall coordinate the test schedule with all necessary parties and subcontractors required to be present for a complete and functional test.

D. The System Checkout and Test which is a comprehensive 100% inspection and test of all fire alarm system equipment and shall include, but not be limited to the following:

1. Fire Alarm Control Equipment:

   a. A visual and functional test of all fire alarm control and auxiliary control equipment.

   b. A visual inspection shall be conducted to establish that all electrical connections and equipment as required are properly installed and operating.

   c. A remote functional fault simulation test shall be conducted on all relevant field wiring terminations to ensure that all wiring is properly supervised as required.

   d. All indicators shall be tested to ensure proper function and operation.

e. All device messages shall be verified to be correct, as installed.

f. All system auxiliary functions including, but not limited to, CPU reporting, elevator recall, fire/ smoke door and shutter control, security interface, HVAC equipment control and shutdown, smoke control initiation, and other specified control functions shall be functionally tested to verify proper operation and proper system messages.

g. Control panel supervisory and alarm current readings shall be taken to verify that the control panel has the appropriate power supplies and standby batteries to operate the system as required. A 3 minute general alarm stress test both under ac power and standby power shall be conducted to further ensure complete operation of the system.

h. The Voice Communication System shall be visually and functionally tested to verify proper operation. Voice paging zoning shall be verified and automatic and manual operation of the voice paging system shall be fully verified. Self-monitoring functions of the voice paging system shall be verified.

i. The Firefighters' Telephone System shall be functionally tested to verify proper zoning, supervision and operation of each firefighters' telephone jack location.

2. Annunciators: All annunciators shall be tested to ensure that each point activates properly and labeling correctly defines the area of alarm.

3. Fire Alarm Peripheral Devices: All fire alarm peripheral devices shall be functionally tested and the location and testing information recorded for each device.

4. Initiating Devices (Manual and Automatic):

a. All manual and automatic initiating devices shall be inspected to ensure proper placement and mounting as recommended by the manufacturer and as indicated in these specifications.

b. All manual fire alarm stations and all automatic initiating devices (smoke detectors, heat detectors, waterflow switches, etc.) shall be functionally tested for alarm operation.

c. A minimum of 10% of initiating devices shall be functionally tested for proper wiring supervision. Failure of any tested device on any zone shall require that all devices in that zone shall be tested for supervision.

d. All device messages shall be verified to be correct as installed.

5. Alarm Signaling Devices:

a. All visual alarm indicators and exit sign flashing shall be functionally tested to ensure proper operation and that they are clearly visible.

b. Alarm signaling devices shall be field-checked and tested for proper operation and output.

c. Decibel reading shall be taken to ensure that the alarm signal level can be clearly heard in all areas of the facility, if required by the authority having jurisdiction. Additional devices may be required to provide adequate sound penetration (or as required by the local authority having jurisdiction). Contractor shall provide a unit price for such devices should they be required.

d. A minimum of 10% of the alarm signaling device shall be functionally tested for proper wiring supervision.

6. Reporting:

a. Upon completion of the 100% System Checkout and Test, four copies of the final report shall be documented, certified, and sent to the Engineer for distribution to the Owner or authorized Owner's Representative indicating that all fire alarm equipment has been tested and is 100% operational.

b. The final report shall be generated by the equipment manufacturers headquarters or authorized representative to ensure integrity and uniformity of all testing procedures and reporting. The report shall contain the testing information, stating the precise location and operational status of each and every peripheral device and shall include a Fire Alarm System Certification and Description Document per NFPA 72.

c. The 100% System Checkout and Test shall be performed by factory-trained representatives, and one of the individuals shall possess a state license for fire alarm installation supervision.

3.7 OPERATING AND MAINTENANCE DATA:

A. The system manufacturer shall submit fire alarm system Operating & Maintenance (O&M) Manuals with complete system documentation including test reports and record drawings.

B. The manufacturer's authorized representative shall instruct the Owner's designated employees in the proper operation of the system and all required periodic maintenance. This instruction will include three copies of a written summary in booklet or binder form so employees can retain for future reference. Basic operating instructions for the system shall be framed and mounted at the main control unit.

3.8 WARRANTY:

A. The fire alarm and security systems shall be warranted against defects in workmanship and materials, under normal use and service, for a period of one year from the date of acceptance by the Owner. Any equipment shown to be defective shall be repaired, replaced or adjusted free of charge.

B. The warranty period shall begin after successful completion of the Owner's inspections and tests. In the event of any system malfunctions or nuisance alarms, the Contractor will take appropriate corrective action. This action may necessitate a repeat of the response test if the Owner so desires. Continued improper performance during warranty shall be cause to require the Contractor to remove the system.

C. The warranty start date will not begin until after a period of 30 consecutive days of system operation without any nuisance alarms caused by malfunctioning of hardware of software.

END OF SECTION 28 31 00