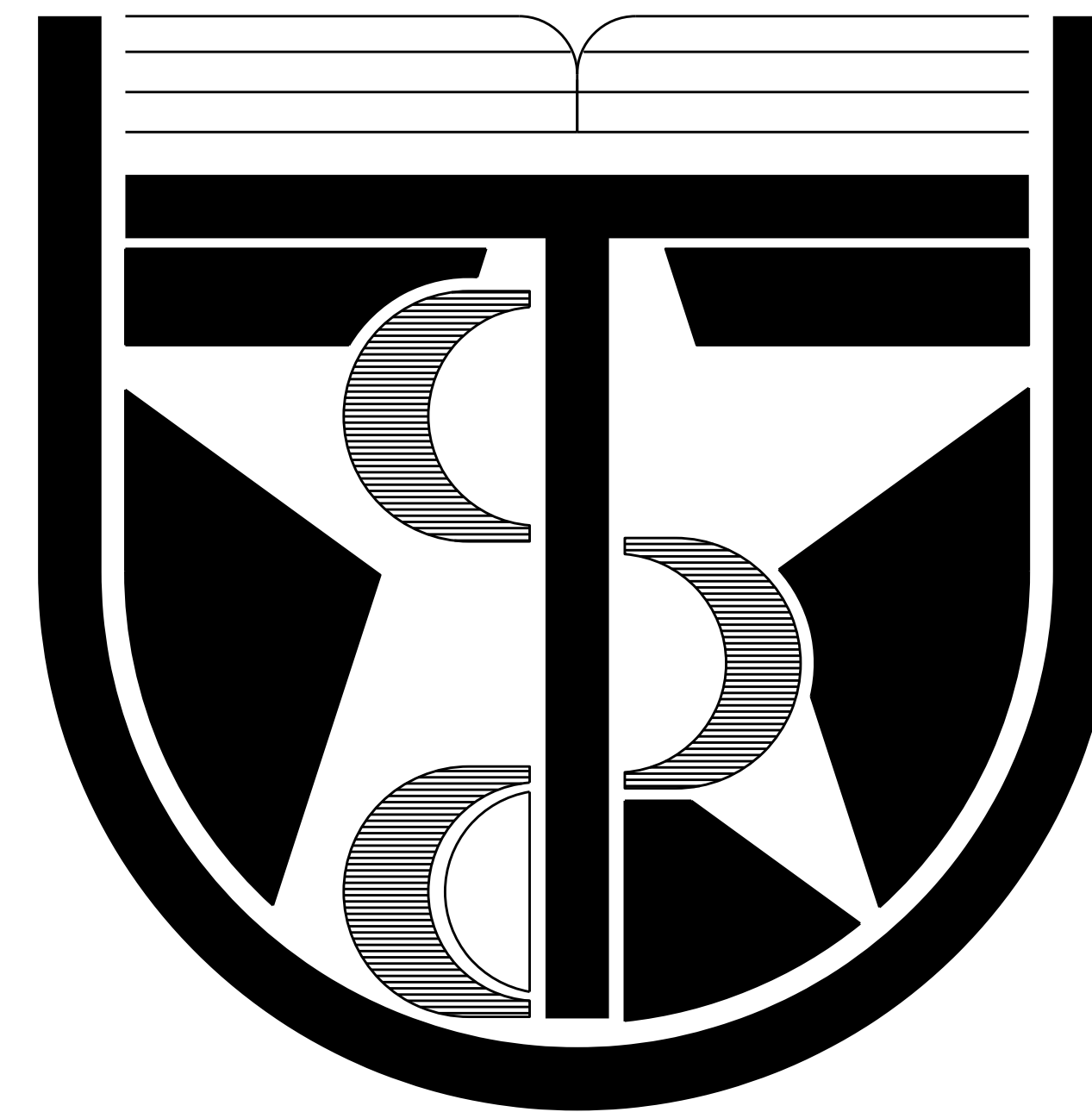


PLUMBING PIPING REPLACEMENT

APRIL 18, 2017 100%

UNIVERSITY OF TEXAS
HEALTH SCIENCE CENTER AT HOUSTON
MEDICAL SCHOOL BUILDING
6431 FANNIN ST.
HOUSTON, TEXAS 77030



UNIVERSITY OF TEXAS
HEALTH SCIENCE CENTER AT HOUSTON
1851 CROSS POINT
HOUSTON, TEXAS 77054

ENGINEERS

E&C Engineers and Consultants Inc.
E&C State of Texas registration number is F-003068
1010 Lamar, Suite 650
Houston, Texas 77002

Telephone 713-580-8800
Facsimile 713-580-8888

<http://www.eceng.com>

ABBREVIATIONS

Table of abbreviations and their corresponding terms, organized in columns. Includes terms like 'AMP', 'AIR COMPRESSOR', 'ELECTRIC UNIT', etc.

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

PIPING TYPES

Table of piping types with symbols and descriptions: RHG (Refrigerant Hot Gas Line), RS (Refrigerant Suction Line), RL (Refrigerant Liquid Line), etc.

MISCELLANEOUS

Table of miscellaneous symbols and descriptions: FLOOR DRAIN, AREA DRAIN, ROOF DRAIN OR OVERFLOW DRAIN, etc.

PIPING SYMBOLS

Table of piping symbols and descriptions: ELBOW UP, ELBOW DOWN, VALVE IN DROP, etc.

GENERAL NOTES

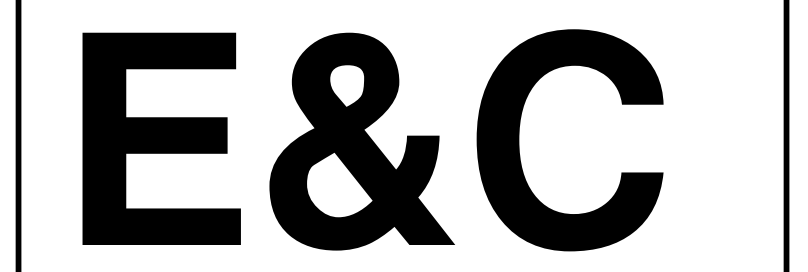
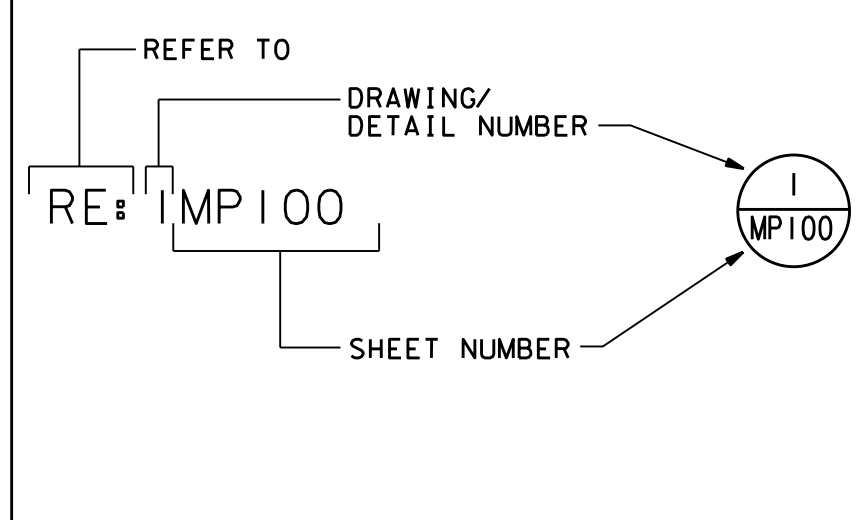
- A. REFER TO SPECIFICATIONS FOR MATERIALS AND METHODS FOR PLUMBING CONSTRUCTION.
B. REFER TO ARCHITECTURAL INTERIOR ELEVATION DRAWINGS...
C. ALL PENETRATIONS THRU THE ROOF TO MECHANICAL EQUIPMENT...

DRAWING LIST

Table with columns for drawing number, title, and description. Includes entries like P-000 PLUMBING SYMBOLS AND ABBREVIATION.

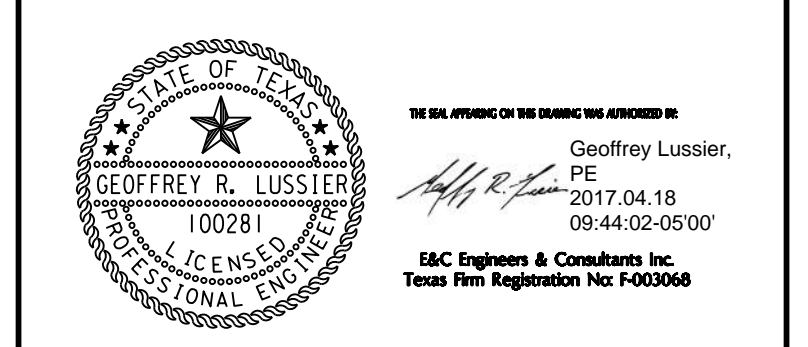
PLUMBING PIPING MATERIALS table with columns for material type and specifications. Includes entries for storm drain piping above slabs.

DRAWING/DETAIL REFERENCE KEY



Engineers & Consultants Inc. TX Firm Registration No: F-003068

1010 Lamar, Suite 650
Houston, Texas 77002
Tel 713/580-8800
Fax 713/580-8888
www.eceng.com



ISSUE

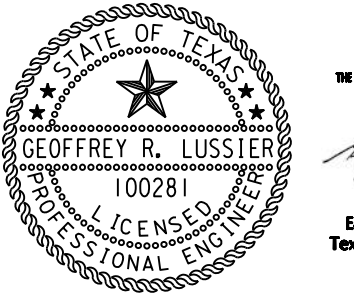
Table with columns for issue number, date, and description. Shows a record for issue 100% on 04/18/2017.

MEDICAL SCHOOL BUILDING PLUMBING PIPING REPLACEMENT

6431 Fannin St. Houston, Texas 77030

PLUMBING SYMBOLS AND ABBREVIATION

Table with columns for project number (3315.00) and sheet number (P-000).



Geoffrey Lusnier, P.E.
2017.04.18
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E&C Engineers & Consultants Inc.
Texas Firm Registration No: F003068

ISSUE

NO.	DATE	DESCRIPTION
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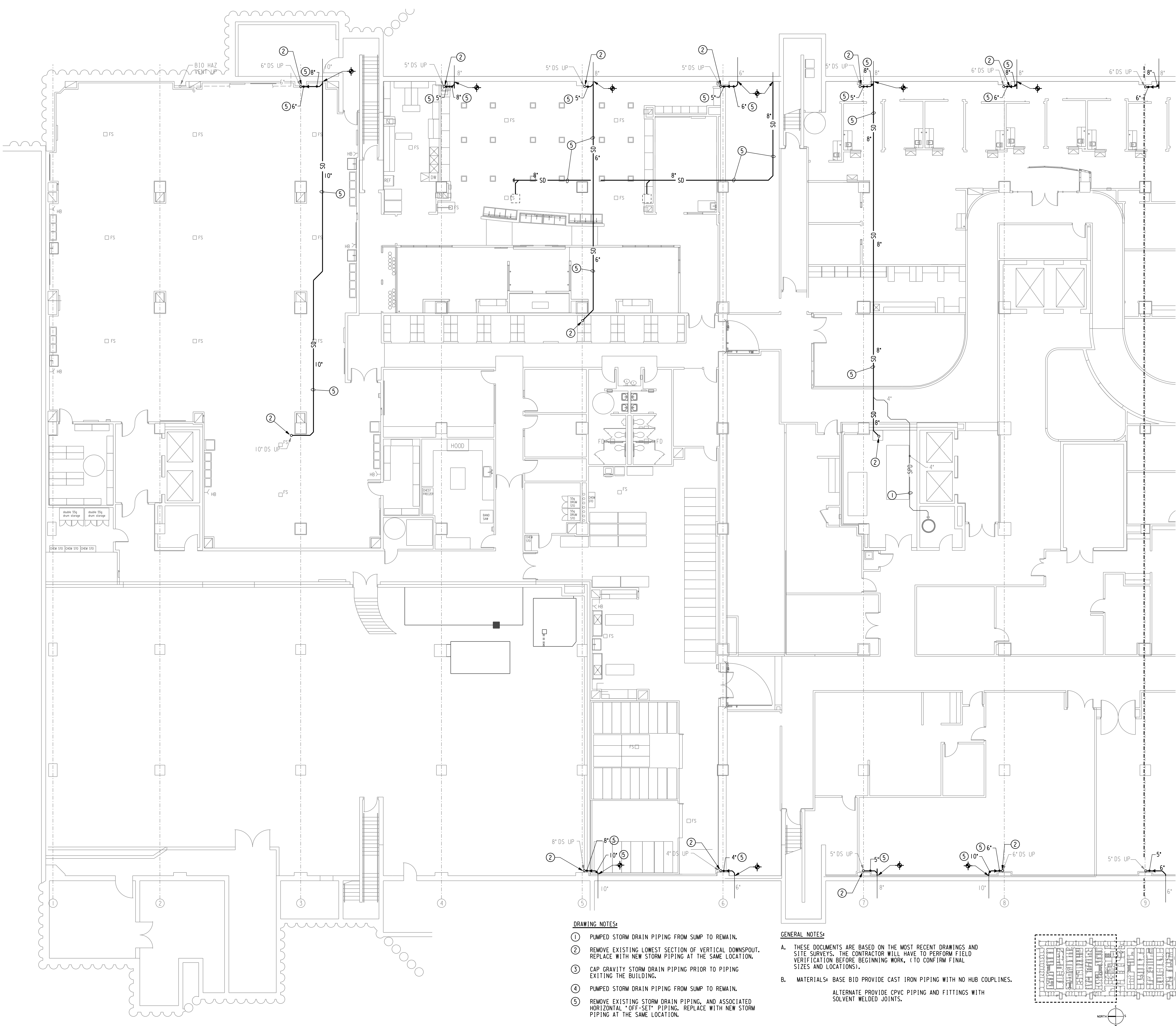
**MEDICAL SCHOOL BUILDING
PLUMBING PIPING
REPLACEMENT**

6431 Fannin St.
Houston, Texas 77030

**PLUMBING
BASEMENT LEVEL
NORTH**

PROJECT NO.
3315.00

SHEET NO.
P-100N

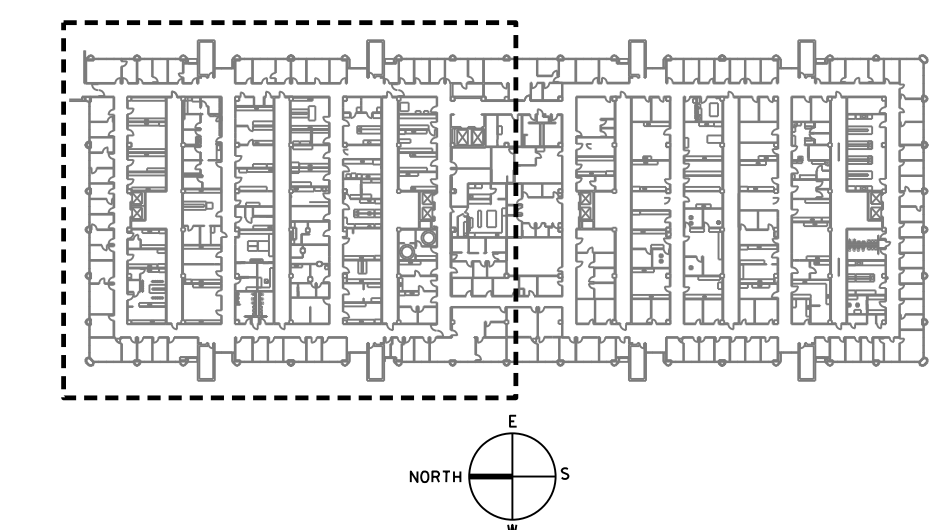


DRAWING NOTES:

- 1 PUMPED STORM DRAIN PIPING FROM SUMP TO REMAIN.
- 2 REMOVE EXISTING LOWEST SECTION OF VERTICAL DOWNSPOUT. REPLACE WITH NEW STORM PIPING AT THE SAME LOCATION.
- 3 CAP GRAVITY STORM DRAIN PIPING PRIOR TO PIPING EXITING THE BUILDING.
- 4 PUMPED STORM DRAIN PIPING FROM SUMP TO REMAIN.
- 5 REMOVE EXISTING STORM DRAIN PIPING, AND ASSOCIATED HORIZONTAL "OFF-SET" PIPING. REPLACE WITH NEW STORM PIPING AT THE SAME LOCATION.

GENERAL NOTES:

- A. THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK. (TO CONFIRM FINAL SIZES AND LOCATIONS).
- B. MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINES.
ALTERNATE PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.





ISSUE

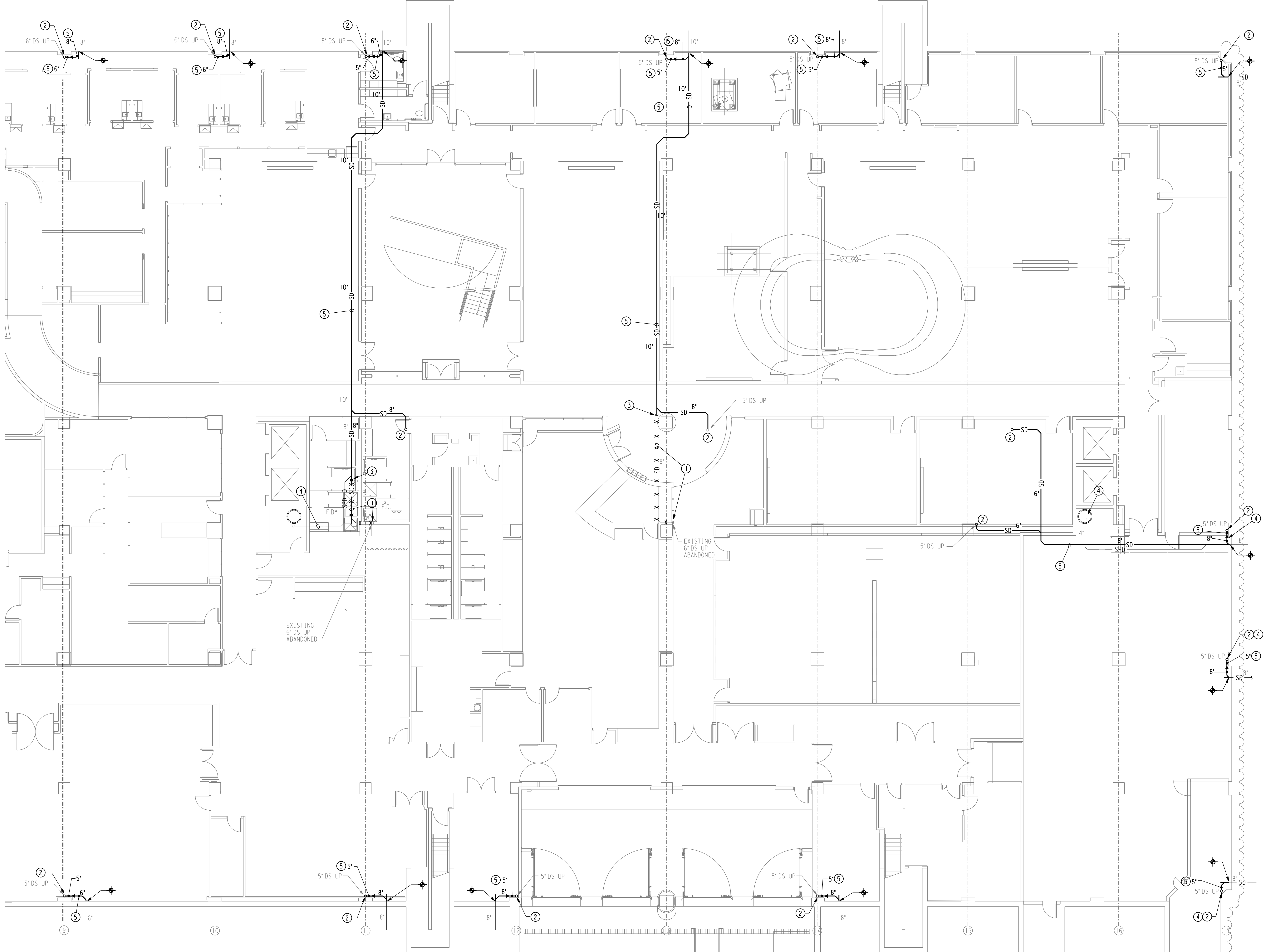
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MEDICAL SCHOOL BUILDING PLUMBING PIPING REPLACEMENT

6431 Fannin St.
Houston, Texas 77030

PLUMBING BASEMENT LEVEL SOUTH

PROJECT NO. 3315.00	SHEET NO. P-100S
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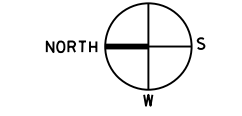
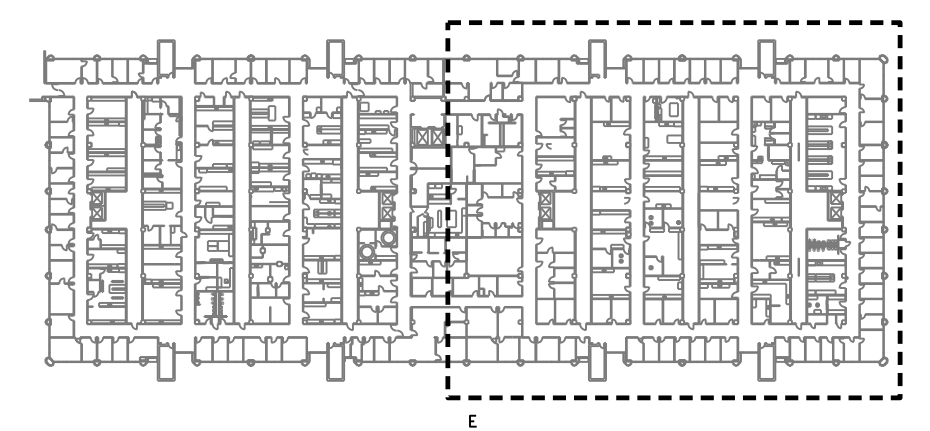


DRAWING NOTES:

- ① REMOVE EXISTING STORM DRAIN PIPING, ASSOCIATED HORIZONTAL "OFF-SET" PIPING AND VERTICAL DOWNSPOUT PIPING.
- ② REMOVE EXISTING LOWEST SECTION OF VERTICAL DOWNSPOUT. REPLACE WITH NEW STORM PIPING AT THE SAME LOCATION.
- ③ CAP GRAVITY STORM DRAIN PIPING PRIOR TO PIPING EXITING THE BUILDING.
- ④ PUMPED STORM DRAIN PIPING FROM SLUMP TO REMAIN.
- ⑤ REMOVE EXISTING STORM DRAIN PIPING, AND ASSOCIATED HORIZONTAL "OFF-SET" PIPING. REPLACE WITH NEW STORM PIPING AT THE SAME LOCATION.

GENERAL NOTES:

- A. THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK, (TO CONFIRM FINAL SIZES AND LOCATIONS).
- B. MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINES.
ALTERNATE PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.



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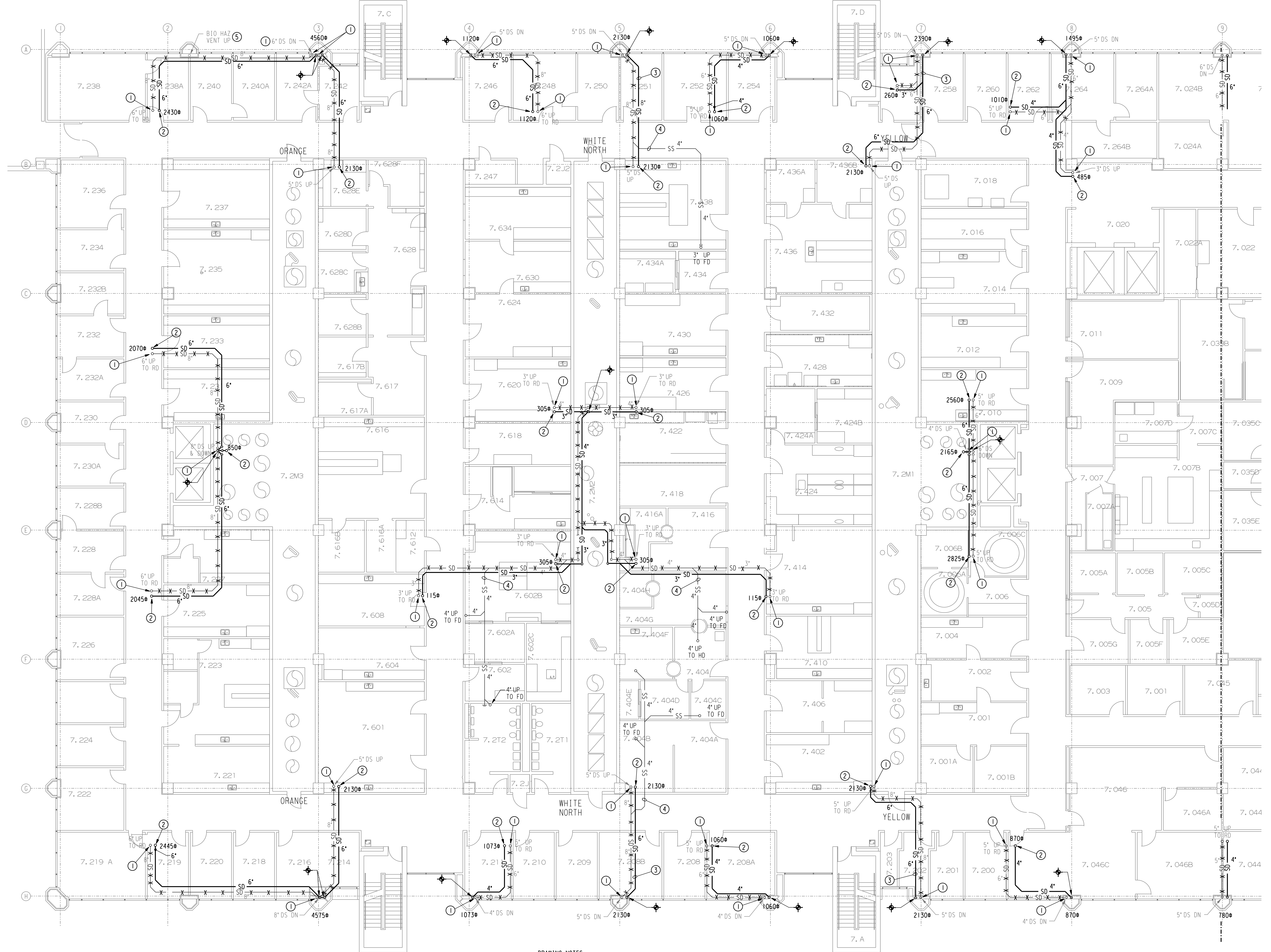
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MEDICAL SCHOOL BUILDING PLUMBING PIPING REPLACEMENT

6431 Fannin St.
Houston, Texas 77030

PLUMBING LEVEL 7 NORTH

PROJECT NO. 3315.00	SHEET NO. P-207N
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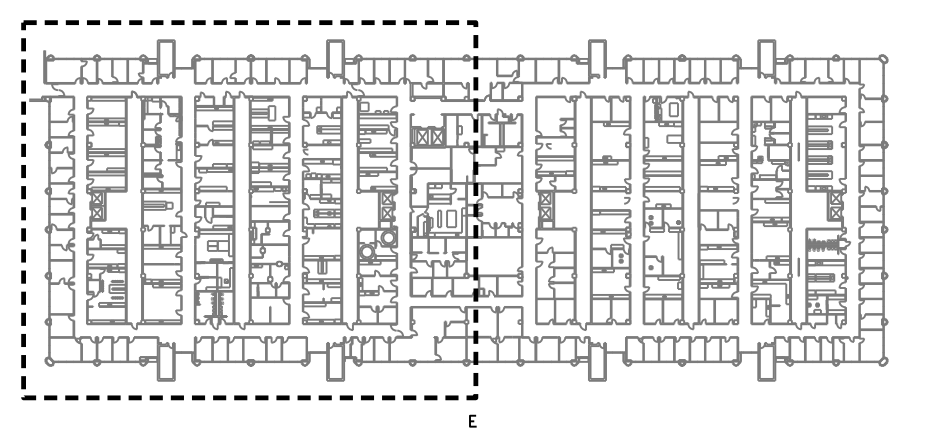


DRAWING NOTES:

- 1 REMOVE EXISTING STORM DRAIN PIPING FROM ROOF DRAIN AND ASSOCIATED HORIZONTAL OFF SET PIPING TO VERTICAL DOWNSPOUT PIPING. REPLACE WITH NEW HORIZONTAL STORM DRAIN PIPING AT THE SAME LOCATION AND CONNECT TO THE TOP OF THE EXISTING RISER.
- 2 NEW STORM DRAIN FROM NEW ROOF DRAIN, ROUTE NEW PIPING AS SHOWN AND CONNECT TO THE TOP OF THE EXISTING DOWNSPOUT.
- 3 ROUTE PIPING AT 1/4" PER FOOT SLOPE.
- 4 CONTRACTOR SHALL CONFIRM/FIELD VERIFY SANITARY SEWER ROUTING IS NOT CONNECTED TO THE STORM DRAIN SYSTEM.
- 5 REMOVE EXISTING BIO HAZARD VENT PIPING. FIELD VERIFY IF PIPE IS ABANDONED. IF ABANDONED, REMOVE IF NOT INFORM OWNER AND ENGINEER.

GENERAL NOTES:

- A. THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK. (TO CONFIRM FINAL SIZES AND LOCATIONS).
- B. MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINGS. ALTERNATE PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.





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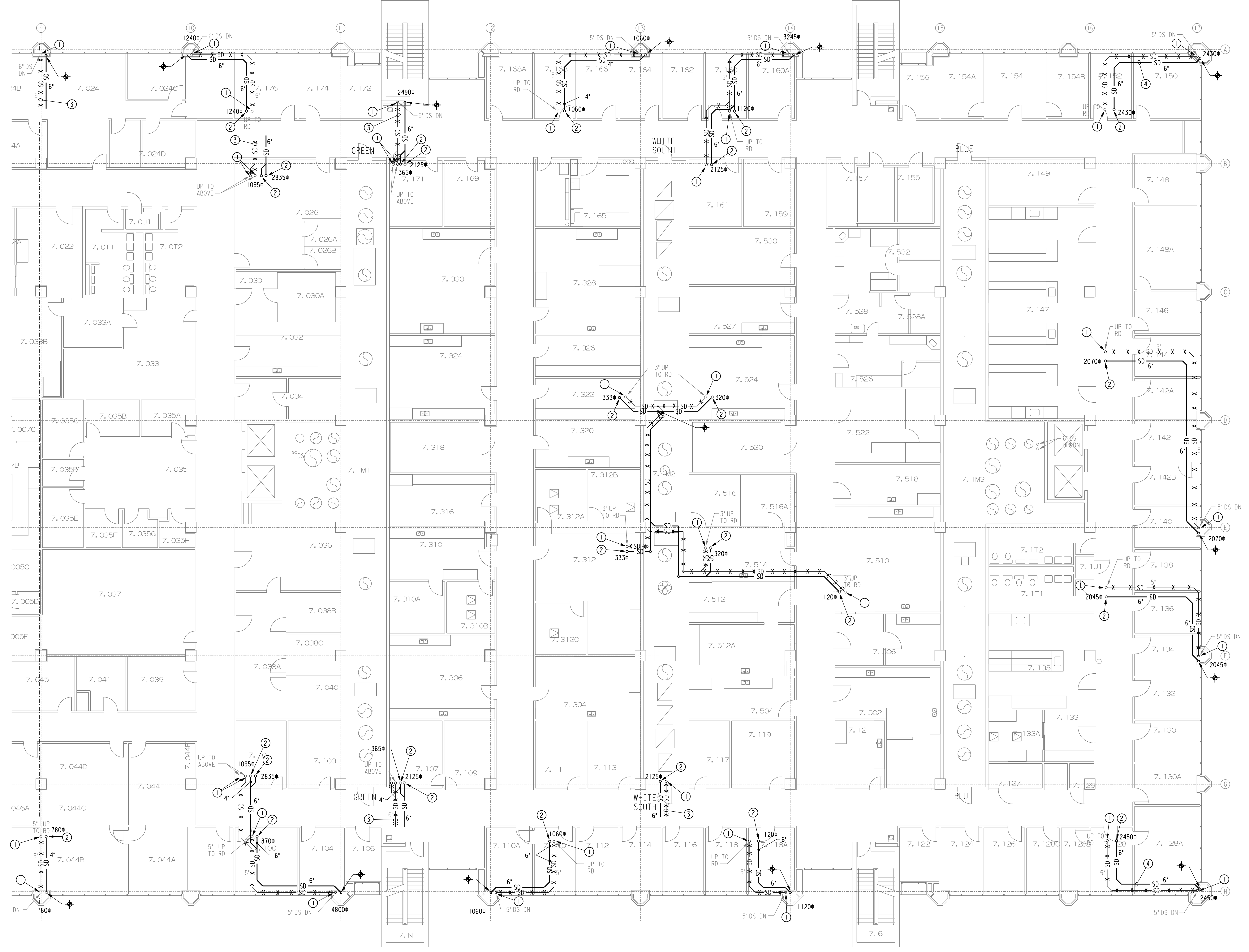
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MEDICAL SCHOOL BUILDING PLUMBING PIPING REPLACEMENT

6431 Fannin St.
Houston, Texas 77030

PLUMBING LEVEL 7 SOUTH

PROJECT NO. 3315.00	SHEET NO. P-207S
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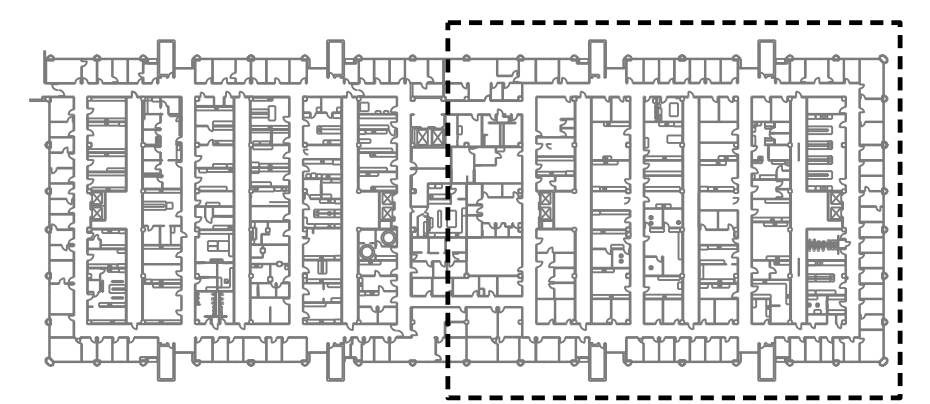


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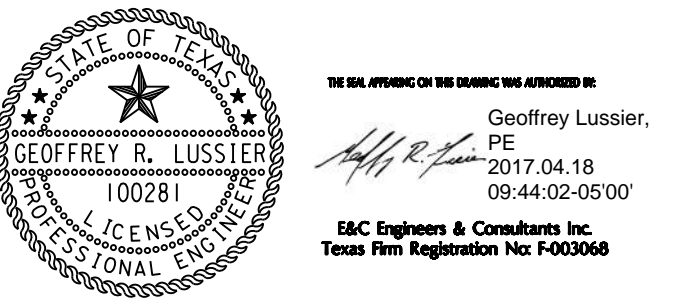
- ① REMOVE EXISTING STORM DRAIN PIPING FROM ROOF DRAIN AND ASSOCIATED HORIZONTAL OFF-SET PIPING TO VERTICAL DOWNSPOUT PIPING. REPLACE WITH NEW HORIZONTAL STORM DRAIN PIPING AT THE SAME LOCATION AND CONNECT TO THE TOP OF THE EXISTING RISER.
- ② NEW STORM DRAIN FROM NEW ROOF DRAIN.
- ③ CONTRACTOR SHALL FIELD VERIFY EXACT LOCATION OF EXISTING STORM DRAIN TO BE REPLACED.
- ④ INSTALL THIS PIPING AT A 1/4" PER FOOT SLOPE.

GENERAL NOTES:

- A. THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK, (TO CONFIRM FINAL SIZES AND LOCATIONS).
- B. MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINGS.
ALTERNATE PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.



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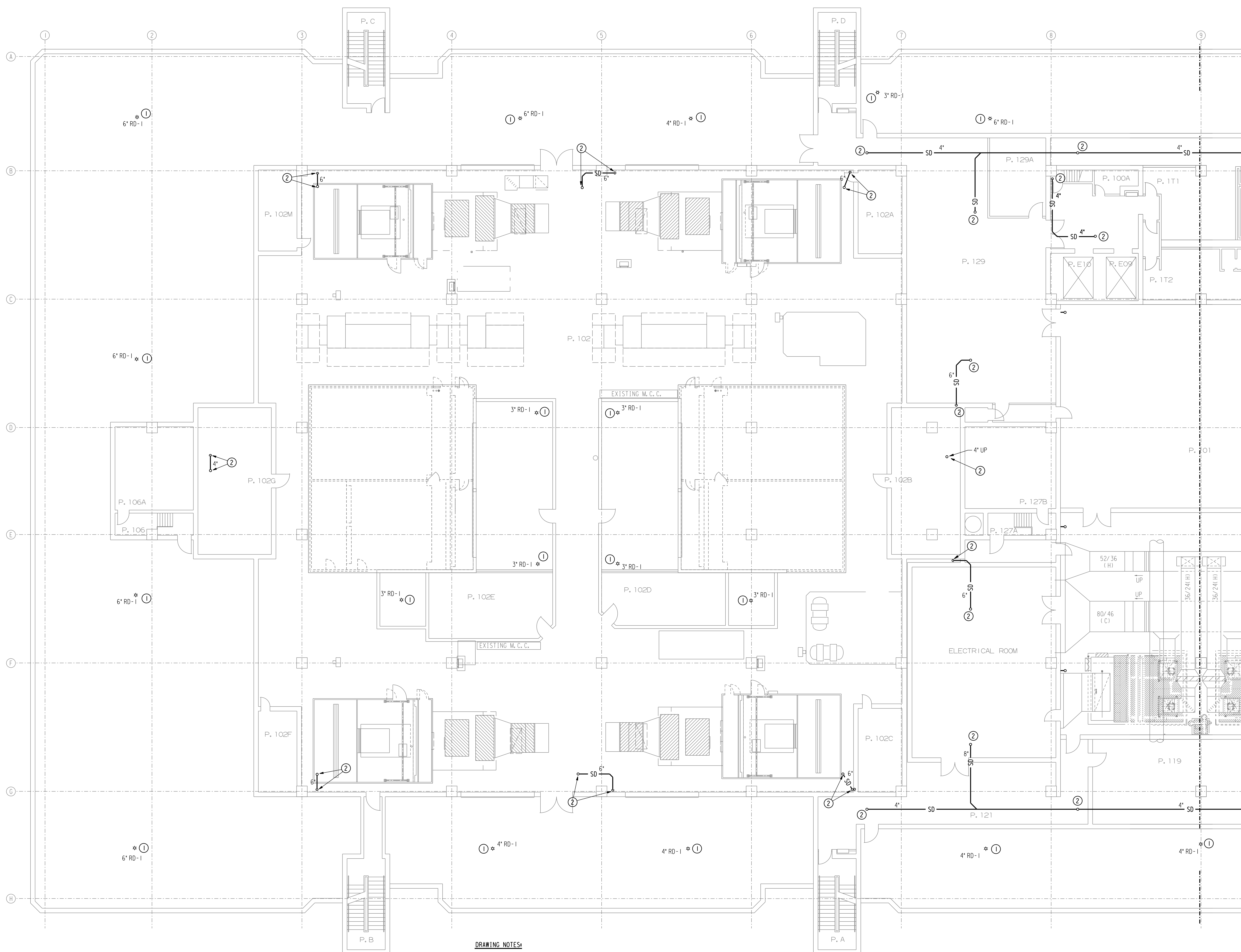
MEDICAL SCHOOL BUILDING PLUMBING PIPING REPLACEMENT

6431 Fannin St.
Houston, Texas 77030

PLUMBING PENTHOUSE NORTH

PROJECT NO.
3315.00

SHEET NO.
P-208N

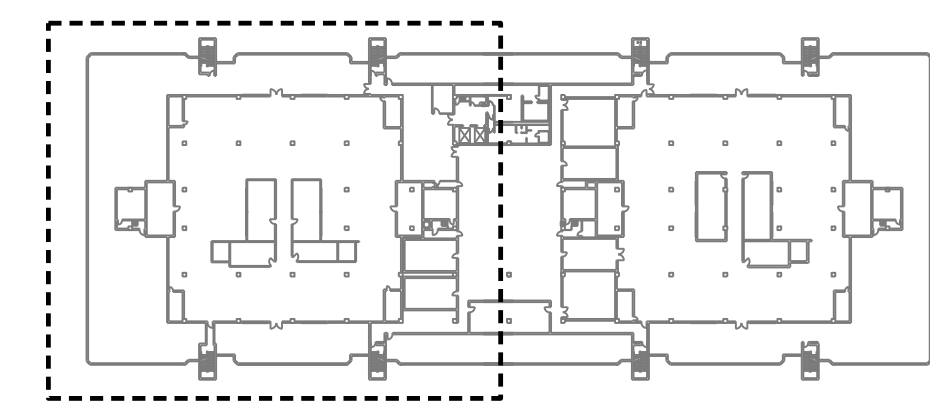


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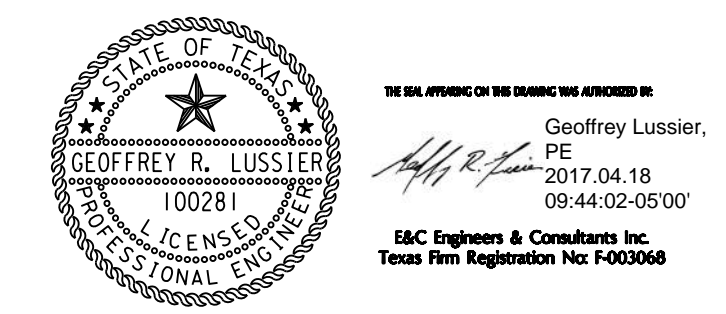
- 1 REMOVE EXISTING ROOF DRAIN AND PREPARE ROOF PENETRATION FOR NEW ROOF DRAIN. PROVIDE NEW ROOF DRAIN AS TAGGED AND SIZED ON THE PLAN.
- 2 REMOVE EXISTING STORM DRAIN PIPING FROM ROOF DRAIN, ASSOCIATED HORIZONTAL "OFF-SET" PIPING TO THE VERTICAL DOWNSPOUT PIPING. REPLACE WITH NEW STORM DRAIN PIPING AT THE SAME LOCATION OF THE SIZE NOTED AND CONNECT TO THE TOP OF THE EXISTING RISER.

GENERAL NOTES:

- A. THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK.
- B. MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINGS. ALTERNATE: PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.



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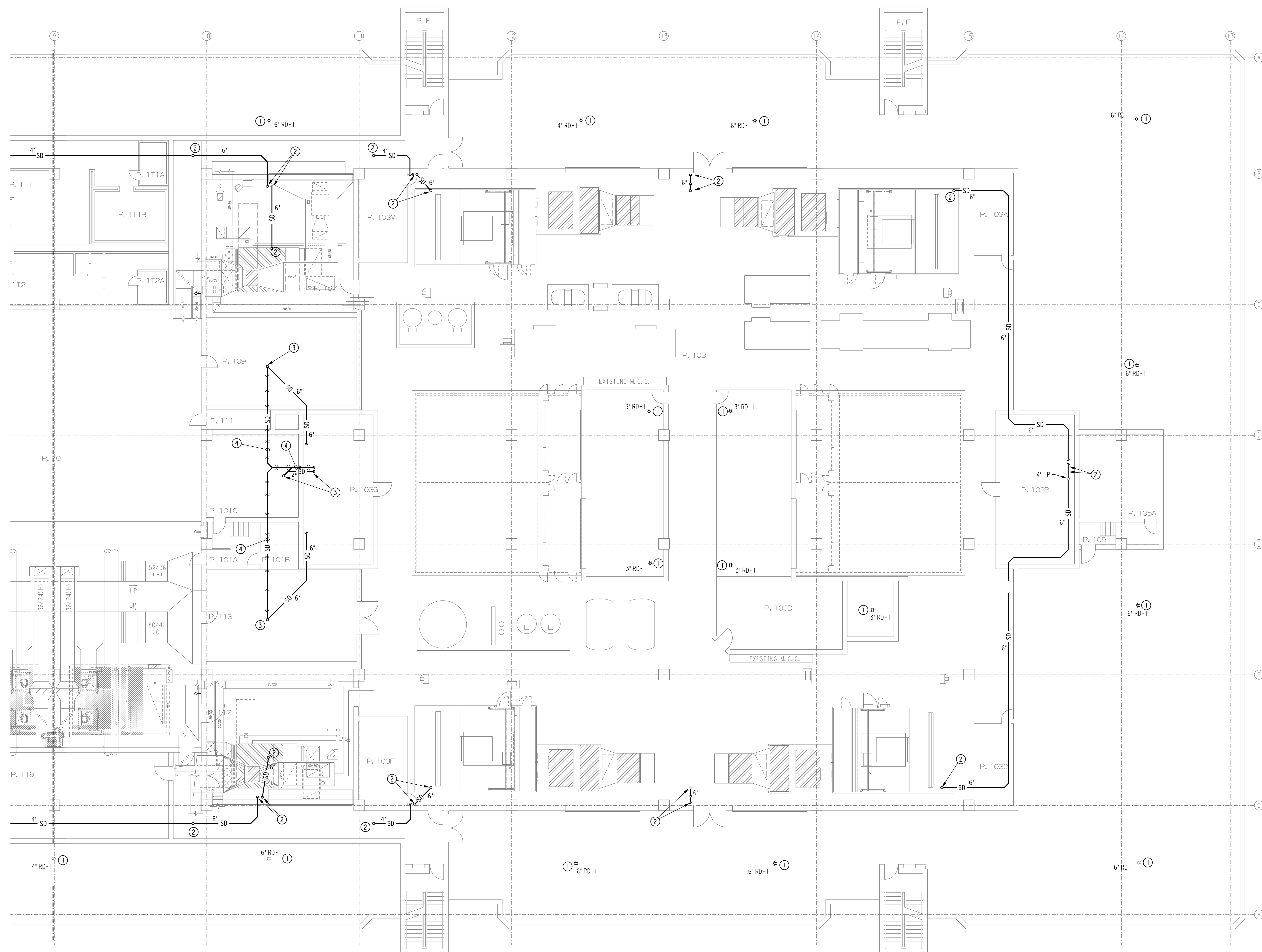
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MEDICAL SCHOOL BUILDING PLUMBING PIPING REPLACEMENT

6431 Fannin St.
Houston, Texas 77030

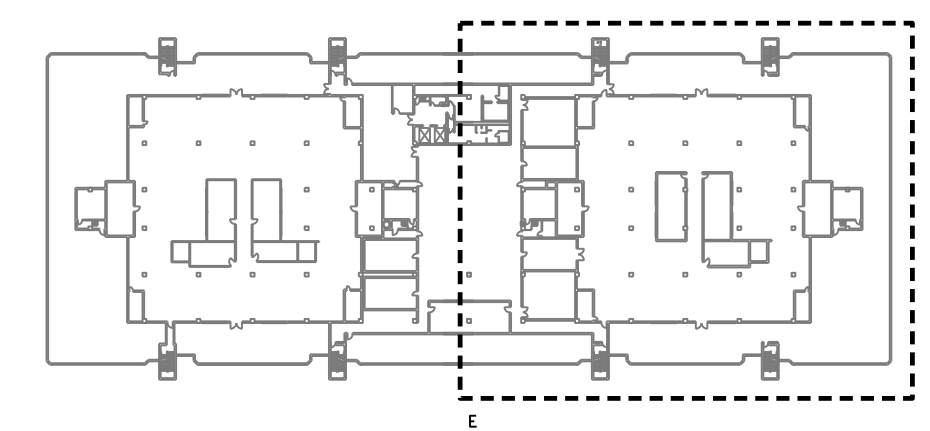
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PROJECT NO. 3315.00	SHEET NO. P-208S
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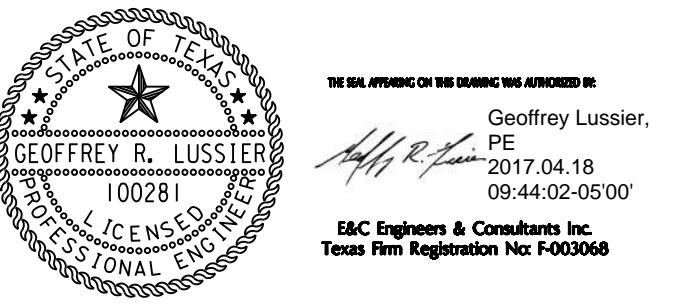


- DRAWING NOTES:**
- REMOVE EXISTING ROOF DRAIN AND PREPARE ROOF PENETRATION FOR NEW ROOF DRAIN. PROVIDE NEW ROOF DRAIN AS TAGGED AND SIZED ON THE PLAN.
 - REMOVE EXISTING STORM DRAIN PIPING FROM ROOF DRAIN. ASSOCIATED HORIZONTAL "OFF-SET" PIPING TO THE VERTICAL DOWNSPOUT PIPING. REPLACE WITH NEW STORM DRAIN PIPING AT THE SAME LOCATION OF THE SIZE NOTED AND CONNECT TO THE TOP OF THE EXISTING RISER.
 - REMOVE EXISTING STORM DRAIN PIPING FROM ROOF DRAIN. ASSOCIATED HORIZONTAL "OFF-SET" PIPING TO THE VERTICAL DOWNSPOUT PIPING. REPLACE WITH NEW STORM DRAIN PIPING AND CONNECT TO THE TOP OF THE EXISTING RISER.
 - REMOVE EXISTING STORM DRAIN PIPING, ASSOCIATED HORIZONTAL "OFF-SET" PIPING AND VERTICAL DOWNSPOUT PIPING.

- GENERAL NOTES:**
- THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK.
 - MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINGS. ALTERNATE PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.



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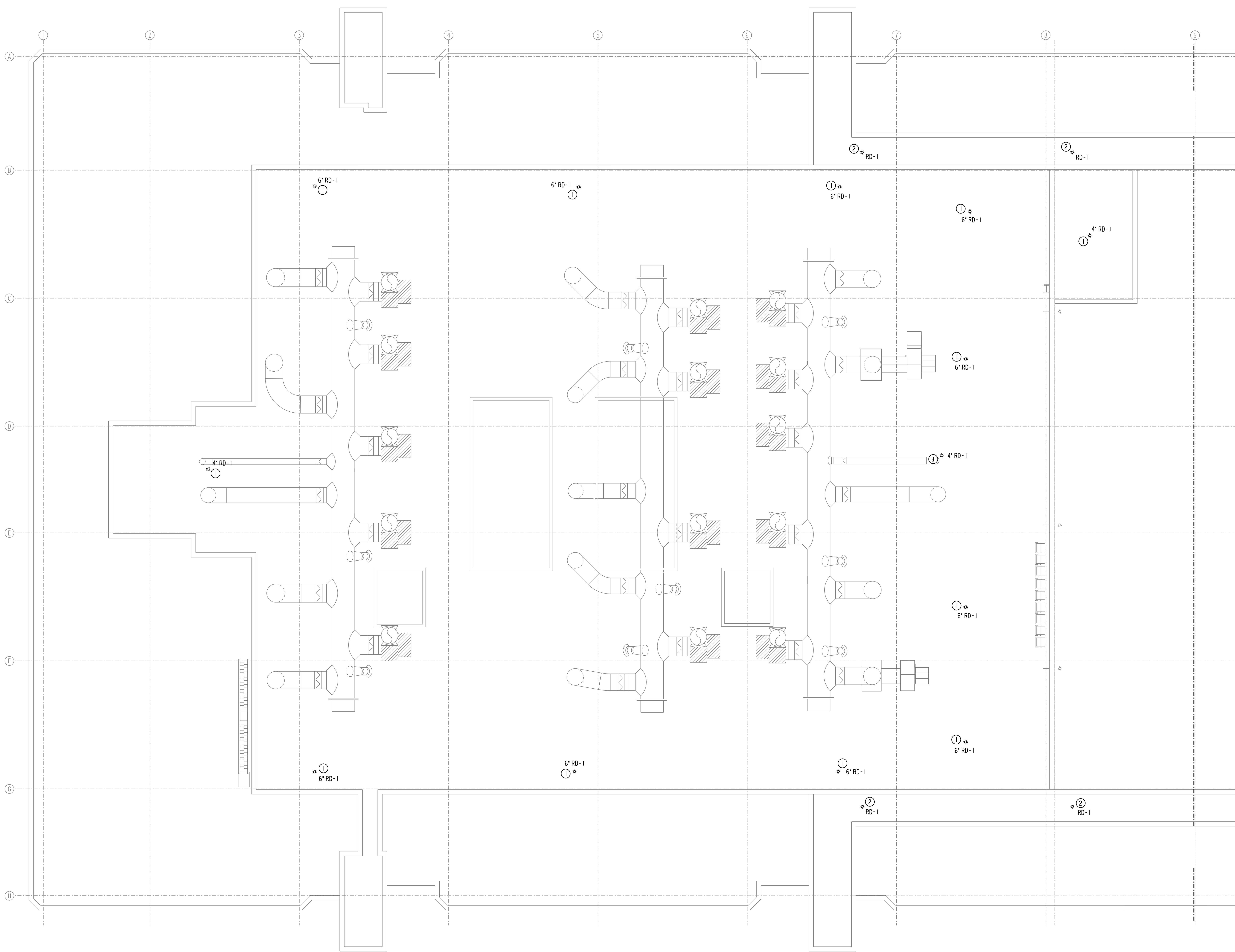
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**MEDICAL SCHOOL BUILDING
PLUMBING PIPING
REPLACEMENT**

6431 Fannin St.
Houston, Texas 77030

**PLUMBING
ROOF
NORTH**

PROJECT NO. 3315.00	SHEET NO. P-209N
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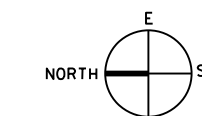
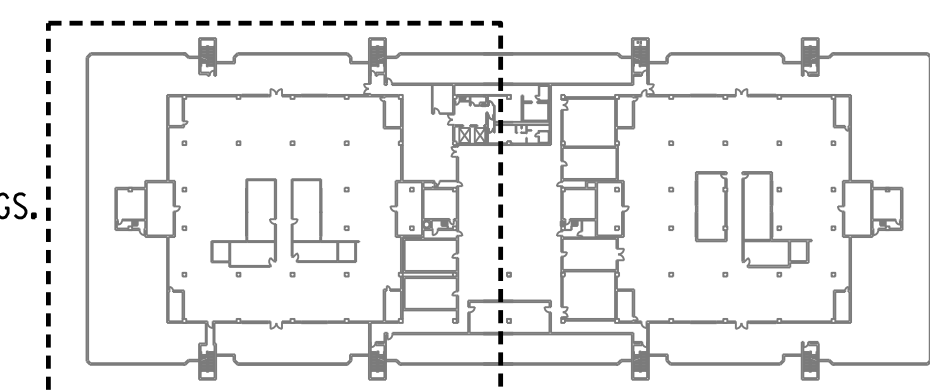


DRAWING NOTES:

- ① REMOVE EXISTING ROOF DRAIN AND PREPARE ROOF PENETRATION FOR NEW ROOF DRAIN. PROVIDE NEW ROOF DRAIN AS TAGGED AND SIZED ON THE PLAN.
- ② REMOVE EXISTING ROOF DRAIN AND PREPARE ROOF PENETRATION FOR NEW ROOF DRAIN. CONFIRM SIZE OF EXISTING DRAIN AND PROVIDE NEW DRAIN OF EQUAL SIZE.

GENERAL NOTES:

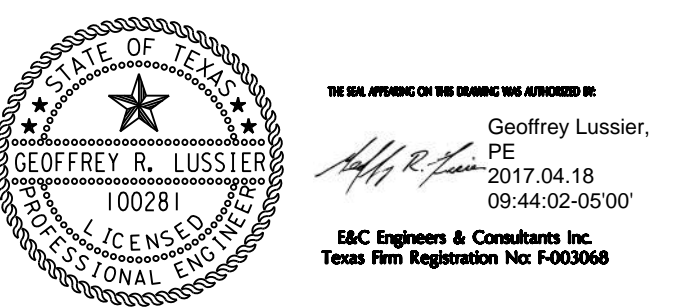
- A. THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK.
- B. MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINGS.
ALTERNATE PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.



E&C

Engineers & Consultants Inc.
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1010 Lamar, Suite 650
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Fax 713/580-8888
www.eceng.com



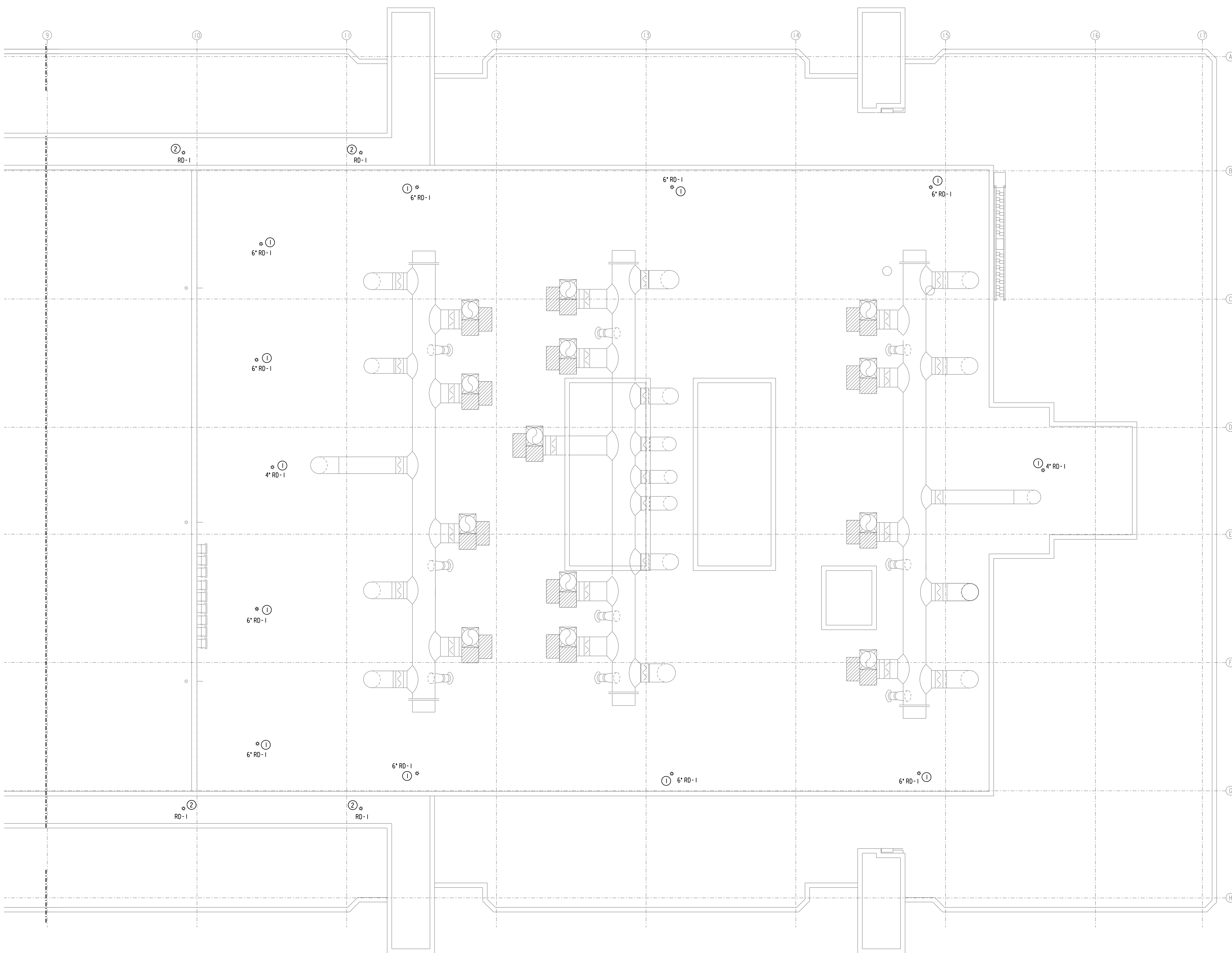
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NO.	DATE	DESCRIPTION
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MEDICAL SCHOOL BUILDING PLUMBING PIPING REPLACEMENT

6431 Fannin St.
Houston, Texas 77030

PLUMBING ROOF SOUTH

PROJECT NO. 3315.00	SHEET NO. P-209S
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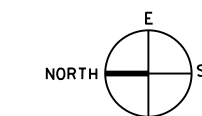
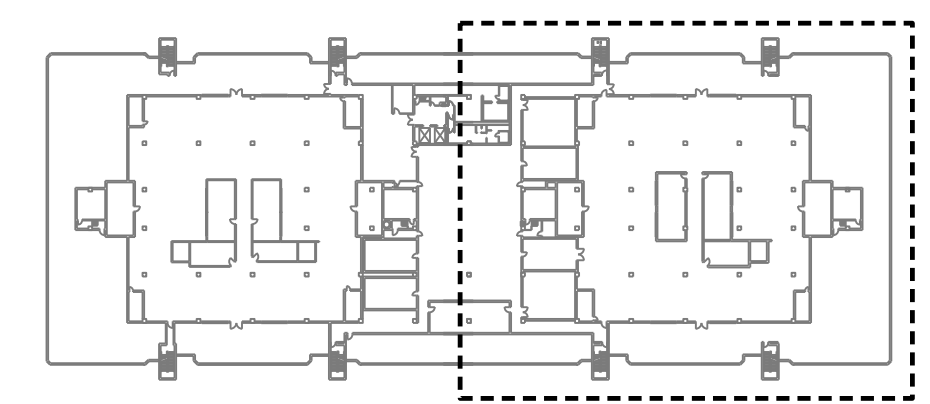


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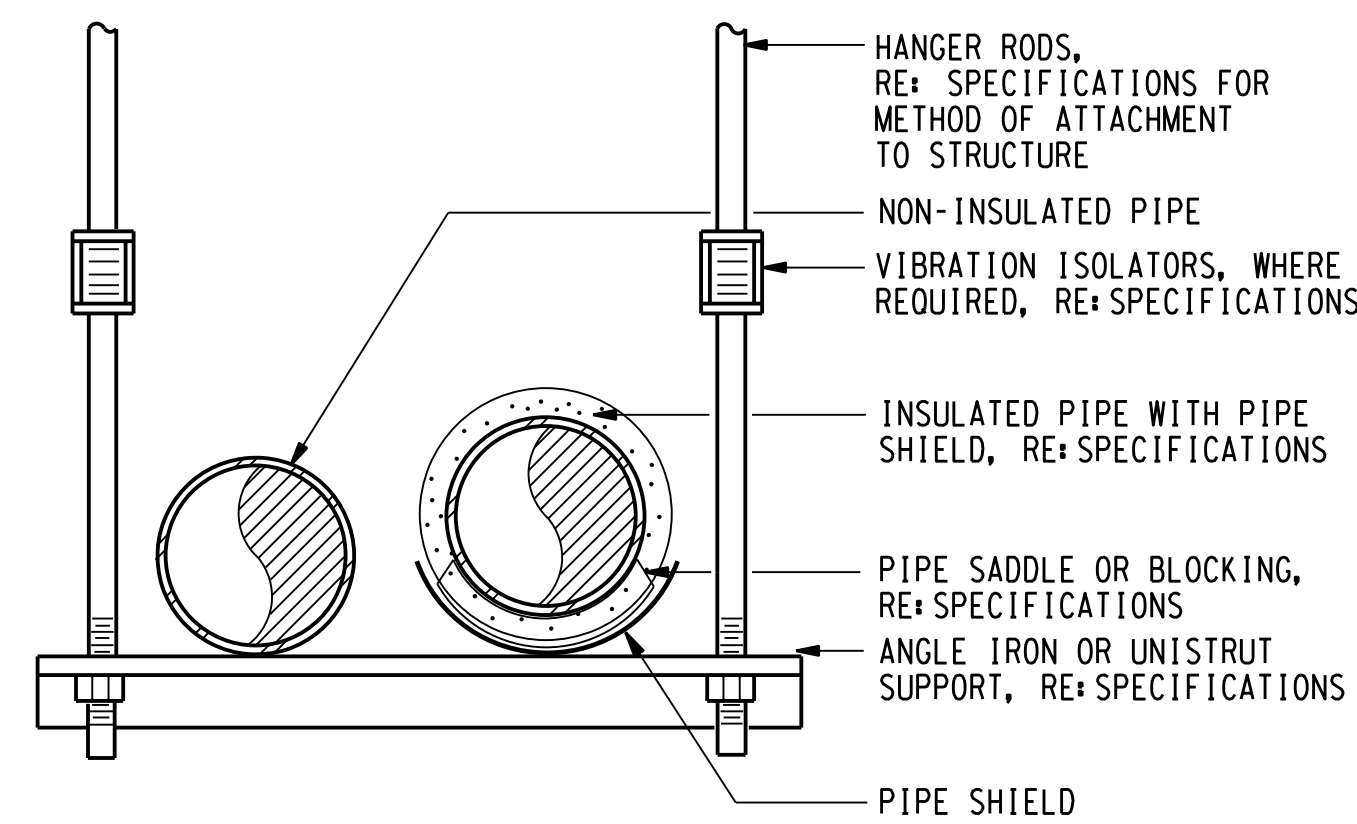
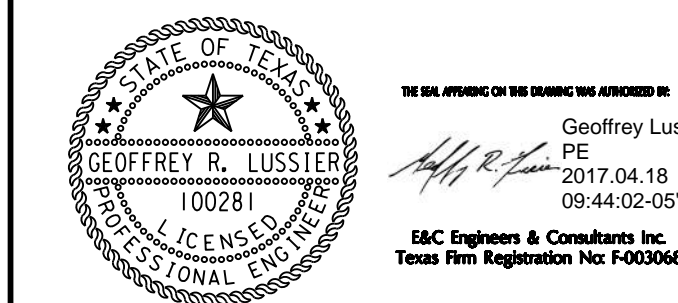
- ① REMOVE EXISTING ROOF DRAIN AND PREPARE ROOF PENETRATION FOR NEW ROOF DRAIN. PROVIDE NEW ROOF DRAIN AS TAGGED AND SIZED ON THE PLAN.
- ② REMOVE EXISTING ROOF DRAIN AND PREPARE ROOF PENETRATION FOR NEW ROOF DRAIN. CONFIRM SIZE OF EXISTING DRAIN AND PROVIDE NEW DRAIN OF EQUAL SIZE.

GENERAL NOTES:

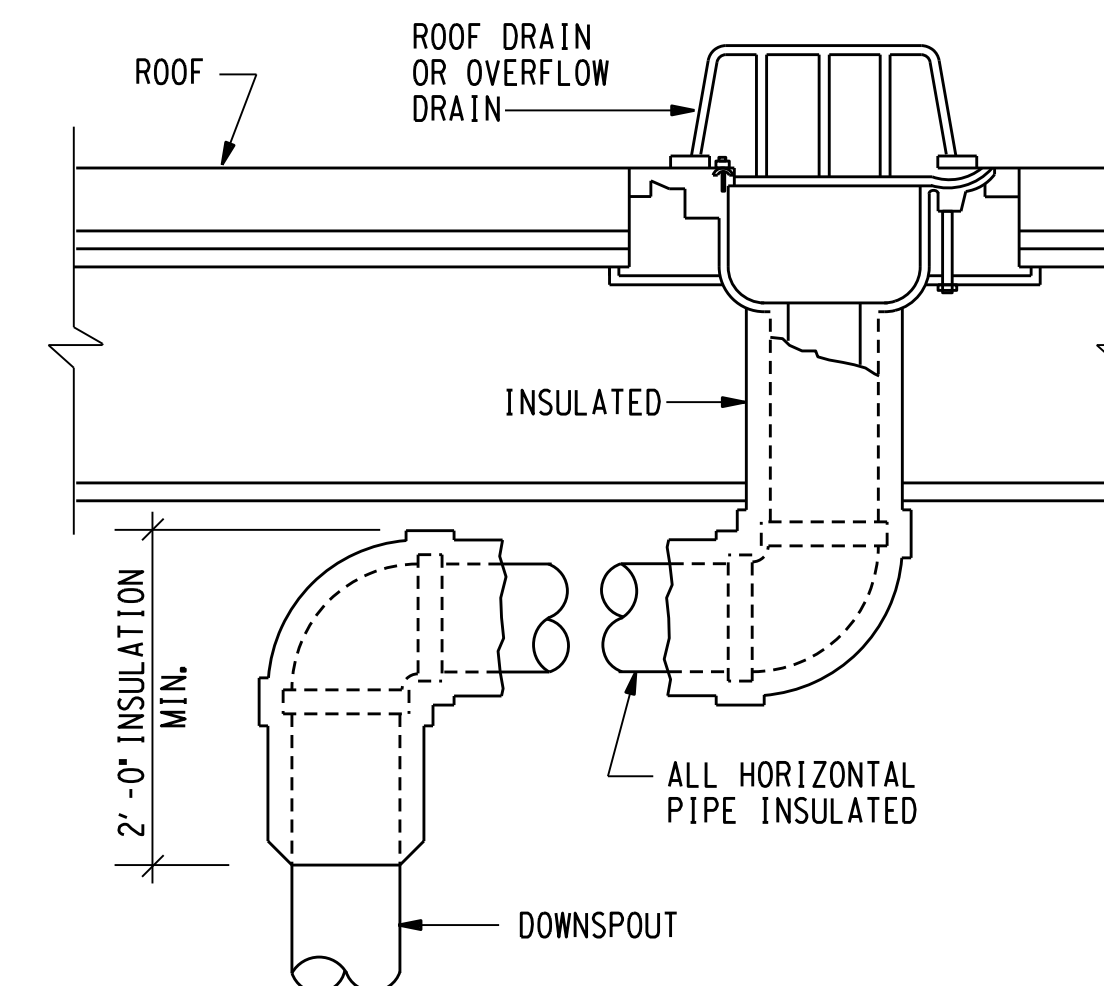
- A. THESE DOCUMENTS ARE BASED ON THE MOST RECENT DRAWINGS AND SITE SURVEYS. THE CONTRACTOR WILL HAVE TO PERFORM FIELD VERIFICATION BEFORE BEGINNING WORK.
- B. MATERIALS: BASE BID PROVIDE CAST IRON PIPING WITH NO HUB COUPLINGS. ALTERNATE PROVIDE CPVC PIPING AND FITTINGS WITH SOLVENT WELDED JOINTS.



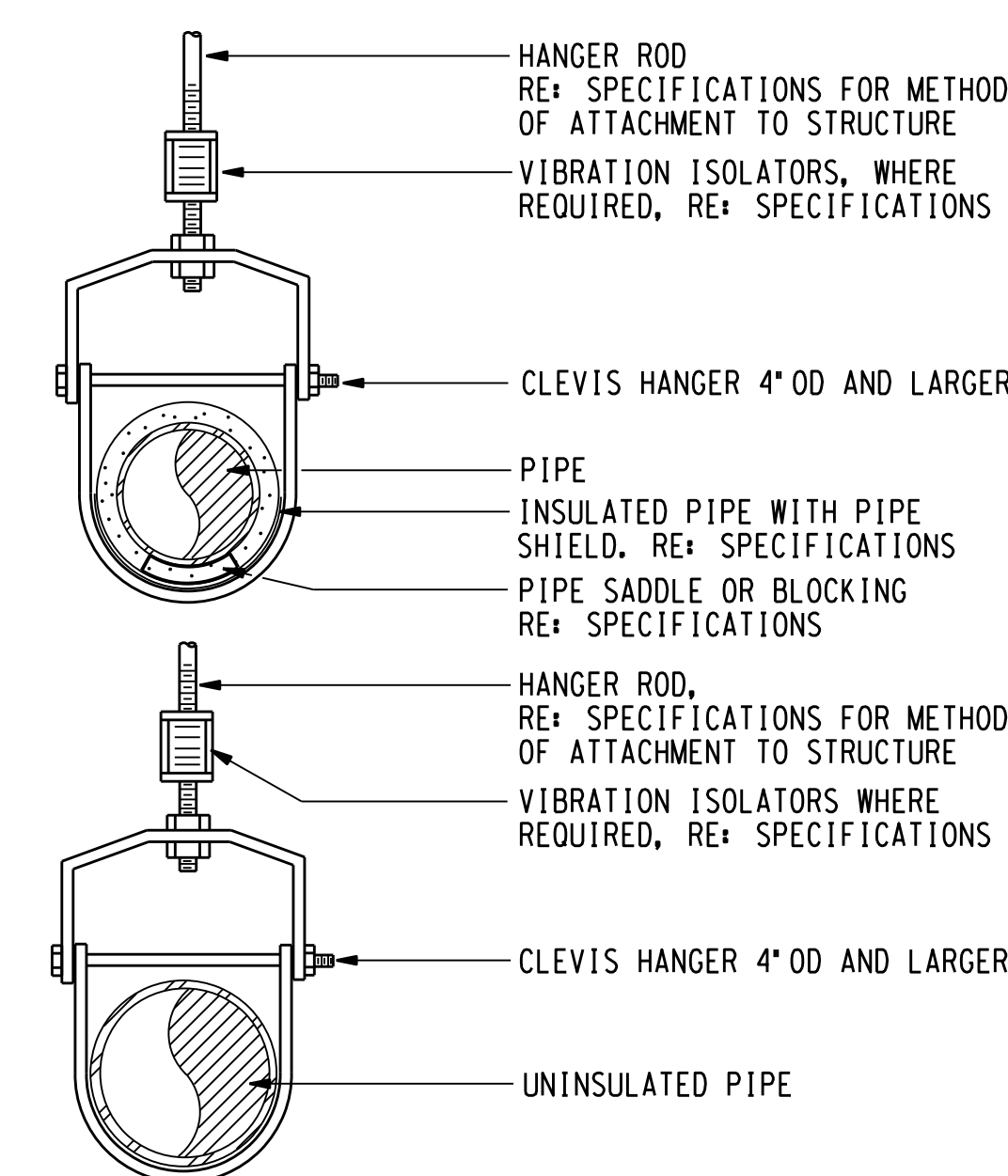
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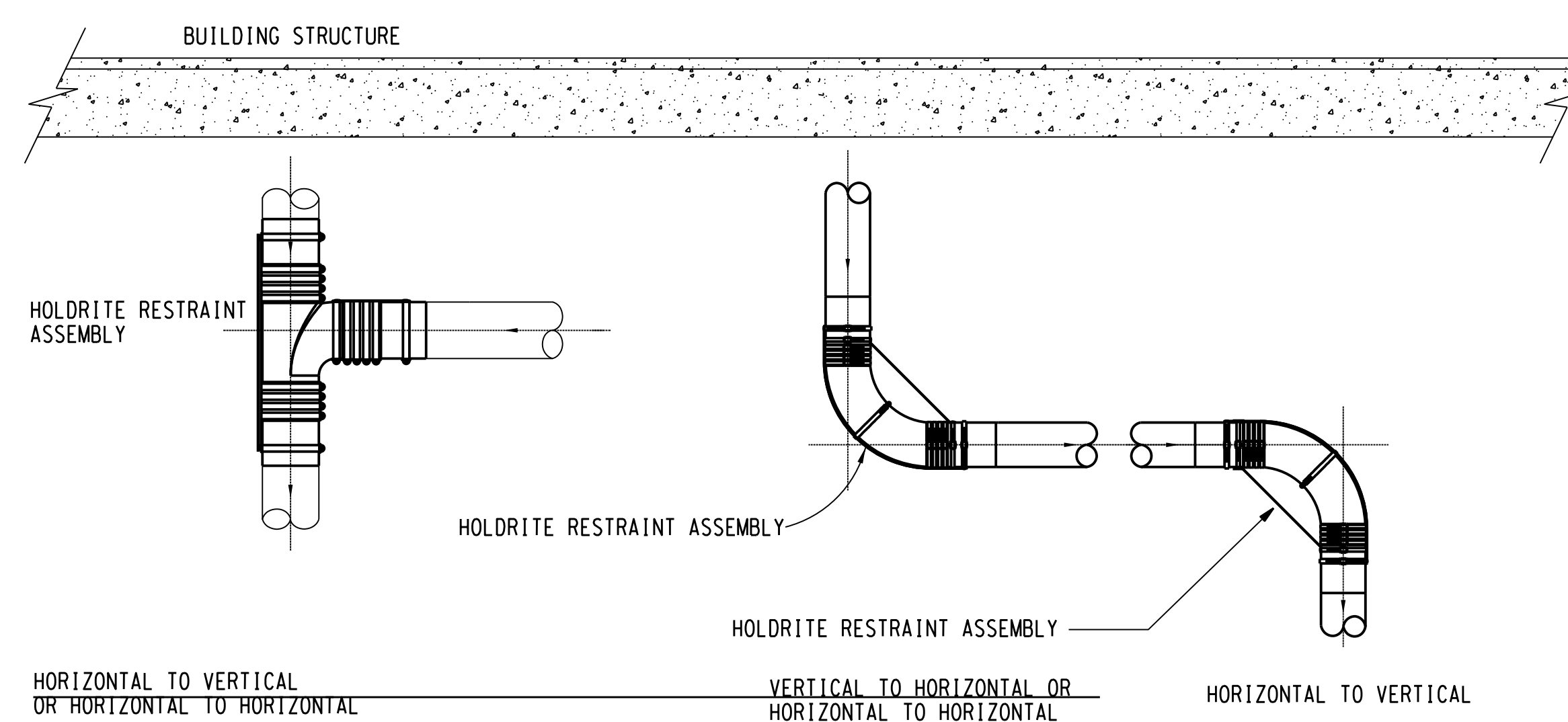
04 TYPICAL TRAPEZE TYPE
MULTIPLE PIPE HANGER
NOT TO SCALE



01 ROOF DRAIN DOWNSPOUT
NOT TO SCALE



02 TYPICAL SINGLE PIPE HANGER
NOT TO SCALE



GENERAL NOTES:

1. PROVIDE JOINT RESTRAINT ON ALL STORM DRAINAGE PIPING AND ON SANITARY SEWER AND/OR WASTE STACKS AND MAINS.
2. PROVIDE JOINT RESTRAINT ON ALL BELL AND SPIGOT AND NO-HUB CAST IRON PIPE AND FITTINGS.
3. IT IS ACCEPTABLE TO PROVIDE HOLDRITE SERIES #117 RESTRAINT KITS ON ALL NO-HUB JOINTS.

03 TYPICAL JOINT RESTRAINT DETAIL FOR
SANITARY, STORM PIPING 4" AND LARGER
NOT TO SCALE

ISSUE

NO.	DATE	DESCRIPTION
	04/18/2017	100%

**MEDICAL SCHOOL
BUILDING
PLUMBING PIPING
REPLACEMENT**

6431 Fannin St.
Houston, Texas 77030

**PLUMBING
DETAILS**

PROJECT NO.
3315.00

SHEET NO.
P-501

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TABLE OF CONTENTS

Section No. Title

DIVISION 22 – PLUMBING

22 00 00 Plumbing Piping Systems

DIVISION 23 – MECHANICAL

23 00 00 Basic Mechanical Requirements
23 05 29 Sleeves, Flashings, Supports and Anchors
23 05 53 Piping and Equipment Identification
23 07 19 Piping Insulation

END OF TABLE OF CONTENTS

E&C Engineers & Consultants, Inc.
TX Firm Registration No: F-003068
Date: 03-14-2018
Engineer of Record: Geoffrey Lussier
State: Texas
License no: 100281

SECTION 22 00 00

PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 00 00, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide complete operating plumbing piping systems including pipe, tube, fittings, and appurtenances as indicated and in compliance with these specifications. The work of this section may include, but not be limited to:

1. Securing and installing plumbing services for the building.
2. A complete domestic hot and cold water distribution system.
3. A complete sanitary soil waste and vent system.
4. A complete storm water piping system.
5. A complete acid waste and vent system.
6. A complete lab air piping system.
7. A complete lab vacuum piping system.
8. Miscellaneous plumbing piping, equipment and specialties required for a complete plumbing system upgrades as specified and included on the contract drawings.

- B. Plumbing Services: Secure all plumbing services necessary for the project as required or shown on the contract drawings, including paying all required fees and charges. Work related to plumbing services may be shown on Plumbing, Civil, Architectural or other drawings in the Contract Documents. Plumbing services include, but are not limited to:

1. Installing all drainage systems with the proper slope as required by code.

- C. Applications: Applications of piping systems include, but are not limited to, the systems as listed below:

<u>SYSTEM</u>	<u>WORKING PRESSURE</u>	<u>OPERATING TEMPERATURES</u>
Domestic Cold Water		
Low	150 psig	55°F to 80°F
Domestic Hot Water		
Low	150 psig	90°F to 120°F
Make-Up Water		
Low	150 psig	55°F to 80°F
Lab Air	100 psig	--
Lab Vacuum	-19" hg	--
Condensate Drainage	--	40°F to 60°F
Sanitary Drainage	--	--
Storm Drainage	--	--
Pressures	Low	Floors 1 through 6.

- D. Basic Materials and Methods: Refer to Section 23 00 00 for additional plumbing piping system requirements.
- E. Valves and Accessories: Refer to this section for additional plumbing piping system components.
- F. Vibration Isolation: Refer to Section 23 05 48, "Vibration Isolation", for piping system isolation.
- G. Insulation: Refer to Section 23 07 00, "System Insulation", for piping system insulation.

1.3 QUALITY ASSURANCE:

- A. Welding: Qualify welding procedures, welders, and operators in accordance with ANSI B31.1, Paragraph 127.5, for shop and job site welding of piping work. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall project inside the pipe. Refer to Section 23 00 00 for additional requirements.
- B. UPC Listing: All materials, fixtures or devices used or entering into the construction of the plumbing system shall be listed for UPC or shall conform to Alternate Standards recognized as "equal" by the City Officials having jurisdiction.
- C. All materials, distribution and utilization equipment is to be UL listed.
- D. All equipment and material is to be new, unused and manufactured in the United States.
- E. A record shall be kept of all permits and inspections submitted to the Master Plumber. A record and/or list of all equipment and devices with their locations (approved room number) will be provided to the owner upon completion.
- F. Cast Iron Pipe Manufacturers: Cast iron pipe shall be as manufactured by Tyler Pipe or Charlotte Pipe and shall bear the CI mark indicating compliance with the CISPI quality assurance and inspection program.
- G. Grooved Systems: To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be of the same manufacturer as the grooved components.

1.4 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets marked to clearly indicate all plumbing piping system materials.
 - 2. Piping fabrication drawings for all main piping runs including connections to existing piping. Fabrication drawings shall include plan views and suitable elevations and shall include all accessories and equipment.
 - 3. Additional items as required in Section 23 00 00.
 - 4. Grooved joint couplings and fittings shall be shown on drawings and product materials, and be specifically identified with the applicable Victaulic style or series number.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver components in factory-fabricated water resistant packaging, as applicable.
- B. Handle components carefully to avoid damages to components, enclosures, and finish.
- C. Store components in a clean, dry space, and protect from weather.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS:

- A. **General:** Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.
1. **Steel Pipe:** ASTM A53 or ASTM A106 black or hot-dipped galvanized as specified. Piping shall be domestically manufactured by one of the manufacturers listed in the latest edition of the American Petroleum Institute (API) approved manufacturers listing.
 2. **Copper Tube:** ASTM B88, Types "K", Type "L", or Type "M" copper water tube as defined by the Copper and Brass Research Association.
 3. **Ductile Iron Pipe:** ANSI A21.51, Class 350 with bell and spigot ends for push-on joints.
 4. **Cast Iron Soil Pipe:** ASTM A74, most current edition.
 5. **Hubless Cast Iron Soil Pipe:** CISPI 301, most current edition.
 6. **Polyvinyl Chloride (PVC) Drainage Pipe:** Underground drainage piping is acceptable to be installed as schedule 40, ASTM D1785, ASTM D 2665 and ASTM F 480 with bell ends and pre-inserted gasket joints.
 7. **Chlorinated Polyvinyl Chloride (CPVC) Drainage Pipe:** Schedule 40 pipe and fittings per ASTM D 638.

2.2 PIPE/TUBE FITTINGS:

- A. **General:** Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing regulations, industry standards, and where applicable, with pipe manufacturer's instructions for selections.
1. **Cast Iron Flanged Fittings:** ANSI B16.1, Class 125 or Class 250, black or galvanized as specified, including bolting and gasketing.
 2. **Cast Iron Threaded Fittings:** ANSI B16.4 or ASTM A126, Class 125 or Class 250, black or galvanized as specified.
 3. **Malleable Iron Threaded Fittings:** ANSI B16.3, Class 150 or Class 300, black or galvanized as specified.
 4. **Malleable Iron Threaded Unions:** ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
 5. **Threaded Pipe Plugs:** ANSI B16.14.
 6. **Steel Flanges/Fittings:** ANSI B16.5, including bolting, gasketing, and butt weld end connections.
 7. **Forged Steel Socket-welding and Threaded Fittings:** ANSI B16.11, rated to match schedule of connected pipe.
 8. **Wrought Steel Butt-welding Fittings:** ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
 9. **Cast Iron Drainage Fittings:** ANSI B16.22 galvanized, recessed fittings with pitched threaded ends.

10. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1/2". Do not thread nipples full length (no all-thread nipples).
 11. Wrought Copper/Bronze Solder-joint Fittings: ANSI B16.22 suitable for working pressure up to 250 psig.
 12. Hubless Cast Iron Pipe Fittings: CISPI 301, most current edition, and comply with governing regulations.
 13. Cast Iron Soil Pipe Fittings: ASTM A74, most current edition.
 14. Compression Gaskets: ASTM C1563 for gasket testing and ASTM C564 for elastomeric compound.
 15. Standard Grooved End Fittings: ASTM A234 forged steel or ASTM A53 fabricated carbon steel, or ASTM A536 ductile iron fittings joined with Victaulic Style 77 or Style 07 couplings and Grade "E" gaskets on steel systems. On copper systems, ASTM B-75 alloy C12200 or sand casting B-584-87 alloy CDA 844 (81-3-7-9) with Style 606 coupling.
 16. Flanged Fittings: Comply with ANSI B16.15 for bolt-hole dimensioning, materials, and flange-thickness.
 17. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.
 18. Flange Bolt Thread Lubricant: Lubricant shall be an antiseize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
 19. Mechanical Joints for Cast Iron and Ductile Iron Pipe: AWWA/ANSI 21.11 with appropriate gaskets, nuts and bolts.
 20. Polyvinyl Chloride (PVC) Fittings: ASTM D2665, Carlon, Vylon "Z" high strength sewer fittings.
 21. Chlorinated Polyvinyl Chloride (CPVC) Drainage Pipe: Schedule 40 drainage pattern fittings meeting the requirements of ASTM D 3311 and any specialty pattern fittings according to the manufacturer's specifications.
- B. Miscellaneous Piping Materials/Products:
1. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section II, Part C, for welding materials.
 2. Brazing Materials: American Welding Society, AWS A5.B, Classification BCup-5.
 3. Gaskets for Flanged Joints: 1/16" thick for all pipe size 10" and smaller and 1/8" thick for all pipe size 12" and larger. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed nonasbestos or equal.
 4. Insulating (Dielectric) Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Clearflow" waterway as made by Victaulic, or isolating gaskets with bolt and washer kits as made by Pipeline Seal and Insulator Company or Equal as made by Watts Manufacturing Co., Inc. and shall have nylon insulation.
 5. Gaskets for Cast Iron Soil Pipe: ASTM C564, neoprene, compression-type.

6. Push-on-joints: ANSI A21.11, rubber compression-type, "Tyton Joint" as manufactured by U.S. Pipe or equal. (for use with ductile iron pipe)
7. Hubless Cast Iron Joints: Heavy duty couplings: Clamp all 125, Husky SD4000.
8. Solder: All solder used for sweating of water piping joints shall be 95/5 tin-antimony or tin-silver. All solder used for sweating of natural gas piping joints shall be phosphorous-free, non-lead bearing silver brazing solder with a melting point in excess of 1000°F.
9. Threadsealing Tape: Threadsealing tape used for plumbing piping applications shall be stretched or nonstretched teflon tape.
10. Solvent Cement: The joining method for the CPVC piping shall be a "one-step" process with primerless type CPVC cement designated by the system manufacturer.

2.3 DOMESTIC WATER VALVES: (INCLUDING COLD, HOT WATER, COMPRESSED AIR AND VACUUM)

- A. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacturer, etc.
- B. Line Shut-Off Valves up to and including 2.5" shall be two-piece bronze body of ASTM B584 Alloy 844, ASTM B61, or ASTM B62, full port ball type rated at 600 WOG with threaded connections, blow-out proof stem, plastic coated lockable lever handle, Teflon packing, 316 stainless steel ball and stem. Acceptable valves are NIBCO Model T-585-70-66-LL-LF, or approved equivalent model by Crane, Milwaukee or Apollo.
- C. Line Shut-Off Valves 2-1/2" and larger where system operating pressure will not exceed 160 p.s.i.g. shall be 200 WOG threaded lug type
- D. Line Shut-Off Valves 2-1/2" and larger installed within systems having design operating pressures between 160 and 250 p.s.i.g. shall be threaded lug type
- E. Line Shut-Off Valves 2-1/2" and larger installed in roll grooved copper systems may be 300 psi roll grooved end type bronze body
- F. Provide stem extensions of a non-thermal conducting material for valves in insulated lines to allow unobstructed operation.
- G. Provide memory stops on all ball valves installed in domestic hot water return lines. Memory stops shall be adjustable after pipe insulation is applied.
- H. Provide line shut-off valves that have the same inside diameter of the upstream pipe in which they are installed.
- I. Domestic Hot Water Return Circuit Balancing Valves 1/2" through 3" shall be machined ball type calibrated balancing valve with lead free ASTM B283-C69300 Brass body/304 Stainless Steel ball construction, glass and carbon filled TFE seat rings, EPDM stem "O" ring, threaded NPT inlet/outlet connections, 400 psig maximum working pressure at 250°F. Valve shall have differential pressure read-out ports across valve seat area fitted with internal EPT inserts/check valves. Valve body shall have 1/4" NPT tapped drain/purge port. Valve shall have calibrated nameplate and memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. Valve shall contain less than 0.25% lead content by weight on wetted surfaces and be designed for positive shut-off.. Valves shall be same size as the pipe installed. Provide valves as scheduled on Contract Drawings manufactured by Bell & Gossett Circuit Setter Plus CB series, or Owner approved equal.

- J. Swing Check Valves, 2" and smaller - "Y" or "T" pattern bronze, Class 150, with threaded connections and screw-in cap. Manufactured by NIBCO Model T-433-Y or approved equivalent model by Milwaukee or Crane.
- K. Spring Loaded Check Valves, 2" and smaller - Silent closing, bronze, Class 125, with threaded connections, Buna disc, bronze or stainless steel spring. Manufactured by NIBCO Model T-480 or approved equivalent model by Milwaukee or Crane.
- L. Swing Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-918-B or approved equivalent model by Milwaukee or Crane.
- M. Swing Check Valves, 2-1/2" and larger - 285 pound CWP, Iron body, with stainless steel trim. Manufactured by NIBCO Model F-938-33 or approved equivalent model by Milwaukee or Crane.
- N. Spring Loaded Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-910 or approved equivalent model by Milwaukee or Crane.
- O. Spring Loaded Check Valves, 2-1/2" and larger - 400 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-960 or approved equivalent model by Milwaukee or Crane.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION:

A. General:

1. Industry Practices: Install pipe, tube, and fittings in accordance with recognized industry practices which will achieve permanently leak proof piping systems, capable of performing each indicated service without failure or degradation of service. Install each run with a minimum of joints and couplings, but with adequate and accessible unions or flanged connections to permit disassembly for maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connections, within 1/16" misalignment tolerance. Coordinate piping locations with other trades to avoid conflict. Give ductwork preference unless directed otherwise by the Engineer.
2. Systems: Install piping parallel or perpendicular to lines of building, true to line and grade, and with sufficient hangers to prevent sags between hangers. Provide fittings at changes in direction. Piping in finished areas shall be concealed, except in mechanical rooms. Where pipes of different sizes join, provide reducing elbows, tees, or couplings. Bushings will not be acceptable.
3. Expansion and Contraction: Install loops, offsets, sizing joints, and expansion joints, as necessary, to avoid strain resulting from expansion and contraction of piping systems on fixtures and equipment.
 - a. Expansion Loops and Offsets: Provide expansion loops and offsets in piping systems for not less than one inch (1") expansion or contraction per 100' of pipe. Use Victaulic style 75 or 77 flexible type couplings on expansion loops in accordance with the latest Victaulic recommendations for expansion compensation.
 - b. Mechanical Grooved Couplings: Provide mechanical grooved connections equal to Victaulic style 75 or 77 where indicated on the Drawings and Specifications to reduce vibration at equipment connections. Provide expansion joints in piping systems by mechanical grooved connections where specifically indicated on the Drawings. Expansion joints shall be of one of the following types:

1. Packless, gasketed slip-type expansion joint grooved end telescoping body for installation with Victaulic style 07 rigid type couplings, providing axial end movement up to 3". Victaulic style 150 Mover.
 2. combination of Victaulic style 77 or 75 flexible type couplings and short nipples joined in tandem for increased expansion. Joined movement and expansion capabilities determined by the number and style of couplings/nipples used in the joint. Victaulic series 155.
 4. Pipe Grading: Install domestic water piping to pitch down in the direction of flow for drainage. Grade storm, soil, and waste piping at 1/4" per foot whenever possible, and not in any case less than 1/8" per foot for pipe sizes 4" and larger, unless shown otherwise on the Drawings. Grade vent piping at 1/4" per foot whenever possible, and not in any case less than 1/8" per foot toward vents. Grade gas piping at a minimum of 1/8" per foot toward condensation traps at connected equipment.
- B. Steel Pipe: Ream steel pipe after cutting and before threading. Thread with clean-cut taper threads of length to engage all threads in fittings and leave no full-cut threads exposed after make-up. Use John Crane or approved equal teflon thread tape applied only to male threads to make-up joints.
- C. Copper Pipe: Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth, No. 00 cleaning pads or wire brush. No acids shall be used to clean either pipe or fittings or as a flux in sweating joints. The use of drilled T connections is not permitted.
- D. CPVC and PVC Pipe: Cut pipe square and remove all burrs. Clean fitting and pipe butt prior to installation. Install all piping in accordance with the manufacturer's recommendations. Underground installation of piping shall be in compliance with ASTM D2321.
- E. Final Connections to Equipment Furnished by Owner or Under Other Divisions of These Specifications: Where Drawings show equipment to be furnished under other Divisions of these Specifications or by the Owner, such equipment will be delivered to the site, uncrated, assembled, and set in-place under those other Divisions of these Specifications or under the separate contracts. Any required automatic control valves shall also be provided under those other Divisions of these Specifications or other separate contracts. Make all final connections of chilled water, hot water, condenser water, gas, domestic water, waste, and vent as shown. Provide valves, unions, strainers, check valves, and traps as required for proper operation of systems and equipment. Equipment not shown or noted on the piping drawings shall not be included in the scope of this requirement.
- F. Pipe Fabrication Drawings:
1. Pipe fabrication drawings shall be submitted for all piping in the Mechanical Rooms, Penthouse and for Equipment connections and all other areas requiring coordination with other trades.
 2. Pipe fabrication drawings shall be double line drawings to scale on 1/4" scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, system type, insulation, support requirements, pipe elevations and other information required for coordination with other trades and fabrication of pipings.
 3. Pipe fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval. Refer to Section 23 01 00 for additional shop drawing requirements.
- G. Basic Materials and Methods: Refer to Section 23 03 00 for additional requirements related to plumbing piping.
- 3.2 PLUMBING SERVICES:
- A. General: Install the various piping systems as described and as required by the local plumbing inspection department.

1. Slope domestic hot and cold water piping to drain and provide with hose valves (drain valves) at low points. Branch taps shall be made from the top of the piping main.
2. Install soil, waste, and vent piping with horizontal lines pitched in accordance with local codes, but in no case less than 1/4" per foot for pipe 3" and smaller and 1/8" per foot for pipe 4" and larger. Install soil, waste, and vent piping with hubs of each length of piping in the upstream position.
3. Make-up "Ty-Seal" or "Charlotte Seal" or "Quick-tite"(extra heavy) gasketed joints using lubrication and joining tools as instructed by the manufacturers. Base of stacks, horizontal runs under pressure, and gasketed pipe 5" and larger shall be made up using "Tyler Lubrifast" joining material. Horizontal joints, 5" and larger, shall be restrained.
4. Torque "No-Hub" joints in accordance with manufacturer's instructions. Do not install "No-Hub" joints below ground.
5. Provide chrome-plated piping at each fixture installed in a finished space. Install with proper strap wrenches to avoid marking or defacing.
6. Provide proper restraints on riser and stack offsets.

3.3 MAKE-UP WATER PIPING SYSTEMS:

- A. General: Provide necessary pipe and fittings. Make final connections to provide cold water make-up and natural gas supply to mechanical equipment. Locate cold water make-up and gas supply where shown and connect with suitable stop valves, check valves and bypass valves as applicable.
- B. Connections: Connect domestic water to automatic fill and manual quick-fill connections on each HVAC piping system and as shown on Drawings. Provide reduced pressure backflow preventers at each system.
- C. Compatibility: Use piping and fittings of same material type as materials of the domestic water supply.

3.4 DOMESTIC HOT AND COLD WATER PIPING SYSTEMS:

- A. Interior Hot and Cold Water Piping:
 1. Piping 3" and smaller, Type "L" copper tubing hard drawn joined using non-lead bearing solder, such as 95-5 silver or antimony solder (95% tin and 5% silver or antimony).
 2. Piping 4" and larger, Schedule 40, galvanized steel pipe, ASTM A53 with galvanized malleable iron fittings, or galvanized cast iron flanged fittings.
 3. Provide isolation fitting whenever dissimilar materials are used.
 4. Option: At the Contractor's option with the owner's approval, for galvanized steel piping 4" and larger, a grooved piping connection system with "cut-grooves" may be used. Grooved couplings shall be Victaulic Style 75 or 77 flexible type with Grade "E" synthetic rubber gaskets. Rigid couplings shall be used at valves and in other areas where piping system rigidity is required and shall be Victaulic Style 07 Zero-Flex couplings with Grade "E" gaskets syntahetic rubber gaskets. Taps to mains shall be made using Victaulic Style 72 or Style 920/920N hot dip galvanized outlet couplings or fittings or Gruvlok Fig. 7045/7046 hot dip galvanized outlet couplings or fittings. Mechanical "T" couplings with U-bolts shall not be permitted. Flange connections shall be made using Victaulic Style 741 or 743 flanges with Grade "E" synthetic rubber gaskets. Fittings for elbows, tees, reducers, etc. shall be Victaulic or Gruvlok hot dip galvanized full flow fittings. All grooved piping connection materials shall be utilized with the manufacturer's recommended groove cutting tool. All grooved piping couplings and fittings used in association with an individual coupling or fitting shall be by the same manufacturer. The use of boltless couplings, reducing couplings and Mechanical "T" fittings with U-bolts is prohibited. All wetted surfaces in the piping system

shall be hot dip galvanized and all proposed grooved piping connection materials shall be suitable for domestic water use at the temperatures and pressures at the point of application. Painted couplings may be used where they meet the above requirements. Grooved reducing couplings shall not be installed.

- B. Piping Runouts to Fixtures: Provide piping run outs to fixtures sized to comply with governing regulations. Where not otherwise indicated, provide run outs sized to comply with the following: lavatories - 1/2" hot, 1/2" cold; water closet flush valves - one and one half inch (1-1/2") cold; urinal flush valves - three-quarter inch (3/4") cold; drinking fountains - 1/2" cold. Provide each fixture with a shut-off valve for each supply line. All exposed lines shall be chromium-plated.
- C. Air Chambers:
1. Riser Shock Arrestors: At the top of each main hot and cold water riser, provide a properly sized Wade Shoktrol or approved equal sealed air chamber.
 2. Fixture Shock Arrestors: At each hot and cold water supply pipe at each fixture, provide a properly sized Wade Shoktrol or approved equal.

3.5 STORM AND SANITARY DRAINAGE SYSTEM:

- A. Vertical Waste and Vent Stacks Above Grade: All above grade waste and vent piping is to be service weight no hub cast iron pipe and fittings with coupling type connectors. Elastomeric gaskets shall be installed using gasket lubricant. All horizontal stack offsets and elbows (4" and larger) shall be joint-strapped and supported with the properly sized restraint assembly as manufactured by the Holdrite Company.
- B. Horizontal Fixture, Waste and Vent Piping Above Grade: Connect to the vertical stack with "No-Hub" cast iron soil pipe and fittings assembled with Stainless Steel No-Hub Coupling Assemblies.
- C. Building Storm Piping Above Grade: All above grade storm drainage piping is to be service weight no hub cast iron pipe and fittings with coupling type connectors. Elastomeric gaskets shall be installed using an approved gasket lubricant. All horizontal stack offsets and all elbows shall be joint-strapped and supported with the properly sized restraint assembly as manufactured by the Holdrite Company.
1. Alternate Above Grade Storm Piping: Alternate Storm drainage piping system shall be manufactured from CPVC Type IV, ASTM Cell Classification 23447. All pipe, fittings and solvent cement shall be manufactured in accordance with ASTM F 2618 and certified by NSF International. All pipe and molded fittings shall be CAN/ULC S102.2 listed for surface burning characteristics with a flame spread of less than 25 and a smoke development of less than 50 as designated on the original package labeling for fittings and on the pipe print string marking. All pipe markings shall be accompanied by a yellow stripe for identification of CPVC chemical waste system. All fittings shall be CPVC drainage patterns meeting the requirements of ASTM D 3311 and specialty patterns according to the manufacture's specifications. Joining method for pipe and fittings shall be solvent cement welding. Solvent cement shall be a "one-Step" primer less type CPVC cement designated by the system manufacture, specially formulated for resistance to corrosive chemicals and manufactures in accordance with ASTM F 493, as specified in ASTM F 2618. All pipe, fittings, and cement shall be supplied together as a complete system. Installation shall be in accordance with the manufacture's instructions and all applicable codes.
 2. Acceptable Manufacturers: Charlotte Pipe, Spears and Ipex.
- D. Insulation: All condensate drains and related piping, roof drain and overflow roof drain bodies and horizontal runs of storm drainage piping within the occupied spaces of the building, shall be insulated as specified in Section 23 07 00.

E. Cleanouts:

1. Locations:

- a. At base of every drainage stack.
- b. Upper terminal of each horizontal drainage pipe.
- c. Each 90' length of horizontal straight run of drainage piping on the exterior, each 50' length of horizontal straight run of drainage piping in the interior.
- d. Where shown on Drawings.
- e. As required by local code.

2. Size: Cleanouts shall be line size for piping up to 4" and 4" size for piping larger than 4".

3. Access: Provide access doors for access to cleanouts installed in concealed locations.

F. Fixture Connections:

1. Water Closets: Galvanized castable nipples.

2. Urinals: Copper or cast iron nipples with suitable adapters.

3. Lavatories: Copper or cast iron nipples with suitable adapters.

4. Service Sinks: Brass or cast iron nipples with suitable adapters.

5. Drinking Fountains: Copper or cast iron nipples with suitable adapters.

3.6 CONDENSATE DRAINAGE:

A. General: Provide a condensate drain pipe to connect each cooling unit drain pan and secondary drain pan to extend to and discharge into an open-type drain in the plumbing system.

B. Assembly: Use Schedule 40, galvanized steel pipe made up with Class 125, galvanized, threaded fittings. Assemble fittings to form a trap with depth equal to or greater than operating pressure of the unit served. Drains shall be of the sizes indicated, but not less than the full size of the drain pan connection. Air handling unit drains shall have deep seal traps to permit unit pan drainage. Install a deep seal trap for each blow-through or draw-through air handling unit to maintain the water seal.

3.7 CHASE AND WALL PIPING SUPPORTS:

A. All piping whether sanitary or water shall be rigidly installed in all chases or walls. Test for rigidity shall be that the piping is virtually immovable by hand short of deforming the piping. Valve, stop and fixture penetrations thru chase or fixture mounting walls shall be firmly supported from just inside the wall or chase prior to penetration to the room-side of the chase or wall.

B. Support inside the chase or wall for Sanitary Waste and Vent Piping shall be accomplished by utilizing fixture carrier bolt-downs, "Uni-Strut" or similar structural bracing system, "U-bolts", nuts and lock-washers, all bolted to the floor and to the piping system.

C. Support for Water Piping or other similar service piping shall be accomplished by using a "system" designed for that purpose. An approved system shall consist of preformed steel supports which shall be installed between studs or joists and preformed nonmetallic pipe holder inserts which are designed to rigidly support or hold the piping to the steel supports.

D. In no case shall Sanitary Sewer Waste or Vent Piping depend on blocks, brick, stone or wood sleepers for its final support. In no case shall Water Piping or similar service piping depend on its final support on "tie-wires", soldering or brazing to metal studs or joists, copper tube soldered to risers and tied to joists or any other method which does not have the written approval of the Engineer. Piping improperly supported shall have improper supports promptly removed and

replaced with specified supports at the direction of the Engineer at no additional cost to the Owner and/or Architect/Engineer.

E. Support system shall be as manufactured by "Holdrite" or an approved equal.

3.8 CLEANING, FLUSHING, TESTING AND INSPECTING:

A. Cleaning: Clean exterior surfaces of installed piping systems and prepare surface for application of any required coatings.

B. Piping Tests:

1. General: Blank off equipment during tests. Perform tests before piping is enclosed in walls, floors, partitions or in any other way concealed from view. Tests may be performed in sections. Tests shall be witnessed by the Engineer or Owner's Representative and local inspectors and results presented to the Engineer for acceptance and approval prior to concealing piping from view. Provide all necessary equipment for testing, including pumps and gauges. Refer to Section 23 01 00 for additional requirements
2. Test Results: After all tests are completed a written test report. The report is to include the date and time of the test, whether or not the system passed and a summary of the remedial work required to fix the system, then the date and time of the re-test.
3. Domestic Water Systems: Test hot and cold water systems hydrostatically to a pressure of 150 psig or 1-1/2 times working pressure, whichever is greater, for a period of 24 hours. Repair all leaks, replacing materials as necessary, and repeat tests until systems are proven tight.
4. Soil, Waste and Vent Piping System: Test soil, waste, and vent piping by plugging all openings and filling system to height required by the owner's representative, but not less than 10' above the level of the pipe being tested, for a minimum of 3 hours. Inspect all joints for leaks, repair all leaks found, and retest until piping is demonstrated to be free from leaks as evidenced by no perceptible lowering of the water level after 3 hours. In addition to water test, apply peppermint or smoke tests, if required by local code.
5. Storm Drainage Piping System: Test storm drainage piping same as specified for Soil, Waste, and Vent Piping System. Refer to the contract drawings for more information.
6. Sump Pump and Sewage Ejector Discharge Piping: Test sump pump and sewage ejector piping same as specified for domestic water systems.
7. Flushing: Flush water piping systems with clean water following successful testing.
8. Fire Protection Piping: Test the fire protection piping system hydrostatically to a pressure of 200 psig for a period of 2 hours. Repair all leaks, replacing materials as necessary, and repeat tests until systems are proven tight.
9. All drain lines; storm drain, sanitary sewer, condensate, etc... shall be flow tested prior to the contractor obtaining notice of substantial completion.

C. Disinfection of Water Systems: Disinfect hot and cold water systems as follows: Fill systems with water solution containing 50 ppm available chlorine; allow to stand for 8 hours, opening and closing all valves several times during this period; thoroughly flush; refill and place system in service; ensure a residual chlorine content of 0.2 ppm. Refer to Section 23 03 00 for additional requirements.

D. Cleaning and Adjusting: Thoroughly clean and disinfect all plumbing fixtures, including all exposed trim. Adjust all flush valves for proper flushing, but without excess use of water. Demonstrate to the Engineer that the entire plumbing system and all its components are functioning properly.

- E. Inspecting: Visually inspect each run of each system for completion of joints, adequate hangers, supports, and inclusion of accessories and appurtenances.
- F. Grooved Piping Installation: Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by Victaulic. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.9 IDENTIFICATION:

- A. Refer to Section 23 03 00 for applicable painting, nameplates, and labeling requirements.

END OF SECTION 22 00 00

SECTION 23 00 00

BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic Mechanical Requirements specifically applicable to Division 23 Sections.

1.02 RELATED DOCUMENTS:

- A. 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 Plumbing 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. 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.
- B. 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.

1.07 SUBMITTALS

- A. Refer to Uniform General Conditions Article 8.
- B. Proposed Products List: Include Products specified in all the contract documents to include drawings and specifications.
- 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.

1.08 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.
- 1.09 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.
- 1.10 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.
- 1.11 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
 17. 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 – 2012.
- S. Ventilation Standard – ASHRAE 62.1 – 2012.
- 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.

1.12 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. In accordance with OSHA 1910.212.
 - 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.
- 1.13 WALL, FLOOR AND CEILING PLATES:
- A. See Section 23 05 29.
- 1.14 SLEEVES, INSERTS, AND FASTENINGS:
- A. See Section 23 05 29.
- 1.15 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.
- 1.16 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.
- 1.17 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.

1.18 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.

1.19 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.

1.20 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.

1.21 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.

1.22 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.

1.23 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.

1.24 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

1.25 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.

1.26 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.

1.27 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.
- D. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer.
- 1.28 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.
- 1.29 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.
- 1.30 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.

1.31 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.

1.32 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.

1.33 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. Jacketing on insulation shall not be painted.
- E. 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.
- F. 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.
- G. 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.
- H. 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:

<u>Service</u>	<u>Testing</u>		
	<u>Testing Medium</u>	<u>Pressure (PSIG)</u>	<u>Time in Hours</u>
Domestic Hot & Cold Water	Water	150	24
Sanitary Piping	Water	Fill to top	24

- 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.

END OF SECTION

SECTION 23 05 29

SLEEVES, FLASHINGS, SUPPORTS AND ANCHORS

PART 1 GENERAL

- 1.01 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
- 1.02 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
- 1.03 RELATED SECTIONS
- A. Section 23 00 00 - Basic Mechanical Requirements
 - B. Section 22 62 21 - Laboratory Vacuum Pump Systems
- 1.04 1.05 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 SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer
 - G. MSS SP69 - 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
- 1.05 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.
- 1.06 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
- 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 through utility tunnels and below buildings 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. 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.
- T. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

- U. 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.
- V. 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. 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.
 - 1) Power-actuated fasteners (shooting) will not be acceptable under any circumstances.
 - 2) Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.
- W. 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.
- X. 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.

- Y. Ductwork: All ductwork shall be supported in accordance with the SMACNA recommendation for the service involved; however, all horizontal ductwork shall be supported at intervals not to exceed the scheduled values indicated elsewhere in this section. Horizontal ducts shall be supported using galvanized steel bands extending up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete bolted to angles secured to the construction above, or secured in another approved manner. For attaching methods for precast double tee structural concrete, refer to details on the Drawings and as specified herein.
 - Z. Terminal units shall be supported by four 16 gauge, 1" wide sheet metal straps with ends turned under bottom of box at corners. Each band shall be secured by not over 3/4" in length, 1/4" diameter sheet metal screws - two on bottom of box and one on side. The other strap end shall be attached to the structure by 1/4" diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor. Where interferences occur, overhead of the box, not allowing direct vertical support by straps, provide trapezes of Kindorf, Unistrut, or B-Line channel suspended by 1/4" diameter galvanized threaded rods providing such channels do not block access panels of boxes. Threaded rods shall be supported from structure by concrete insert or by drilled-hole threaded concrete expansion anchor.
 - 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.
- 2.02 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.
- 2.03 CONCRETE FOUNDATIONS ("Housekeeping Pads"):
- A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

2.04 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.

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. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating. Repair any damaged galvanized plating with a coating of 'Galvalum'.
- L. 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 PIPE SUPPORT SCHEDULES

STEEL PIPE SIZE	MAX. HANGER SPACING	HANGER ROD DIAMETER
<u>Inches</u>	<u>Feet</u>	<u>Inches</u>
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), <u>and at all Joints</u>	5	5/8
Glass, <u>and at all Joints</u>	4	1/2

END OF SECTION

SECTION 23 05 53
PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. Perform all Work required to provide and install Owner's equipment tags, fire damper tags, valve tags, stencils, and pipe markers indicated by the Contract Documents with supplementary items necessary for proper installation.
- B. Contractor shall make it possible for Owner's operations and maintenance personnel to readily identify the various pieces of equipment, valves, piping, ductwork, fire dampers etc., by marking them in accordance with this Specification.

1.03 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.
 - 2. NFPA 99 – Standard for Health Care Facilities.
 - 3. NFPA 13 – Installation of Sprinkler Systems.
 - 4. NFPA 14 – Installation of standpipe and Hose Systems.
 - 5. International Plumbing Code.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Provide manufacturer's catalog literature for each product.
- B. Record Documents:
 - 1. Submit Equipment Matrix with Valve and Fire Damper schedules completed..xlsx

C. Operation and Maintenance Data:

1. Manufacturer's Installation Instructions: Indicate special procedures and installation.

PART 2 - PRODUCTS

2.01 GENERAL

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

2.02 MANUFACTURERS

A. Equipment Tags, Valve Tags, and Markers:

1. Marking Systems, Inc.
2. Seton Name Plate Company.
3. W.H. Brady Company.
4. Graphic Products, Inc.

2.03 PIPE AND DUCT MARKERS

- A. Round Pipe and Duct Markers shall conform to ANSI A13.1-2007 "Scheme for the Identification of Piping Systems", refer to Attachment "A" for abbreviation and label color designations. Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
- B. Rectangular Duct Stencils shall conform to ANSI A13.1-2007 "Scheme for the Identification of Piping Systems", refer to Attachment "B" for abbreviation and label color designations. Letter height shall be a minimum of 1-1/4". Stencil material shall be fiber board; Stencil paint shall be exterior, gloss, acrylic enamel. The following rectangular duct systems shall be stenciled:
 1. Chemical Fume Hood Exhaust.
 2. Biosafety Cabinet Exhaust.
 3. Radioisotope Exhaust.
 4. ETO Exhaust.
- 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: Heat sealed or heat shrink, spring fasteners, clips or snap-on are acceptable.
- E. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- F. All medical gas piping shall have minimum information per NFPA 99, plus operating pressure.
- G. Pipe markers and arrow markers also shall be provided for all piping systems.

- H. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, up through 6 inch. For piping systems larger than 6 inches, use Seton or Brady strap-on markers or similar by Marking Services, Inc.

2.04 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

- A. Description: 3/4" x variable length" vinyl label, 3.0 Mil self-adhesive vinyl similar to Dura Label Pro. Label color shall be black text on a white background.
- B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.
- C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer's instructions.
- D. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.

3.02 APPLICATION OF MARKERS AND STENCILS

- A. Piping runs throughout the Project 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 pipe markers and/or stencils. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements. In addition to pipe markers and/or stencils, arrow markers shall be used to indicate direction of flow.
- B. As a minimum, locate pipe markers and/or stencils as follows:
 - 1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.
 - 2. Every 20 feet in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.
 - 3. At each branch or riser take off on piping systems, excluding short takeoffs for fixtures and terminal units.
 - 4. Provide a pipe marker or stencil and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.
 - 5. At access doors, manholes and similar access points that permit view of concealed piping.
 - 6. Near major equipment items and other points of origination and termination.
- C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

- D. Provide a double-ended arrow marker when flow can be in either or both directions.
- E. Indicate delivered water temperature on domestic hot water supply and return lines.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- G. Identify control panels and major control components outside panels with plastic nameplates.
- H. Tag automatic controls, instruments and relays. Key to control schematic.
- I. Identify medium pressure gas piping (14 inches water column to 5psi) with the statement, "WARNING – ½ to 5psi NATURAL GAS".

ATTACHMENTS:

"A" - Label Abbreviations, Background and Text colors

END OF SECTION 20 05 53

ATTACHMENT “A”

Mechanical/Fire Suppression/Plumbing Piping System Abbreviations and Letter/Label Coloring

Pipe Contents	Label Abbreviation	Label Colors (Background/Text)
Acid Waste	ACID	Orange/Black
Argon	AR	Green/White
Biosafety Cabinet Exhaust	BCE	Purple/white
Brine Water	BR	Orange/Black
Carbon Dioxide	CO ₂	Gray/white
Chemical Fume Hood Exhaust	CFHE	Purple/white
Chilled Water Return	CHWR	Green/White
Chilled Water Supply	CHWS	Green/White
Condensate Drain	CD	Green/White
Condenser Water Return	CWR	Green/White
Condenser Water Supply	CWS	Green/White
Deionized Water Supply	DIS	Green/White
Deionized Water Return	DIR	Green/White
ETO Exhaust	ETOE	Purple/white
Fire Suppression Water	FIRE	Red/White
Fuel Oil Return	FOR	Yellow/Black
Fuel Oil Supply	FOS	Yellow/Black
Gray Water	Gray Water	Gray/White
Grease Waste (Kitchen)	GW	Black/White
Hazardous Waste	HAZ	Orange/Black
Helium	He	Brown/white
High Pressure Condensate	HPC	Blue/White
High Pressure Steam (above 125#)	HPS	Blue/White
Hot Water Heating Return	HWR	Green/White
Hot Water Heating Supply	HWS	Green/White
Instrument Air	IA	Red/white
Laboratory Compressed Air	Lab Air	Yellow and white checkerboard/black
Laboratory Vacuum	Lab Vac	White and black checkerboard/black boxed
Laboratory Waste	Lab Waste	Orange/Black
Laboratory Vent	Lab Vent	Orange/Black
Low Pressure Condensate	LPC	Blue/White
Low Pressure Steam (below 25#)	LPS	Blue/White
Medical Compressed Air	Med Air	Yellow/black
Medical–Surgical Vacuum	Med Vac	White/black
Medium Pressure Condensate	MPC	Blue/White
Medium Pressure Steam (above 25# - below 125#)	MPS	Blue/White
Natural Gas	NG	Yellow/Black
Nitrogen (gaseous)	N ₂	Black/white
Nitrogen (liquid)	LN2	Black/White
Nitrous Oxide	N ₂ O	Blue/white
Non-Potable Water	-	Green/White
Medical Oxygen	O ₂	Green/white
Potable Cold Water	DCW	Green/White
Potable Hot Water Return	DHWR	Green/White
Potable Hot Water Supply	DHW	Green/White

ATTACHMENT “A”

Pipe Contents	Label Abbreviation	Label Colors (Background/Text)
Pumped Condensate Return	PCR	Blue/White
Quench Vent	-	White/Fluorescent Orange
Radioisotope Exhaust	RE	Yellow/magenta
Refrigerant Liquid Line (Circuit #1, 2, 3, etc. as applicable)	Refrig Liq #	Green/White
Refrigerant Suction Line (Circuit #1, 2, 3, etc. as applicable)	Refrig Suct #	Green/White
Reverse Osmosis Water Supply	ROS	Green/White
Reverse Osmosis Water Return	ROR	Green/White
Sanitary Waste	SS	Green/White
Sanitary Vent	SV	Green/White
Storm Drain	SD	Green/White
Softened Water	SW	Green/White
Waste Anesthetic Gas Disposal	WAGD	Violet/white

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

1.01. SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.02. PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. 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.

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

2.01. DOMESTIC HOT AND COLD WATER AND HEATING HOT WATER:

- A. All domestic hot and cold water lines in buildings, including valves, strainers, unions, flanges, etc., except where specifically noted to the contrary, shall be insulated.
- B. All domestic cold water lines shall be insulated as scheduled with preformed fiberglass insulation with a factory applied All Service Jacket, vapor sealing all joints, and factory performed fittings with vapor seal. For domestic hot and cold a flexible, "25-50" rated, closed cell elastomeric thermal insulation such as "Self Seal Armaflex 2000" is also acceptable. Elastomeric products shall be supplied in a preslit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint. All elastomeric insulating products shall be guaranteed not to react with copper piping. Valves shall be insulated with mitered pipe covering with voids filled with glass fiber blanket insulation. Valves and fittings shall be vapor sealed with a water base asphaltic emulsion. Fittings on concealed insulation shall be built up to the thickness of adjacent insulation with glass fiber fitting wrap and shall be finished with Glasfab tape embedded in vapor barrier emulsion. Exposed fitting insulation shall be built up to same thickness as adjoining pipe insulation with one coat cement and after drying shall be finished with a white vapor seal and canvas jacket secured with "Arabol" adhesive and be suitable for painting. Seams in jacket shall be placed in the least noticeable locations. Where seams, joint or fittings are rough they shall be covered with an application of insulating cement trowelled on smoothly before the canvas is applied with Arabol adhesive. The canvas must be free of wrinkles and have a smooth, neat appearance.
- C. All domestic hot water and heating water piping systems shall be insulated as specified above for cold water except the vapor barrier may be deleted and the lap and butt joints secured with staples and a field applied adhesive (self sealing lap and butt joints alone are not acceptable). The insulation thickness shall be as scheduled. Where service temperature exceeds 250°F, insulation shall contain high temp binders.
- D. The only domestic hot and cold water piping that will not require insulation are the exposed runouts under non-handicap plumbing fixtures. Where pipe chases are tight, adequate provision shall be made at the rough in stage utilizing offset fittings or other means (except springing the pipe) to insure that insulation can be applied throughout the length of the pipe.

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.) 3/4" 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.

2.06. EXPANSION JOINTS

- A. Where expansion bends occur in the lines, a two foot (2') double layer contraction joint shall be provided in the main line starting two feet from the end of the main line ells on both sides of the expansion loop. Contraction joints shall consist of two 1-1/2" thick x 24" long pipe covering cuts into 17-1/4" and 6" lengths to provide a 3/4" space by 10-1/4". A slip joint mastic (Pittseal III) shall be placed between layers from the 3/4" space provided on the inside layer to the 3/4" space on the outside layer.

- B. The $\frac{3}{4}$ " space on inside layer shall be filled with mineral wool loose fill and the $\frac{3}{4}$ " space on the outer layer shall also be filled with same loose fill and joint sealer pressed $\frac{1}{2}$ " deep into space for sealing (Pittseal III). Around the outside layer at the $\frac{3}{4}$ " space, there shall be wrapped a 4" wide piece of glass fabric and sealed down with vapor seal mastic. On pipe sizes smaller than aforementioned, the same contraction joint shall be provided using one inch (1") thick "FOAMGLAS" or "KOOLPHEN K" pipe covering for the inner layer. On two inch (2") IPS, both inner and outer layer shall be 1" thick "FOAMGLAS" or "KOOLPHEN K".
- C. The joint and vapor seal mastic shall be Pittsburgh Corning Corporation Pittcote 300. (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.
- D. The slip joint sealer shall be Pittsburgh Corning Corporation's Pittseal III.

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/ft³ 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/ft³ 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	14	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° 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.

3.04 PAINTING:

- A. All exposed insulation shall be prepared to receive painting specified under Section 09 91 00.
- B. The pipe primer shall be Pittsburgh Corning Corporation Pittcote 300.

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# to 120#; 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.

END OF SECTION