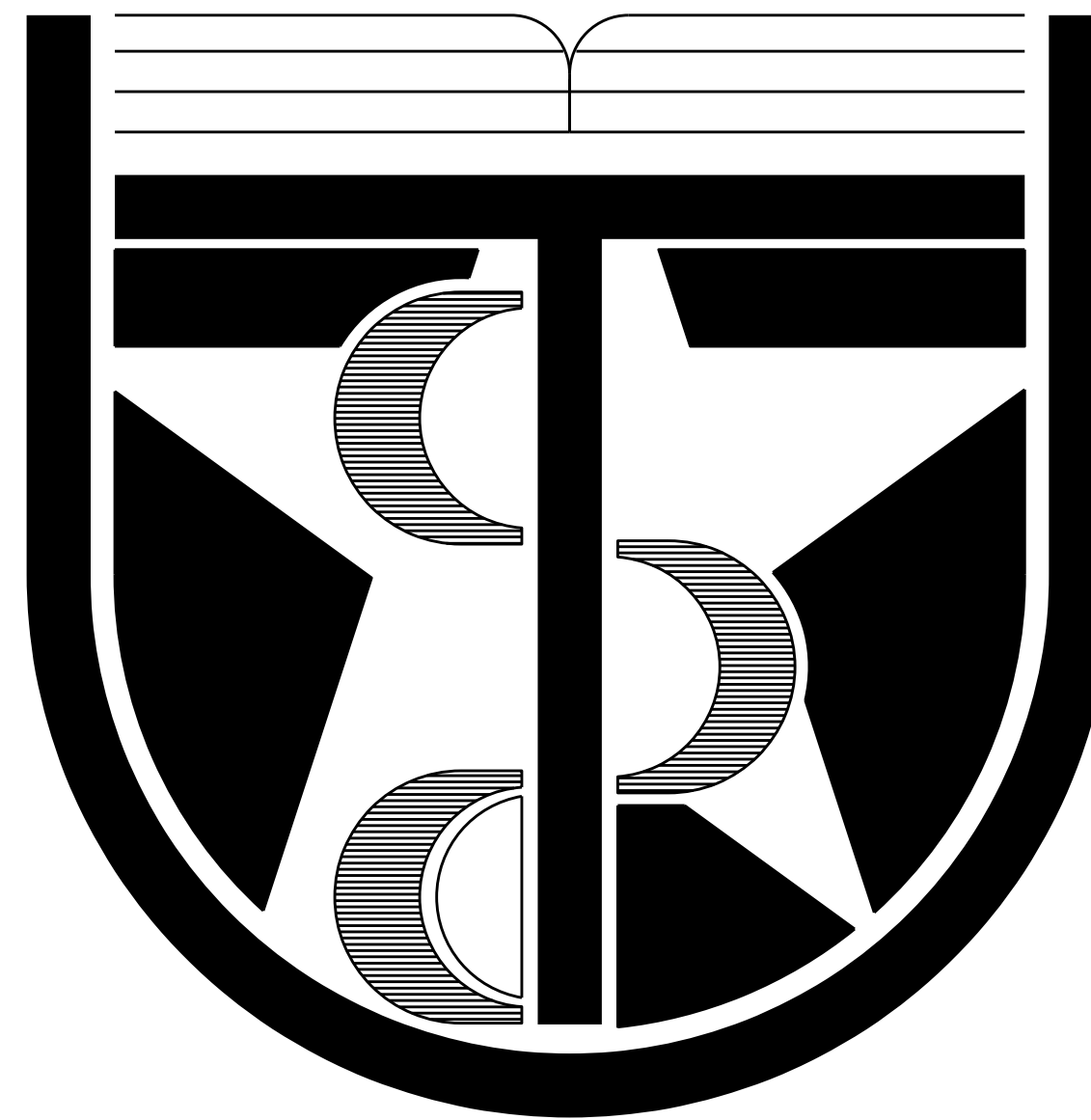


EXHIBIT E  
VACUUM PUMP REPLACEMENT  
PROJECT DRAWINGS AND SPECIFICATIONS  
JANUARY 3, 2017 100% CD

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

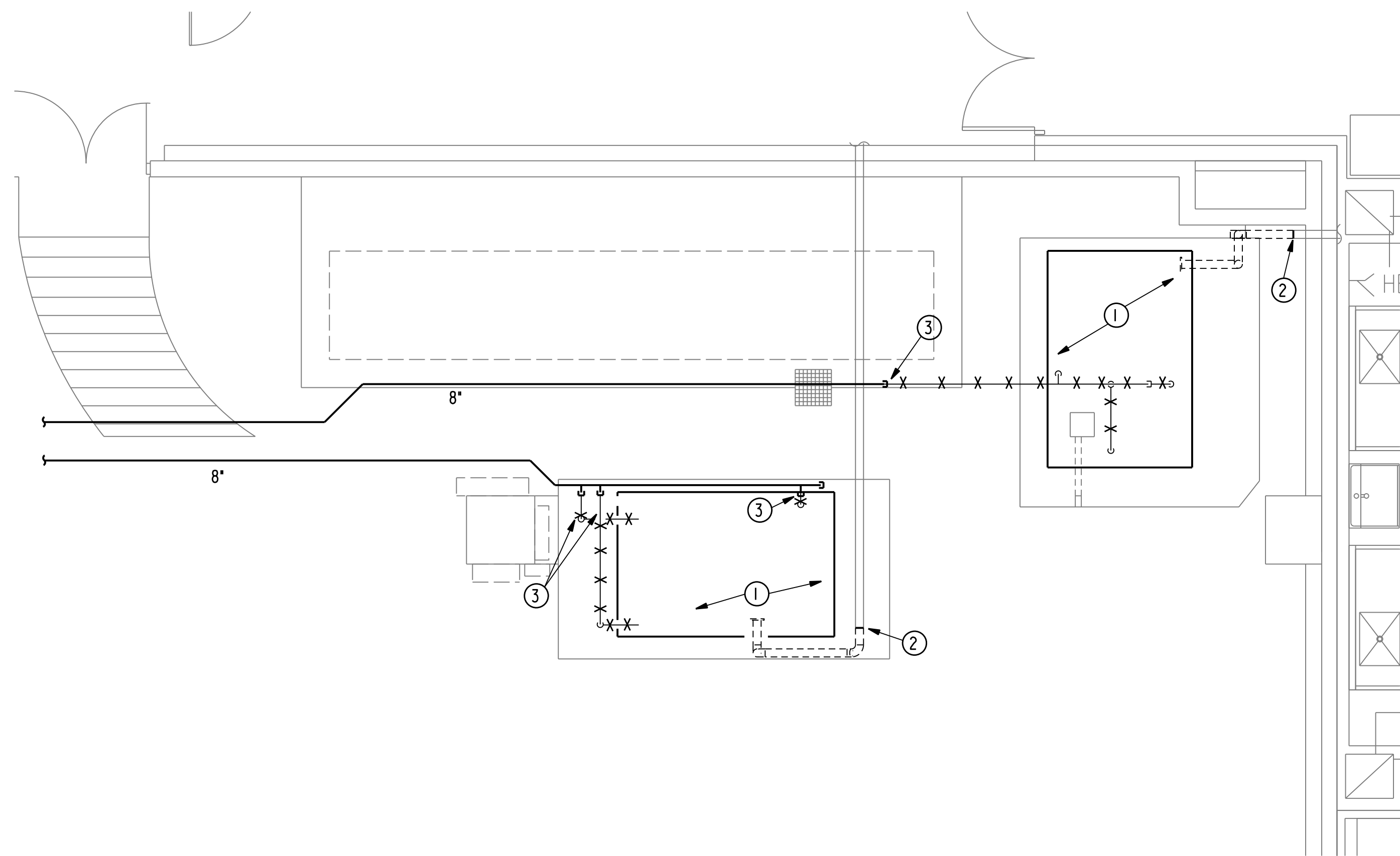
## ENGINEERS

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>





## 01 VACUUM PUMP DEMOLITION

SCALE: 1/4" = 1'-0"

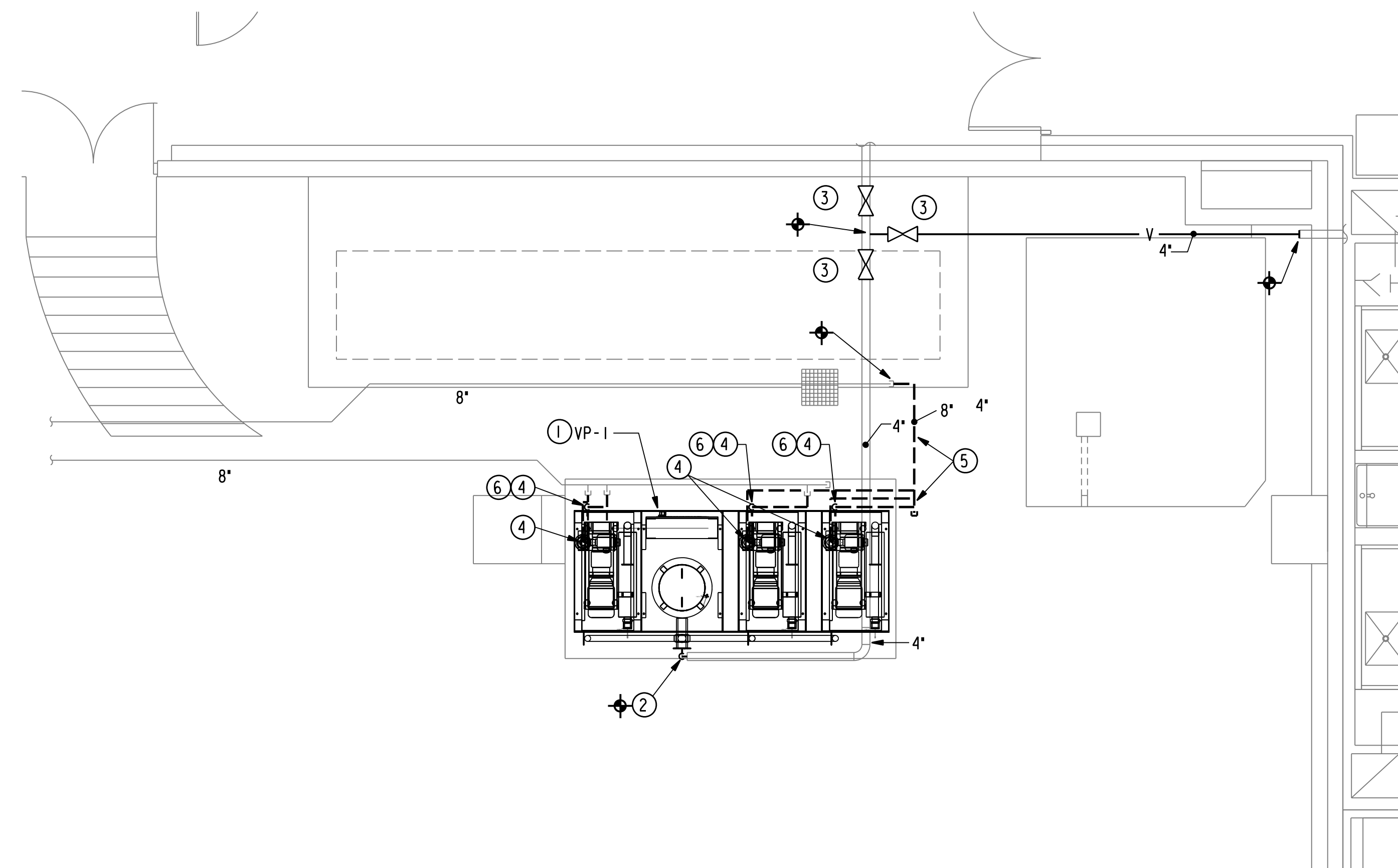
### DEMOLITION PLAN NOTES:

- ① REMOVE ENTIRE EXISTING TRIPLEX VACUUM PUMP/SYSTEM. SAVE THE ONE 15HP VACUUM PUMP AND MOTOR. THE SAVED VACUUM PUMP IS TO BE INSTALLED AND INCORPORATED INTO THE NEW SYSTEM DURING THE RENOVATION. CLEAN AND PREPARE THE EXISTING HOUSEKEEPING PAD FOR NEW EQUIPMENT INSTALLATION. REMOVE ALL EXISTING VACUUM EXHAUST CONNECTIONS AND VACUUM EXHAUST PIPE/DUCT TO UPSTREAM OF THE TWO EXISTING PUMP SYSTEM CONNECTIONS.
- ② CUT EXISTING 4" VACUUM PIPING AT THIS LOCATION AND PREPARE PIPING FOR RECONNECTION DURING RENOVATION.
- ③ CUT EXISTING VACUUM EXHAUST CONNECTION, PREPARE THE EXISTING CONNECTION FOR RECONNECTION DURING RENOVATION.

### WORK ORDER:

1. THE NEW PIPING AND VALVING TO FORM A COMBINED HEADER SHALL BE COMPLETED FIRST.
2. THE EXISTING SOUTH VACUUM SYSTEM SHALL BE DEMOLISHED AND THE HOUSEKEEPING PAD PREPARED FOR THE NEW SYSTEM INSTALLATION.
3. THE NEW SYSTEM IS TO BE BROUGHT ON-LINE AND THE EXISTING NORTH SYSTEM VALVED OFF AND TAKEN OFF-LINE.
4. THE NORTH SYSTEM IS DEMOLISHED.

THESE ARE THE MAJOR STEPS TO COMPLETE THIS INSTALLATION WITH A MINIMUM AMOUNT OF DOWNTIME TO THE USER.

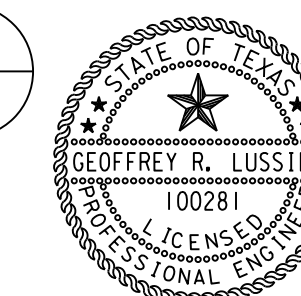
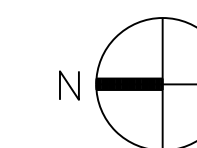
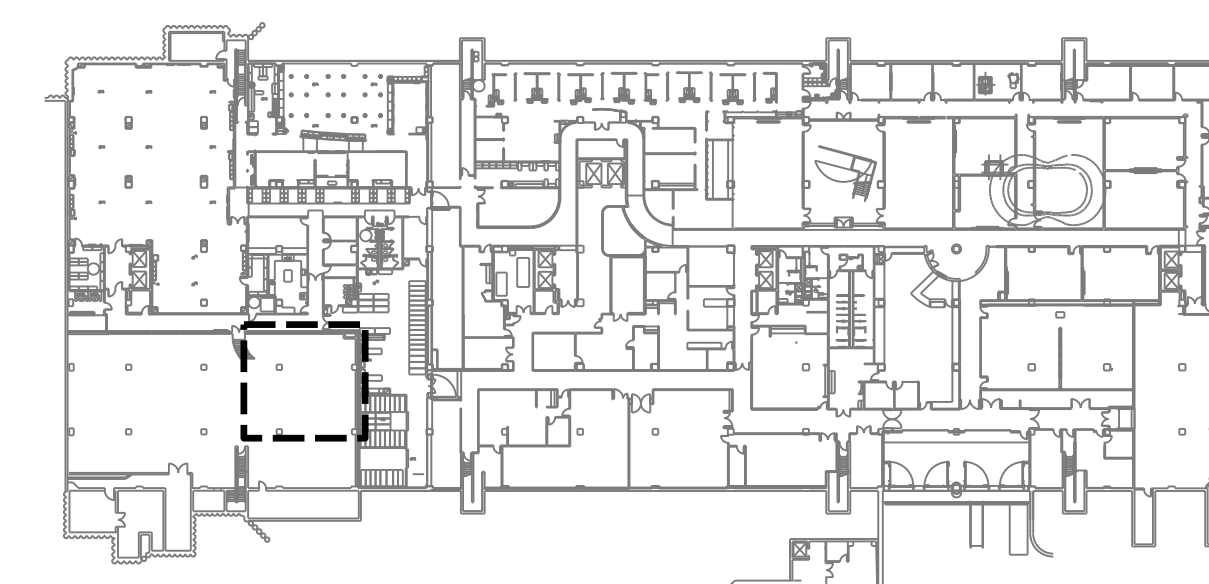


## 02 VACUUM PUMP RENOVATION

SCALE: 1/4" = 1'-0"

### RENOVATION PLAN NOTES:

- ① NEW VACUUM PUMP SYSTEM. INSTALL ON EXISTING HOUSEKEEPING PAD AND ROUTE DRAIN LINE TO NEAREST FLOOR SINK.
- ② 4" VACUUM HEADER DROP AND CONNECT TO MAIN SUCTION CONNECTION ON SYSTEM.
- ③ NEW 4" SHUT-OF VALVE, SET UP TO ISOLATE THE NORTH AND SOUTH SIDES OF THE BUILDING.
- ④ NEW 3" VACUUM EXHAUST RISE FROM VACUUM PUMP DISCHARGE FLANGE.
- ⑤ EXTEND VACUUM EXHAUST PIPING/DUCT TO FORM A NEW HEADER ABOVE THE NEW SYSTEM.
- ⑥ NEW 3" VACUUM EXHAUST RISE FROM LOWER VACUUM PUMP DISCHARGE FLANGE.



WE ARE APPROVED ON THE BASIS AND AUTHORIZED BY:  
 Geoffrey R. Lussier,  
 P.E.  
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# E&C

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## UTHSC-H MSB BASEMENT EQUIPMENT REPLACEMENT

E&C PROJECT # 3315

SKETCH: PB200  
 DRAWING: PLUMBING  
 BASEMENT PLANS

REVISION: 90% REVIEW  
 SCALE: 1/4"=1'-0"  
 DATE: 01-20-2017

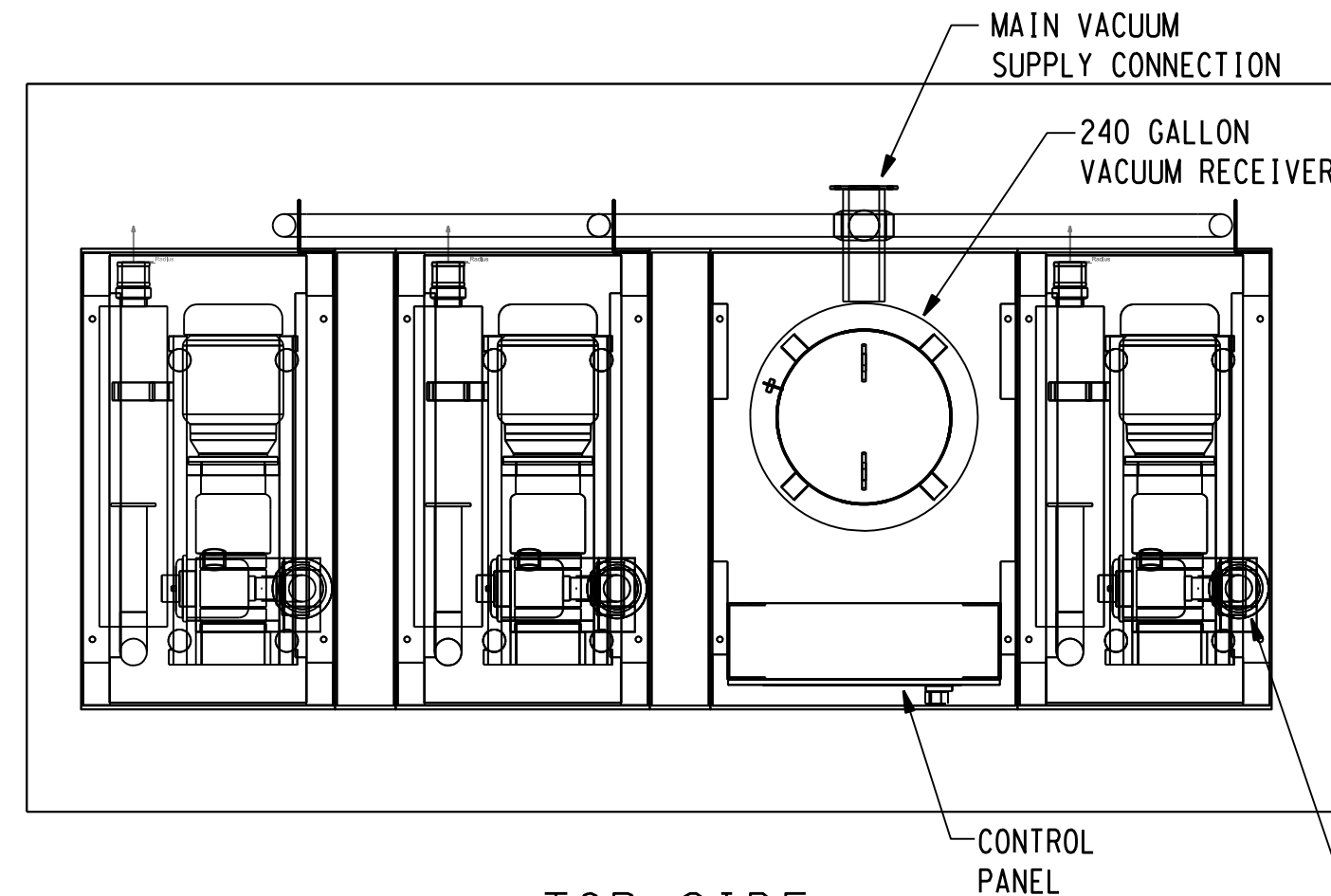
**PLUMBING PIPING MATERIALS**

A. COMPRESSED AIR AND VACUUM PIPING: TYPE 'L' COPPER (ASTM B88) WITH WROUGHT COPPER SOLDER FITTINGS (ANSI B16.22) USING 95/5 SOLDER.

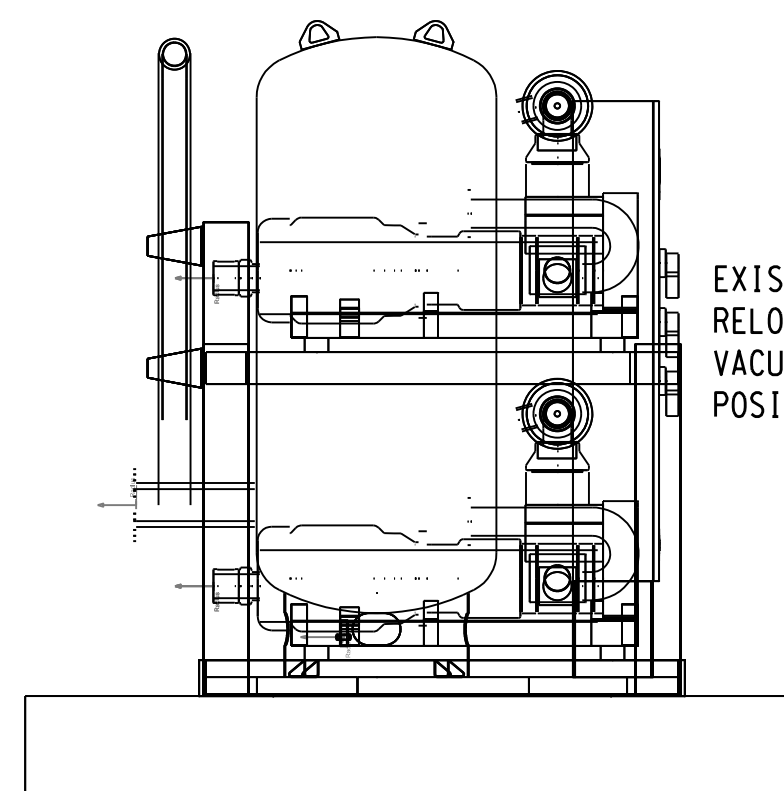
RE: PLUMBING SPECIFICATIONS FOR ADDITIONAL INFORMATION.

**PLUMBING EQUIPMENT SCHEDULE**

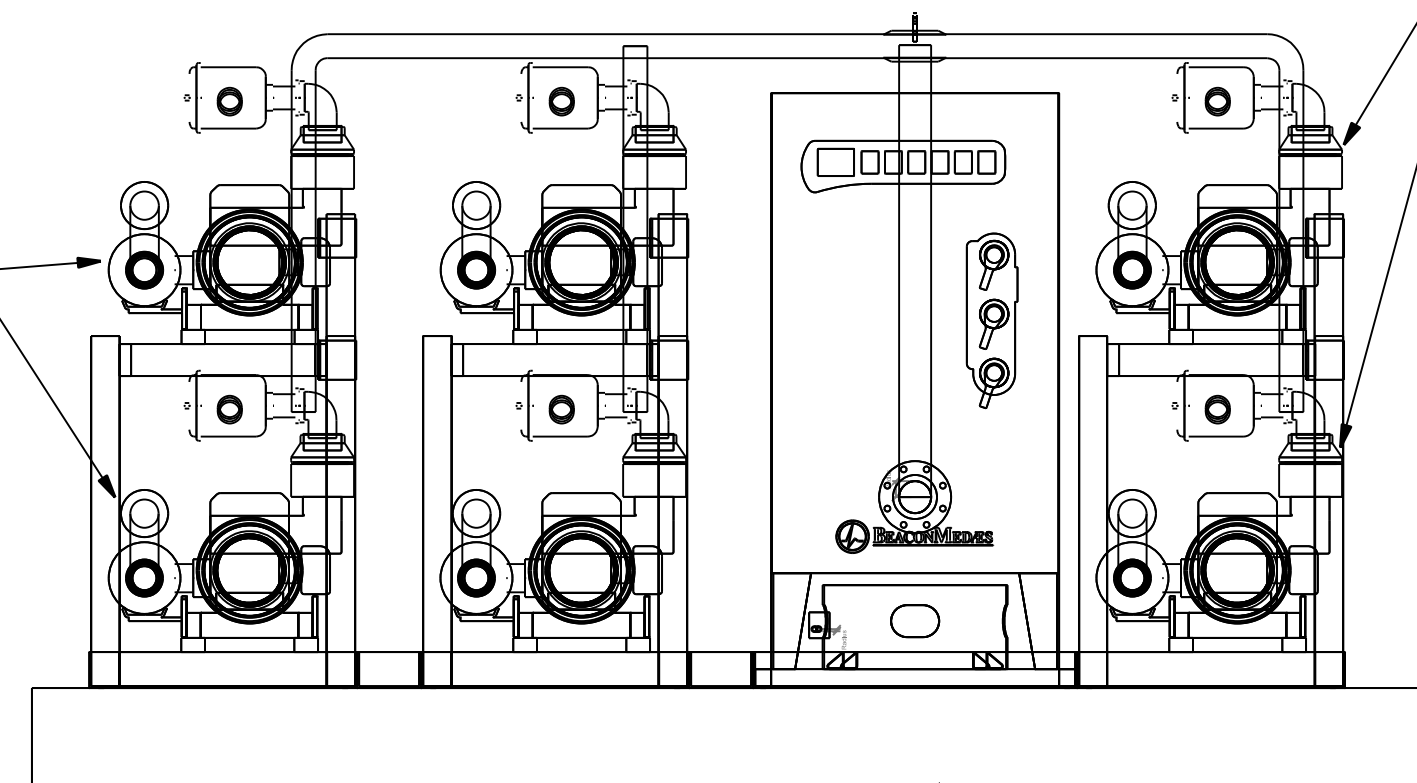
UNIT NO.	LOCATION	TYPE	TANK CAP. GAL.	DELIVERY PER TURBINE/COMPRESSOR		RPM	MOTOR			REMARKS
				SCFM	PRESS.		HP	VOLTS	PH	
VP-1	NORTH BASEMENT EQUIPMENT ROOM	CLAW	240	128 EACH 768 TOTAL	19" Hg	1800	15 EACH	480	3	BEACON MEDAES MODEL NO. VHS150-240V-HCV-SPL SPECIAL QUADRUPLEX EXPANDABLE TO HEXAPLEX, 15HP LIFELINE CLAW MEDICAL VACUUM WITH VARIABLE SPEED DRIVE AND SINGLE POINT CONNECTION (SPC), BASE MOUNTED SYSTEM. PROVISION FOR DUAL POWER FEEDS, HEXAPLEX CONTROLS AND FRAMEWORK AND PIPING FOR RE-USE OF TWO (2) EXISTING MM1502 PUMPS.



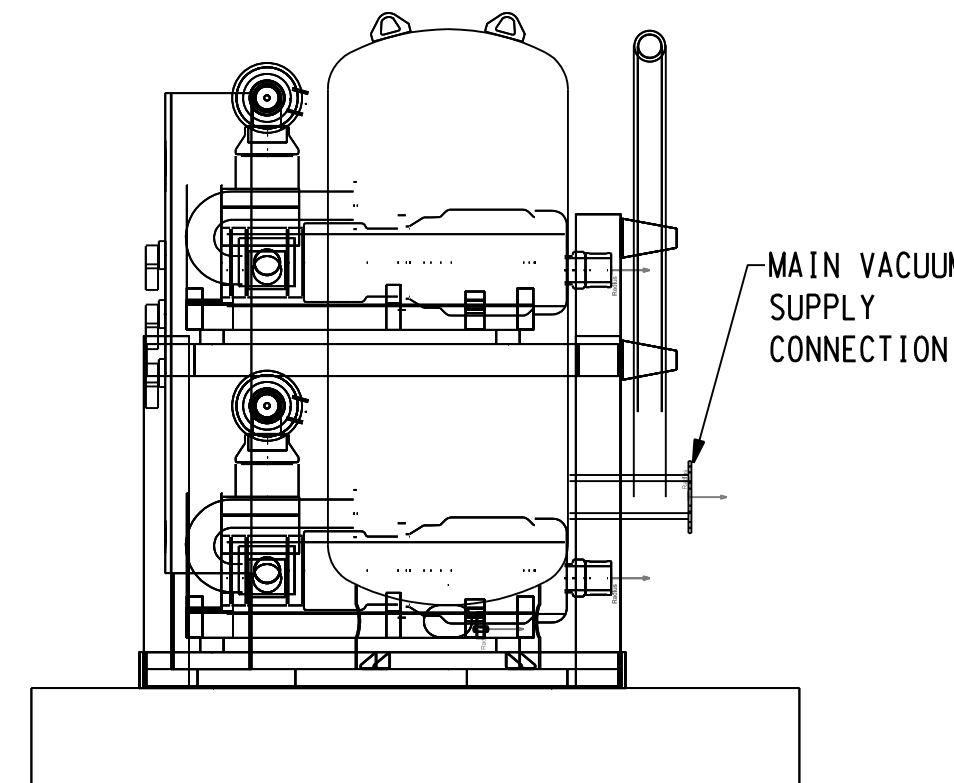
TOP SIDE



LEFT SIDE

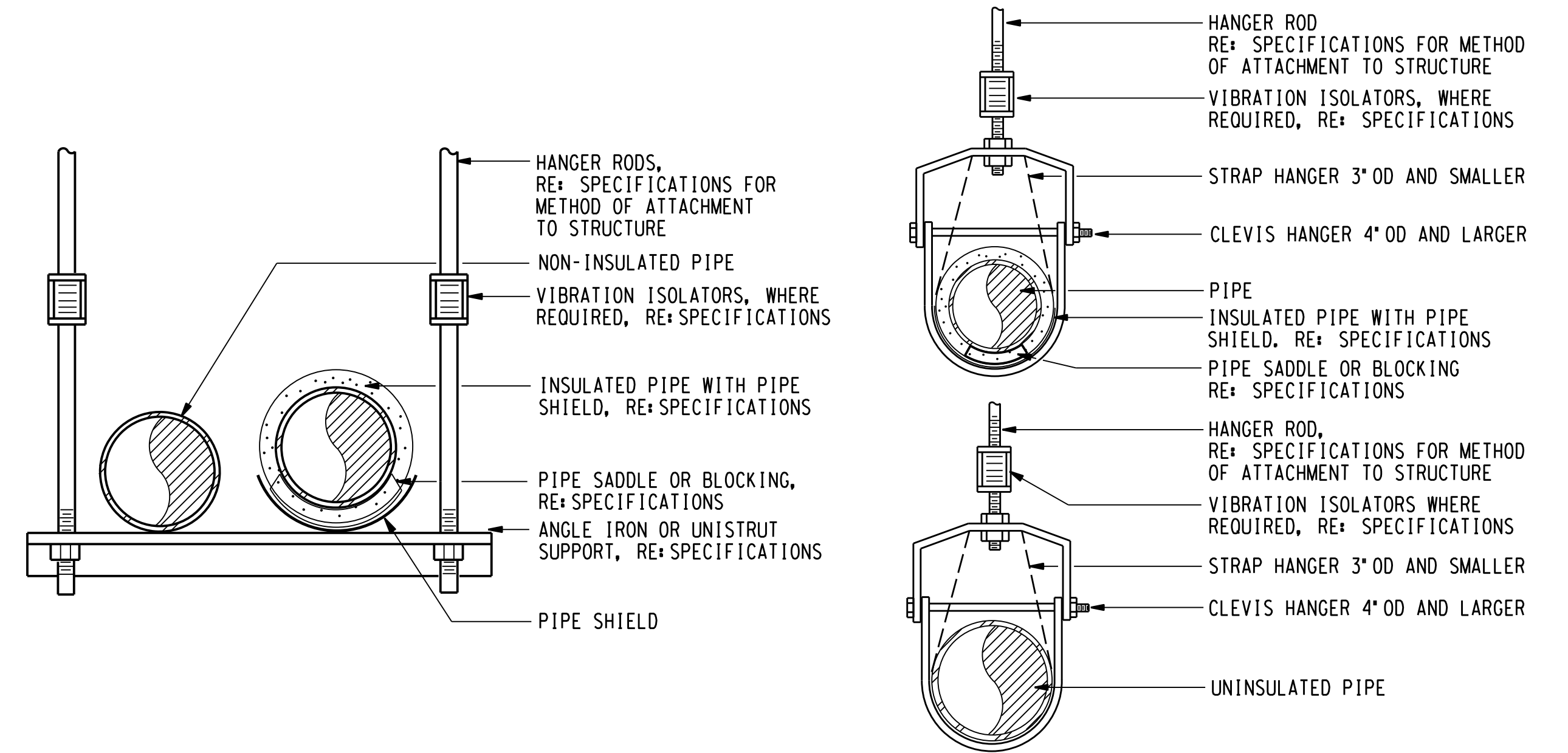


FRONT SIDE



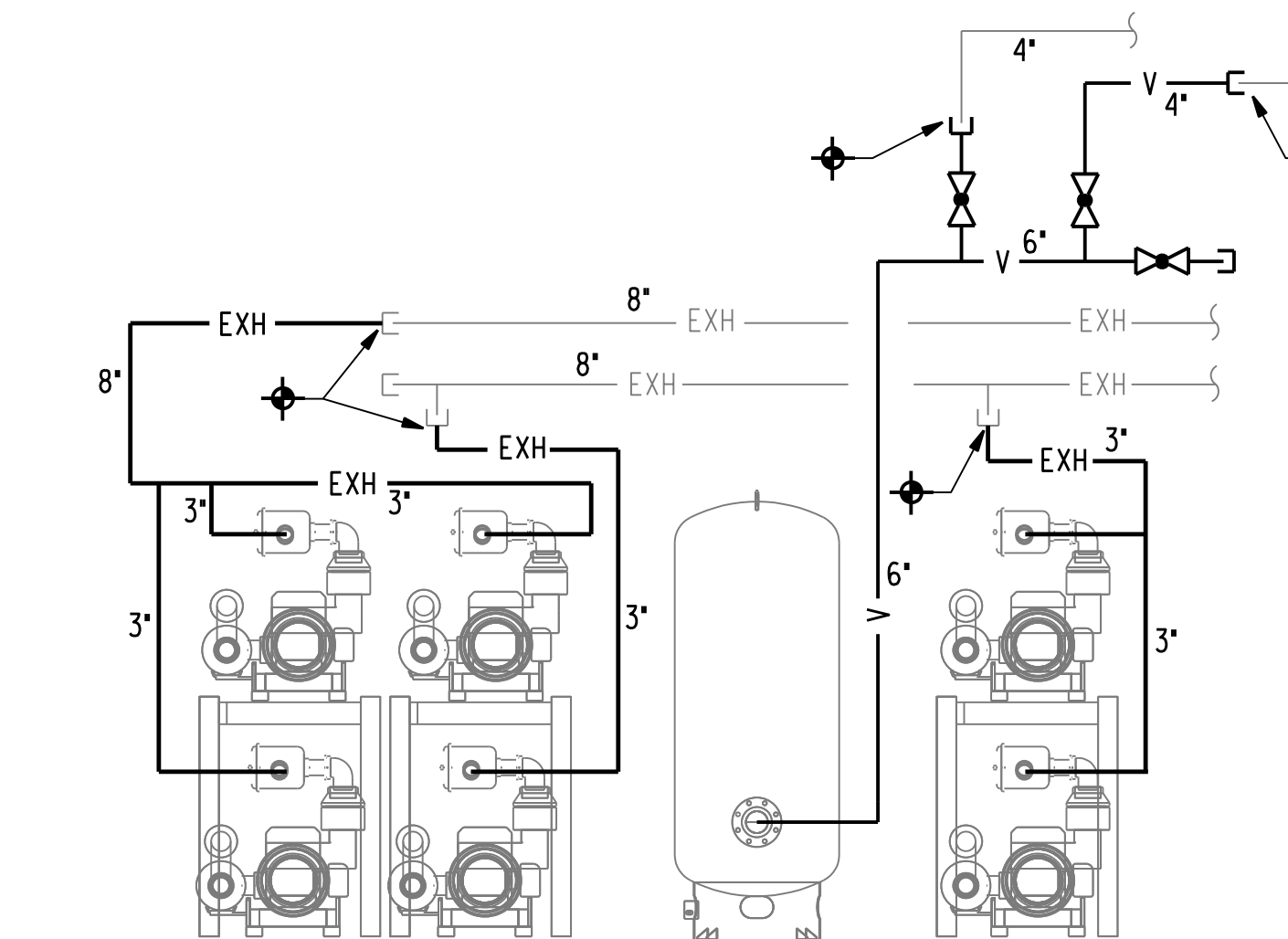
RIGHT SIDE

**04 VACUUM PUMP SYSTEM LAYOUT**  
NOT TO SCALE

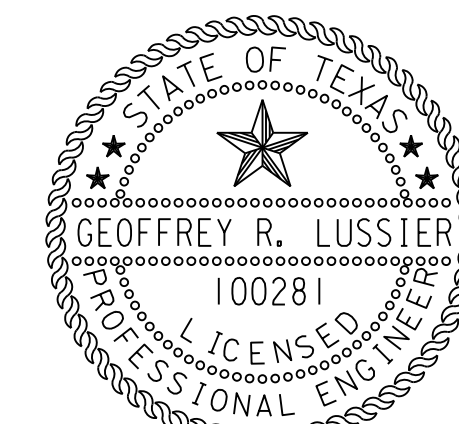


**03 TYPICAL TRAPEZE TYPE MULTIPLE PIPE HANGER**  
NOT TO SCALE

**02 TYPICAL SINGLE PIPE HANGER**  
NOT TO SCALE



**05 VACUUM PIPING ONE LINE**  
NOT TO SCALE



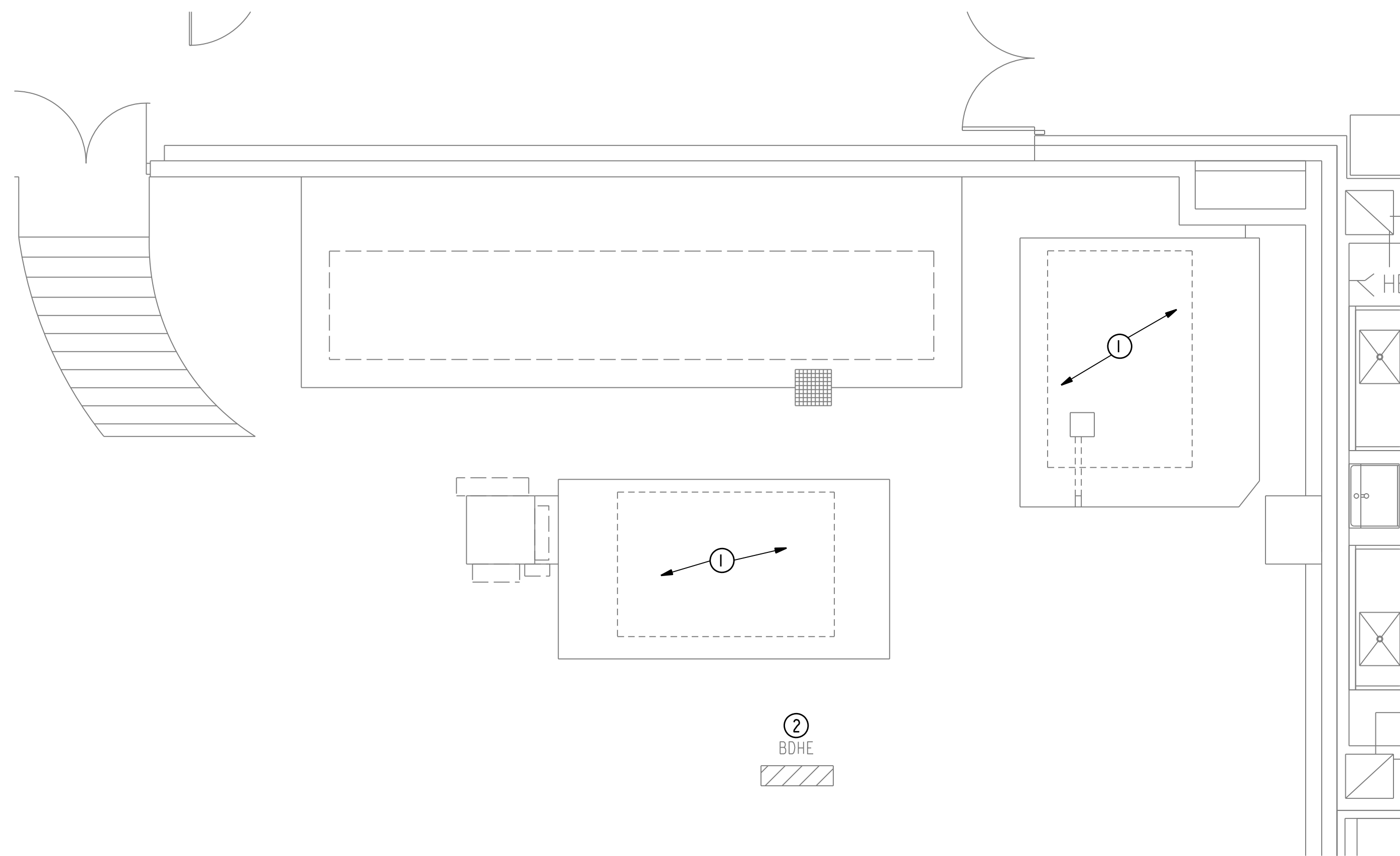
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16:13:47-06'00"  
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**UTHSC-H  
MSB BASEMENT EQUIPMENT REPLACEMENT**

E&C PROJECT # 3315

SKETCH: PB201  
DRAWING: PLUMBING BASEMENT DETAILS  
REVISION: 1  
SCALE: NONE  
DATE: 01-03-2017



## 01 VACUUM PUMP DEMOLITION

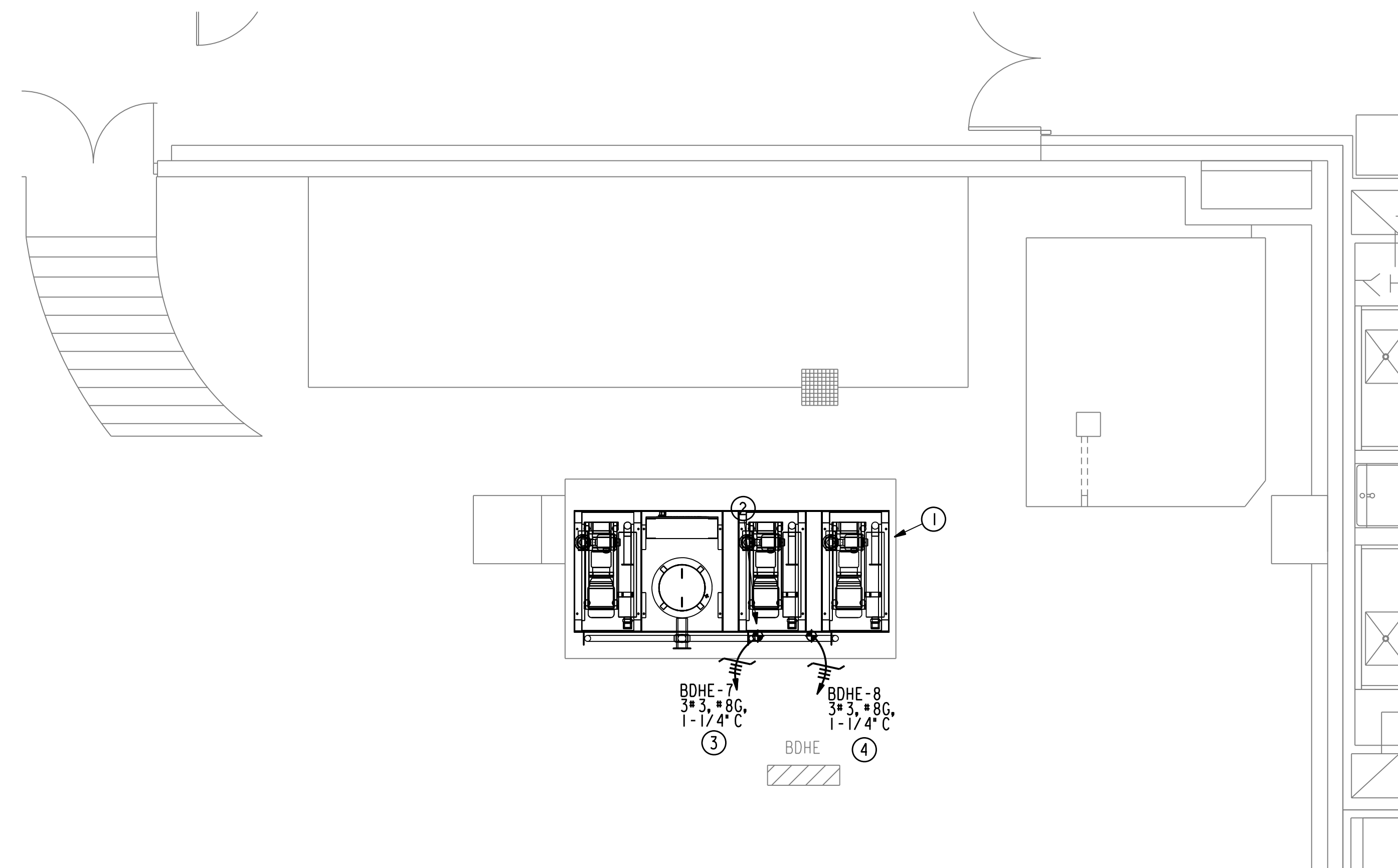
SCALE: 1/4" = 1' - 0"

### DEMOLITION PLAN NOTES:

- ① REMOVE BRANCH CIRCUIT TO TRIPLEX VACUUM PUMP COMPLETELY. PUMP IS SERVED FROM DISTRIBUTION PANEL BDHE. CONDUIT HANGERS MAY BE REUSED FOR NEW BRANCH CIRCUIT TO NEW VACUUM PUMP. RE: ALTERATION PLAN FOR ADDITIONAL INFORMATION.
- ② RACK MOUNTED EXISTING DISTRIBUTION PANEL BDHE TO REMAIN. PANEL SERVES BOTH TRIPLEX VACUUM PUMPS TO BE REMOVED.

### LOAD ANALYSIS:

SIX (6) 25HP MOTORS REMOVED = -204A  
 SIX (5) 15HP MOTORS ADDED = 126A  
 LOAD REDUCED ON PANEL BDHE = -78A

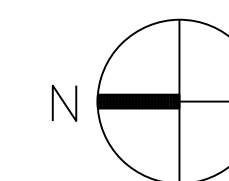
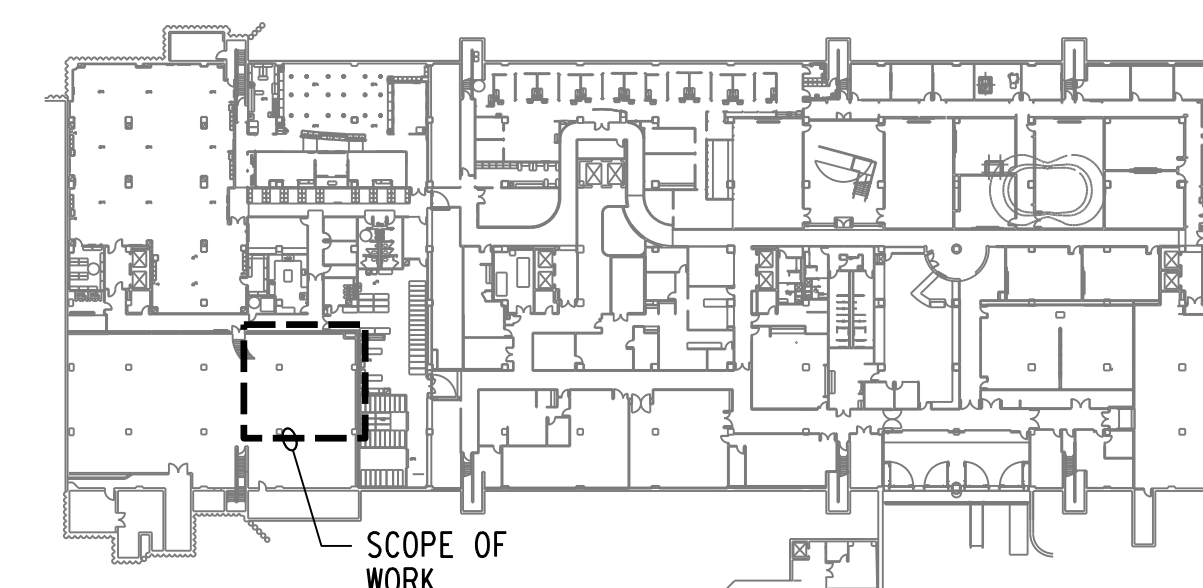


## 02 VACUUM PUMP RENOVATION

SCALE: 1/4" = 1' - 0"

### RENOVATION PLAN NOTES:

- ① NEW VACUUM PUMP SYSTEM. RE: PLUMBING PLANS FOR MORE INFORMATION.
- ② NEW VACUUM PUMP CONTROL PANEL WITH INTEGRAL DISCONNECTS, OVERLOADS, AND CONTROLS. CONTROL PANEL SHALL HAVE TWO ELECTRICAL FEEDS. ONE FEED FOR THREE PUMPS AND A SECOND FOR THE OTHER THREE PUMPS. MAKE ELECTRICAL CONNECTIONS AS REQUIRED.
- ③ EXISTING CIRCUIT AND BREAKER FOR EXISTING VACUUM PUMP SYSTEM TO BE REMOVED. BREAKER IS LABELED "CLINICAL VACUUM SOUTH". EXISTING BREAKER TO REMAIN. REMOVE 125A TRIP RATING PLUG AND REPLACE WITH NEW 90A TRIP RATING PLUG. EXTEND WIRE AND CONDUIT FROM PANEL TO VACUUM PUMP AS REQUIRED. RE-LABEL BREAKER "CLINICAL VACUUM FEED A".
- ④ EXISTING CIRCUIT AND BREAKER FOR EXISTING VACUUM PUMP SYSTEM TO BE REMOVED. BREAKER IS LABELED "CLINICAL VACUUM NORTH". EXISTING BREAKER TO REMAIN. REMOVE 125A TRIP RATING PLUG AND REPLACE WITH NEW 90A TRIP RATING PLUG. EXTEND WIRE AND CONDUIT FROM PANEL TO VACUUM PUMP AS REQUIRED. RE-LABEL BREAKER "CLINICAL VACUUM FEED B".



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## UTHSC-H MSB BASEMENT EQUIPMENT REPLACEMENT

E&C PROJECT # 3315

SKETCH: EB200  
 DRAWING: ELECTRICAL  
 BASEMENT PLANS  
 REVISION: 1  
 SCALE: 1/4"=1'-0"  
 DATE: 01-03-2017

TABLE OF CONTENTS

Section No.    Title

**DIVISION 22 – PLUMBING**

22 62 21                    Laboratory Vacuum pump Systems (Rotary Claw)

**DIVISION 23 – MECHANICAL**

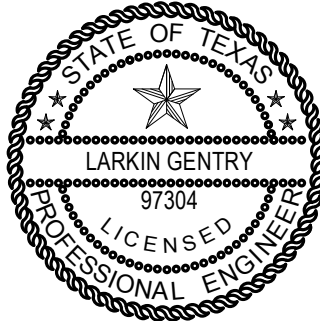
23 00 00                    Basic Mechanical Requirements  
23 05 29                    Sleeves, Flashings, Supports and Anchors

**DIVISION 26 – ELECTRICAL**

26 00 00                    Electrical

**END OF TABLE OF CONTENTS**

E&C Engineers & Consultants, Inc.  
TX Firm Registration No: F-003068  
Date: 1-03-2017  
Engineer of Record: Larkin Gentry  
State: Texas  
License no: 97304

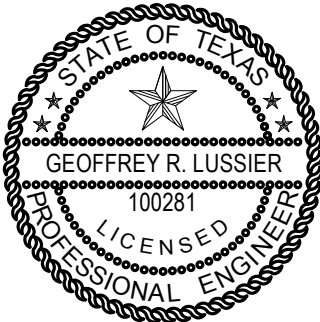


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Larkin Gentry  
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Texas Firm Registration No: F-003068

E&C Engineers & Consultants, Inc.  
TX Firm Registration No: F-003068  
Date: 1-03-2017  
Engineer of Record: Geoffrey Lussier  
State: Texas  
License no: 100281



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*Geoffrey R. Lussier*  
Geoffrey Lussier,  
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2017.01.03  
16:07:24-06'00'

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

## **SECTION 22 62 21 – LABORATORY VACUUM PUMP SYSTEMS (ROTARY CLAW)**

### **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. This section includes the furnishing of all labor and materials necessary for complete installation, cleaning, testing, start-up and certification of laboratory vacuum pump system, including; pumps, receiver tank, controls, interconnecting piping, local alarms, remote alarm contacts, valves, supports, and all related accessories.

#### **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. NFPA 99 Standard for Health Care Facilities.
  - 2. NFPA 70 National Electrical Code.

#### **1.04 QUALIFICATIONS**

- A. General: Companies specializing in manufacturing, installing, testing, certifying and servicing the products and systems specified in this section shall have minimum five years documented experience and be certified as required by the Texas Department of Health and NFPA 99.
- B. Manufacturers: Firms regularly engaged in manufacture of medical vacuum systems equipment and products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years. References may be required.
- C. Equipment Supplier: The medical vacuum systems equipment supplier shall provide the services of a manufacturer authorized product specialist to periodically coordinate with the installing Contractor during initial installation of the pipeline systems and have a service organization located within 50 miles of the project Site to provide ongoing service support to UT Health Science Center - Houston after project completion.

- D. Installer: Firm with at least 5 years of successful installation experience on projects with medical gas systems work similar to that required for project. All installations of the medical vacuum piping systems shall be done only by, or under the direct supervision of a holder of a master plumber license or a journeyman plumber license with a medical gas piping installation endorsement issued by the Texas State Board of Plumbing Examiners. All installers of medical gas system components must be qualified in accordance with the requirements of NFPA 99 and ASSE 6010, Medical Gas Systems Installers Professional Qualifications Standard. In addition, all brazers of medical gas system piping must be qualified in accordance with the requirements of either Section IX, Welding and Brazing Requirements of the ASME Boiler and Pressure Vessel Code, or AWS B2.2, Standard for Brazing Procedure and Performance Qualification.
- E. System Verification Testing Agency: Testing shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ANSI/ASSE Standard 6030, Medical Gas Verifiers Professional Qualifications Standard. Quality control standards of testing agency shall be in strict accordance with American National Standards Institute (ANSI) Q-91. Firm shall be regularly engaged in the testing and certification of similar facilities with a minimum of 5 years of experience.

#### 1.05 QUALITY ASSURANCE

- A. All materials, equipment, installation, testing and certification shall be in strict accordance with NFPA 99 for Level 1 Medical–Surgical Vacuum.
- B. Manufacturer's name, address and contact information shall be permanently labeled on equipment.
- C. Maintain one copy of each Contract Document on Site.
- D. Prior to any installation Work, the installer of medical vacuum piping shall provide and maintain documentation on the job Site for the qualification of brazing procedures and individual brazers as required by NFPA 99.

#### 1.06 SUBMITTALS

- A. General:
  - 1. All submitted data shall be specific to this project and identified as such. Generic submittal data will not be accepted.
- B. Product Data:
  - 1. Manufacturers descriptive literature, illustrations and installation instructions for all components included within this project indicating compliance with applicable referenced standards, size, dimensions, model number, electrical characteristics, support and connection requirements.
- C. Shop Drawings:
  - 1. Wiring diagrams for laboratory vacuum source equipment system. Differentiate between manufacturer-installed and field-installed wiring.
- D. Record Documents:



1. Record actual locations of equipment, piping, valves and controls.
  2. Provide record of test procedures and the results of all tests indicating room and area designations, dates of the tests, and names of persons conducting the tests.
  3. Brazer Certificates: Installation Contractor shall present written documentation (less than 1 year old) from a recognized agency trained in administering and testing brazing techniques as per AWS B2.2 or ASME Section IX, certifying that all brazers have been thoroughly trained and tested in the complete installation of medical gas systems.
  4. Inspection and Test Reports: Furnish documentation that all installer inspections and tests required by NFPA 99 for Level 1 Medical–Surgical Vacuum have been performed. Identify test type, procedure and results.
  5. Independent Third Party System Verification Testing Agency Reports and Certification: Documentation verifying that completed systems have been installed, tested, purged, and analyzed in accordance with the requirements of referenced standards and Contract Documents. Provide copy of agency's written Q-91 standards.
  6. Statement of Warranty: Provide equipment manufacturers Statement of Warranty for all furnished equipment and components. Warranty shall specifically indicate project by name and date of equipment start-up.
  7. Provide full written description of manufacturer's warranty.
- E. Operation and Maintenance Data:
1. Operation Data: Include manufacturer's installation and operating instructions.
  2. Maintenance Data: Servicing requirements, inspection data, preventative maintenance schedule, exploded assembly views, replacement part numbers and availability, location and contact numbers of service depot.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Equipment and components shall arrive on-Site properly protected and undamaged with containers, packaging and labels intact.
- B. Each pipe and tank opening shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.
- C. Loose fittings, valves, gauges and other components shall be delivered sealed, labeled, and kept sealed until installation.
- D. Store, handle and protect materials and equipment in accordance with Manufacturer's recommendations.
- E. Provide equipment and personnel necessary to handle equipment and components by methods to prevent damage to products or packaging. Provide additional protection during handling as necessary to prevent breaking scraping, marring, or otherwise damaging products or surrounding areas.
- F. Lift heavy components only at designated lifting points.

G. Protect all equipment and components that are to be installed within this project from theft, vandalism, and exposure to rain, freezing temperatures and direct sunlight.

H. Protect installed equipment and components from damage and prevent use.

#### 1.08 SCHEDULING

A. Schedule Work to ensure installation is complete, tested and certified prior to Substantial Completion.

#### 1.09 WARRANTY

A. Manufacturer shall warrant furnished equipment and components to be free of defects in material and workmanship under normal use for a period of thirty-six (36) months from date of start-up.

### **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.

B. Furnish a central vacuum system consisting of dry rotary claw type vacuum pumps mounted on skids with automatic lead/lag electrical controls and an ASME coded receiver. The complete vacuum system including electrical controls shall be designed, assembled, and factory tested by the vacuum pump manufacturer. Vacuum systems that are designed and/or fabricated by sources other than the vacuum pump manufacturer shall not be accepted. The vacuum system shall meet or exceed the requirements listed in the latest edition of NFPA 99C.

C. The Contractor shall ascertain for himself the space and access available for the installation of a factory assembled packaged unit and, as an option, may furnish factory assembled modular units and interconnect the various components in place at the Site in lieu of providing a factory assembled packaged unit. However, all components shall be compatible and be tested as a complete system prior to shipment, and be furnished by a single source manufacturer. All electrical services and interconnecting equipment wiring and piping must be provided for within this Contractor's bid.

D. Each vacuum pump shall have a factory piped intake to the receiver with NFPA 99 compliant integral flex connector, isolation valve, and check valve.

E. An automatic means shall be provided to prevent backflow from any on-cycle vacuum pumps through any off-cycle vacuum pumps.

F. A shutoff valve and check valve shall isolate each vacuum pump from the centrally piped system and other vacuum pumps for maintenance or repair without loss of vacuum in the system.

G. Piping shall be arranged to permit service and a continuous supply of medical-surgical vacuum in the event of a single fault failure.

H. Refer to the Plumbing Fixture Schedule on Contract Drawings for required quantity of pumps, capacities, receiver size, component skid arrangement and electrical characteristics.

- I. Laboratory vacuum pump system design must be equal in all aspects to the rotary claw Mink MM Series system manufactured by Busch, Inc. and packaged by Beacon Medaes, Inc.

## 2.02 VACUUM PUMPS

- A. Each vacuum pump shall be direct-driven through a shaft coupling by a NEMA C-face, footless, TEFC electric motor wired for operation on a 208-230 or 460 volt, 60 hertz, 3 phase power supply. Belt drives shall not be permitted.
- B. Each vacuum pump shall be air-cooled and have absolutely no water requirements.
- C. Each vacuum pump shall be capable of running continuously at an (ultimate) vacuum of 24" Hg (sea level).
- D. Each vacuum pump shall be dry-running, featuring two claw-type, non-contacting rotors and shall not require any sealing fluid, assuring virtually maintenance-free operation. Each vacuum pump shall require an oil change in the gearbox only, at approximately 20,000 operating hour intervals. Each vacuum pump shall include a built in, anti-suck-back valve mounted at the pump inlet and shall be equipped with a 5 micron inlet filter for removal of particulates.

## 2.03 VACUUM RECEIVER

- A. A receiver tank shall be provided to add capacity to the vacuum piping system in order to reduce frequent cycling of a pump operating on a vacuum switch. Intake piping from each vacuum pump shall be manifolded and connected to the receiver tank at the factory in order for the receiver to function as a dropout tank to help prevent carry-over of solids or liquids into the pumps.
- B. The receiver shall be ASME Code stamped and shall be rated for full vacuum to 150 psig working pressure.
- C. Tank interior shall be epoxy coated for corrosion resistance.
- D. The receiver shall be provided with a sight/level gauge, a manual drain and have a three valve bypass system to allow for draining of the receiver without interrupting the vacuum service.
- E. Receiver shall have capacity and physical dimensions as scheduled on Contract Drawings.

## 2.04 CONTROL SYSTEM

- A. The vacuum system shall be equipped with a NFPA 99C compliant electrical control center. This control center shall alternate the vacuum pumps on a demand basis when the lead vacuum pump has met vacuum demand and on an additional timed basis to provide approximate equal run time for each vacuum pump in use.
- B. All vacuum pumps shall be controlled in a cascading lead-lag sequence when operating in the auto mode. The control system shall be programmed to minimize motor starts per hour per NEMA standards.

- C. The control system shall contain IEC magnetic motor starters with solid state overloads; low voltage(24V) control transformers with primary and secondary fusing; Hand-Off-Auto mode selector switches with integral pump run indicating lights; reserve-pump-in-use visual and audible alarms with silence and reset push buttons; dry contacts for remote indication of alarm; hour meters; a programmable controller to provide automatic alternation of pumps, minimum run timers, and vacuum control with adjustable set-points through a data interface; a main disconnecting means and power distribution block for dual point power connection; an equipment ground bus; IEC style terminal blocks; circuit breaker disconnects for each motor; single variable speed drive, all housed in a NEMA 4/12 enclosure.
- D. The entire control center assembly shall be UL508 listed.
- E. Control circuits shall be arranged in such a manner that the shutdown of one pump does not interrupt the operation of another pump.
- F. The touch screen controls shall have a master screen that is a 5.7" high resolution LCD, the individual unit screens are 3.5" high resolution LCD. There is built in Ethernet connectivity with an embedded web page. The master screen provides: Vacuum level, VSD motor speed, trends and graphs for multiple time periods, service times and history, alarm and shutdown logs as well as all the system setting access.

#### 2.05 LABORATORY VACUUM PUMP SYSTEM PIPING

- A. Interconnecting piping within the medical vacuum pump system and all exhaust piping shall be Type "K" or "L" hard-drawn seamless copper, either ASTM B 819 medical gas tube or ASTM B 88 water tube.
- B. Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings. Cast copper alloy fittings shall not be permitted.
- C. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.
- D. Threaded joints in medical vacuum piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and connections to equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required, these shall be I.P.S. brass.
- E. Mechanically formed, drilled and extruded tee-branch connections are not permitted.
- F. Couplings and fittings incorporating an o-ring seal are not permitted.
- G. Roll-grooved joints are not permitted.
- H. Straight-threaded connections, including unions, flared and compression-type connections, are not permitted.

- I. Seal fluid supply lines shall be Aeroquip MatchMate Plus or equal high-pressure hose with crimp on fittings. Rigid steel pipe with screwed fittings is not acceptable because of potential seal fluid leaks from pipe joints.

#### 2.06 LABORATORY VACUUM SHUT-OFF VALVES

- A. Shut-off valves shall be full port, double seal, ball-type three piece design, designed for vacuum to 29 inches Hg and working pressures up to 600 WOG with bronze/brass body, blow-out proof stem and chrome plated brass ball and be serviceable in the line. Valve body shall have Teflon™ (TFE) material ball seat and stem seals. Seats/seals, lubricants and valve material shall be compatible with medical oxygen, nitrous oxide, compressed air, carbon dioxide, nitrogen and mixtures thereof at continuous pressure up to 600 psig and up to 100 degrees Fahrenheit.
- B. Valve shall be provided with and operated by a lever-type handle requiring only a quarter turn from a fully open position to a fully closed position.

#### 2.07 LABORATORY VACUUM CHECK VALVES

- A. Check valves shall be center guided, self-aligning, spring loaded ball type check with brass body, Teflon seat, straight-through flow, 400 psi WOG minimum working pressure, having vibration free, silent operation.
- B. Check valves shall be 100% leak tested and comply with NFPA 99.

#### 2.08 ACCESSORIES

- A. Flexible connectors for the inlet and discharge connections, and one set of vibration pads shall be included with the vacuum system.

### **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 all system components in complete compliance with referenced standards and manufacturer's published instructions.
- D. Locate equipment with adequate access space for service. Provide no less than minimum as recommended by manufacturer.
- E. Provide minimum 4" thick reinforced concrete pad with chamfered corners beneath floor mounted equipment. Pads shall extend minimum of 4" on all sides beyond the limits of the mounted equipment unless otherwise noted.
- F. Anti-vibration mountings shall be installed for vacuum pumps as required by equipment dynamics or location and in accordance with the manufacturer's recommendations.
- G. Flexible connectors shall be used to connect the vacuum pumps with their intake and outlet piping.

- H. Vacuum piping from building distribution system shall connect to receiver tank inlet prior to flowing into pumps.
- I. Locate laboratory vacuum pumps exhaust in a manner and location that will minimize the hazards of noise and contamination to the facility and its environment. The exhaust shall terminate outdoors, at least 25 feet from any door, window, air intake, or other openings in the building; at least 3 feet above all air intakes and where prevailing winds, adjacent buildings, or other influences cannot divert the exhaust into occupied areas or disperse the exhaust.
- J. The exhaust terminal shall be turned down and screened with non-corroding material to protect against the entry of vermin, debris, or precipitation.
- K. The exhaust piping shall be free of dips and loops that might trap condensate or oil. Where such low points are unavoidable, a drip leg and valved drain shall be installed. Vacuum exhausts from multiple pumps shall be joined together to one common exhaust. The common exhaust shall be sized to minimize back-pressure in accordance with the pump manufacturer's recommendations.
- L. Each pump shall be isolated by a ball valve and a check valve to prevent flow of exhaust air into the room when pumps are removed for service.
- M. Vacuum indicators shall be readable from a standing position.
- N. Provide low voltage wiring from vacuum source equipment to master alarm annunciators as required by NFPA 99. All low voltage wiring shall be routed within conduit.
- O. Coordinate with Electrical Contractor to insure that emergency electrical service is provided for the vacuum source equipment conforming to the requirements of the essential electrical system as described in NFPA 99.
- P. Remove all dirt, dust, construction debris and all other foreign materials from installed equipment and components. Equipment finishes shall be free from all rust, scratches, dents, etc. Contractor shall be responsible for all cleaning and re-finishing required to provide Owner with equipment that is in factory-new condition at Substantial Completion of the project. All labels shall be clean and legible.

### 3.02 TESTING AND INSPECTION

- A. Inspection and testing shall be performed on medical–surgical vacuum source system before being put into service to assure the facility, by a documented procedure, that all applicable provisions of NFPA 99 have been adhered to, that the system is functioning properly, and system integrity has been achieved or maintained.
- B. System verification tests shall be performed only after all installer performed tests, have been completed. Equipment Vendor or installing Contractor shall not perform system verification, final testing or certification.
- C. It shall be the responsibility of the Third Party Medical Gas System Verification Testing Agency to make periodic job Site visits to assure all requirements of this specification and NFPA 99 are strictly adhered to.
- D. Certification shall clearly state that the system is approved for laboratory use and meets all requirements of NFPA-99 inclusive of all referenced and/or related documents. Any exceptions or limitations shall be clearly stated on the same certification document.

3.03 VENDOR SUPERVISION

- A. An authorized representative of the equipment manufacturer shall periodically check with the installing Contractor during initial installation of the laboratory vacuum pump system and shall assist the Contractor in final checking to make certain that all components are operating as recommended by the manufacturer, as specified, and in accordance with NFPA 99. The equipment manufacturer's representative shall provide a minimum of 4 hours instruction to UT Health Science Center - Houston personnel in the use, operation and maintenance of the system.

**END OF SECTION 22 62 21**

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 the following Sections:
  - 1. Section 23 05 29 - Sleeves, Flashings, Supports and Anchors
  - 2. Section 22 62 21 - Laboratory Vacuum pump Systems (rotary claw)
- 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.
  - 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 <u>Inches</u>	MAX. HANGER SPACING <u>Feet</u>	HANGER ROD DIAMETER <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

DIVISION 26 00 00 - ELECTRICAL

1. GENERAL

- A. Furnish all labor, supervision, materials, equipment, apparatus and appurtenances required for a complete working and coordinated electrical system as shown on the drawings and specified herein.
- B. Wherever applicable or not otherwise specified, all electrical work including equipment, material and installation shall be in accordance with base building specifications and practices.
- C. All electrical work shall be constructed and finished in every respect in a workmanlike and substantial manner. Furnish and install all work necessary to complete the system in accordance with the best trade practice and to the satisfaction of the engineer. The entire installation shall be ready in every respect for satisfactory and efficient operation when completed. The engineer will interpret the meaning of the drawings and specifications and may reject any work and materials which, in their judgment, is not in full accordance therewith.
- D. Submit a single certification stating that all portions of the work are in accordance with contract requirements. Warranty all work against faulty and improper material and workmanship for a period of one year from date of final acceptance by the tenant, except that where guarantees or warranties for longer terms are specified, such longer term shall apply. At no additional cost to tenant or engineer, within 24 hours after notification, correct any deficiencies which occur during the warranty period, to the satisfaction of the tenant.
- E. The contractor covenants and agrees that he and his subcontractors and his and their agents and employees will provide and maintain a safe place to work and will comply with all laws and regulations of all governmental authorities having jurisdiction thereof, and the contractor agrees to indemnify, defend and hold harmless, the engineer and tenant from and against any liability, loss, damage or expense, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractors and his and their agents and employees to provide and maintain a safe place to work or to comply with laws and regulations of governmental authorities having jurisdiction thereof.
- F. The contractor and each subcontractor covenants and agrees to indemnify, defend and hold harmless the Engineer and tenant against any liability, loss, damage or expenses, including attorneys' fees, arising from a failure or alleged failure on the part of the contractor, his subcontractor or his or their agents and employees to properly discharge the obligations assumed by him or them in the performance of the work, including any act or omission allegedly resulting in death or personal injury or property damage on improper construction, construction techniques, or the use of improper or inappropriate material or tools.
- G. The drawings show various conduit and wiring systems schematically and provide circuit numbers for reference only. Provide additional neutral wire where it is necessary to run circuits of the same phase in common conduit (maximum of three phase conductors in a single conduit). Balance all panelboards and record all circuit numbers on as-built drawings.
- H. Comply with all applicable requirements of the building owner, the tenant lease and building design criteria for tenant improvements.
- I. Architectural specifications and general, special and supplementary conditions, where provided, shall form a part of these specifications.

2. CODES AND PERMITS

- A. All work shall be done in full compliance with the National Electrical Code, all applicable state and local codes, requirements and ordinances and applicable requirements of NFPA, UL and other applicable standards.

- B. All equipment and materials shall be new and listed by the Underwriters' Laboratories, Inc., Manufactured in full accordance with applicable ASME, NEMA, ANSI, or IEEE standards.
- C. Secure and pay for all necessary approvals, permits, inspections, etc., and deliver the official records of the granting of such to the tenant without additional cost to the tenant.

3. COORDINATION

- A. Coordinate the work of this section with the work of other sections in ample time for the proper installation and connection. Carefully check space requirements with other trades to ensure that all equipment and materials can be installed in the spaces allotted thereto.
- B. Carefully check the documents of other Divisions to ascertain the requirements of any materials or equipment being furnished or furnished and installed by that Division and provide the proper installation and connections including any control wiring required.
- C. Transmit all information required for work being performed by other trades in ample time for the proper installation and connection and for the provision of all openings required in floors and walls.
- D. Refer to architectural drawings for exact locations of all lighting fixtures, outlets and switches, including mounting heights. Refer to the architectural drawings for finishes of equipment and materials not specified herein.
- E. All interruptions of services (power, fire alarm, water, HVAC, etc.) and all work in occupied tenant spaces (e.g. plumbing or electrical work in an occupied tenant's space below a space under construction) must be scheduled through the building manager a minimum of 24 hours in advance. Any interruptions or construction which will affect normal operation of the building or it's tenants shall be scheduled, with the building manager's approval, on an after-hours basis.
- F. Field core drilling and cutting of holes in the existing structure for the work under this section shall be the responsibility of this contractor. Drilling and cutting shall be coordinated through the general contractor and approved by the building manager. Where the services of a structural engineer are necessary to approve such drilling and cutting, this contractor shall bear the cost of such services. All costs for drilling, cutting, and associated structural reinforcing shall be borne by this contractor.
- G. Cutting and patching of new and existing building finishes for installation of work of this section shall be coordinated through the general contractor and approved by the building manager. Where cutting and patching is approved, it shall be performed by the trades who normally install the work which is being removed and the cost of cutting and patching shall be borne by this contractor.

4. EXISTING CONDITIONS

- A. Before submitting a bid, the contractor shall become thoroughly familiar with actual existing conditions at the building and the present installations to which connections must be made or which must be changed or altered. The intent of the work is shown on the drawings and described herein, and no consideration will be granted by reason of lack of familiarity on the part of the contractor with actual physical conditions at the site.
- B. Schedule all work connecting with existing systems to ensure a minimum of service interruption. Notify the building manager in writing of any planned interruption in service in ample time for the building manager's convenience and proceed with plan only after the building owner's written approval is obtained.
- C. Where specifically called for on the drawings or when permission is specifically given by the tenant or building manager, existing equipment and material may be reused.
- D. Verify and become thoroughly familiar with building systems, such as life safety and emergency lighting and provide for the proper wiring and interconnects where applicable.

- E. This contractor shall repair any fireproofing damaged by this contractor, to the integrity of the original construction.
- F. This Contractor shall include relocation of 30 lineal feet of 3/4" conduit and three junction boxes to allow proper installation of the Mechanical and Plumbing systems.

5. DEMOLITION

- A. Refer to Architectural Demolition and Renovation Plans for scope of area being renovated and walls to be removed.
- B. Where electrical devices occur in walls being removed, the electrical contractor is responsible for removing all wire and conduit back to a junction to remain, to the homerun junction box or flush with chase walls, floor penetrations or areas where access to the conduit is restricted. Where the circuit is released the electrical contractor shall remove the wire from the breaker and turn the breaker to the "off" position.
- C. Where electrical devices are removed, it is the responsibility of the electrical contractor to ensure circuit continuity to remaining electrical devices, that are not in areas where the demolition is occurring.

6. SUBMITTALS

- A. Prepare and submit detailed shop drawings for electrical equipment as requested herein. Equipment installed without approval thereof shall be done at the risk of this contractor and the cost of removal of such equipment or related work which is judged unsatisfactory for any reason shall be at the expense of this contractor.
- B. During the progress of the work, make a careful record of all instances where the actual installation differs from that indicated on the contract drawings. Where branch circuit conduit connections between individual devices are not shown on the contract documents, as-built drawings shall show the branch circuit connections between devices as actually installed. Upon completion of the installation, furnish two complete sets of reproducible as-built drawings. These drawings shall be submitted to the engineer for approval. After approval they shall become the property of the tenant and building owner. Final payment will be withheld until receipt of the approved as-built drawings.
- C. Submittal reviews for equipment will not be made upon submission of manufacturers' names. Submittal reviews for equipment will be made only after receipt of complete and satisfactory submittals. Equipment will be reviewed for general compliance with the design concepts shown on the Construction Documents. The opinion and judgment of the Engineer shall be final.
- D. Notify the engineer, in writing, within 5 days of award of contract, of the proposed delivery schedule for any equipment or material which will prevent the installation from being completed at the time of the scheduled project completion.
- E. Submit manufacturer's data or shop drawings of the following apparatus, as applicable, giving full information as to dimensions, materials, features, performance data and other information pertinent to the submitted equipment.
  - Light fixtures and lamps
  - Wiring devices
  - Electrical equipment

7. TESTING

- A. The contractor shall fully test all systems, which the contractor has installed, for proper operation and shall demonstrate such proper operation to the tenant and engineer's representative.
- B. Prior to energization, all new feeder and branch circuit conductors shall be checked for continuity and short circuits.



- C. All new feeder conductors shall have their insulation resistance tested after its installation is complete except for connection at the source and point of termination. Tests shall be made using a Biddler Megger or equivalent test instrument at a voltage of not less than 1,000 volts dc, and after one minute of operation at slip speed. Resistance shall be measured from conductor to conductor and conductor to ground for all installed conductors. Conductors which do not meet or exceed the following insulation resistance values shall be removed, replaced and retested:

<u>WIRE SIZE (AWG)</u>	<u>INSULATION RESISTANCE (OHMS)</u>
No. 12 _____	1,000 K
No. 10 and No. 8 _____	250 K
No. 6 through No. 2 _____	100 K
No. 1 through No. 4/0 _____	50 K
250 MCM and larger _____	25 K

8. LIGHTING FIXTURES AND LAMPS

- A. Furnish and install light fixtures and lamps as specified on the drawings. Light fixtures shall be complete with all required accessories for proper installation in the ceiling types in which they are installed.
- B. All indoor fluorescent fixture ballasts shall be Advance Mark V energy saving ballasts, unless noted otherwise. All fluorescent lamps shall be Phillips F32T8/TL841/ALTO or an approved equal, unless noted otherwise.
- C. All lighting fixtures and lamps shall be furnished by the electrical contractor, unless noted otherwise on the drawings as reused or relocated existing building standard fixtures furnished by the building owner; or fixtures furnished by the tenant.
- D. Lighting fixtures which are noted to be relocated or reused shall be cleaned and relamped prior to reuse. Fixtures that are damaged or defective shall not be reused, notify Engineer in writing of quantity of fixtures to be replaced. Existing light fixtures which are removed and not reused shall be stored as directed by the building manager.
- E. Conductors for connection to individual light fixtures in grid type ceilings from their associated junction boxes shall be No. 14 AWG THHN, 600 volt, solid copper conductors in 72" long 3/8" flexible metal conduit fixture tails, or by Type MC cable fixture tails where permitted by the local authority having jurisdiction, in lengths not to exceed 10'.
- F. All lay-in lighting fixtures shall be connected to a branch circuit junction box with a flexible fixture tail. A maximum of four fixture tails shall be connected to a single junction box. Fixture to fixture wiring of lay-in fixtures is not permitted.
- G. Provide a minimum of two hold-down clips per fixture, located at opposite corners of fixtures.

9. WIRE AND CABLE

- A. Control wiring shall be stranded copper, No. 14 AWG minimum with Type THW or THHN/THWN insulation. Power wiring sized No. 12 AWG shall be solid or stranded copper with Type THHN/THWN insulation. Power wiring sized No. 10 AWG and larger shall be stranded copper with Type THHN/THWN insulation. Stranded wire shall not be terminated under screw terminals.
- B. Conductor splices, taps, and terminations shall be made using connectors or lugs approved for the intended use. Preinsulated spring connectors may be used for connections and splices of wire sizes up to No. 8 AWG.

- C. All power wiring shall be color coded to match the base building color coding schedule. Color coding shall be via color coded insulation or color coded tape at every conductor splice, termination or tap.
- D. Branch circuits homeruns shall be limited to three phase conductors, on different phases, with neutral and ground conductors as shown and shall be installed in conduit. Separate neutral conductors shall be provided for each phase on data circuits and elsewhere where shown or noted on the drawings, where scheduled or specified.
- E. Type MC cable may be used, where approved by the local authority having jurisdiction: for drops in partitions to receptacles; for single circuit branch circuit wiring from receptacle to receptacle; for lay-in fixture pigtails; for switch leg drops; from fixture junction boxes or nonlay-in fixtures; or for single circuit branch circuit wiring from fixture to fixture (except lay-in fixtures) and fixture to junction box. Type MC cable shall be copper conductors with THHN insulation and a full size green THHN insulated ground wire and an aluminum or galvanized steel flexible armor.
- F. Type MC cable shall not be used for branch circuit homeruns or for receptacle to receptacle wiring in partitions. Type MC cable shall not be used where more than three conductors (phase/neutral/ground) are required, where exposed, or in lengths exceeding 20'.
- G. Type MC cable shall be supported in accordance with the NEC.
- H. For 120 volt, 20 amp branch circuits with a length of 75' or more to the homerun junction box or first outlet, provide minimum No. 10 AWG conductors to the homerun junction box or first outlet. Where the additional circuit length from the homerun junction box or first outlet to the last outlet exceeds 75', provide minimum No. 10 AWG conductors to the last outlet. For 208 volt, 20 amp branch circuits with a length of 100' or more, provide No. 10 AWG conductors for the entire branch circuit. For 208 volt, 30 amp branch circuits with a length of 100' or more, provide No. 8 AWG conductors for the entire branch circuit. For 277 volt, 20 amp branch circuits with a length of 150' or more, to the first outlet provide No. 10 AWG conductors to the center of the load (minimum first outlet, where there is only one outlet).
- I. Conductors for lighting and power branch circuits shall be of such a size that the drop in potential from the panelboards to the farthest point on the circuits shall not exceed 2% at maximum load and 70% power factor, at 120/208 volts and 1% at maximum load at 277/480 volts.

#### 10. CONDUIT AND BOXES

- A. All power wiring shall be installed in an approved raceway, except where Type MC cable is allowed, as specified hereinabove. All control wiring shall be installed in an approved raceway, except that low voltage control wiring may be installed without a raceway, in concealed accessible locations, when a UL-listed plenum rated cable is used. Conduit shall be concealed to the maximum extent possible and when exposed, shall be run parallel and perpendicular to building lines. All conduit and Type MC cable shall be independently supported from the building structure. Supports shall be independent from the ceiling system supports.
- B. Electrical metallic tubing (EMT) shall be used for branch circuit raceways indoors where concealed or exposed. Electrical metallic tubing may not be used in damp or wet locations or where subject to physical damage, and for any emergency or power feeders.
- C. Rigid Steel and Intermediate Metal Conduit: Use rigid steel or intermediate metal conduit to run all electrical raceway systems where exposed to weather; in damp or wet locations; where subject to physical damage; and where cast in concrete walls or floor slabs which have waterproof membranes and where cast in masonry walls. Use rigid steel conduit for all 5/15 kV and 600 volt power feeders and all emergency branch and power feeders, unless otherwise noted. Use rigid steel or IMC conduit for all exposed conduit below 8'-0" above finished floor. IMC conduit shall not be used in sizes larger than 4". Use threaded type couplings and fittings. Split type couplings and fittings are not acceptable.

- D. PVC-coated Rigid Steel: Use polyvinyl chloride (PVC) externally-coated rigid steel conduit and fittings for electrical raceway systems for branch circuits to wet areas; where exposed outdoors; and elsewhere, as shown. Conduit and fittings shall be installed such that the PVC-coating is continuous and watertight such that no portion of the metal conduit or fittings is exposed to moisture.
- E. Flexible conduit, in lengths not to exceed 48", shall be used to extend conduit connections to motors, transformers and other permanently connected appliances, equipment or devices which are vibration producing or require access for maintenance or adjustment. Liquid tight flexible metal conduit shall be used for all flexible connections in damp or wet areas.
- F. PVC conduit shall not be used.
- G. Minimum conduit size shall be 3/4" for power wiring and 3/4" for voice and data, unless noted otherwise on the drawings.
- H. Outlet and junction boxes shall be minimum 4" square or octagonal by 2-1/8" deep with coverplates or plaster rings as required. Larger boxes shall be provided where required by the NEC. Deep boxes shall be provided for all outlet and junction boxes used in suspended ceiling spaces.
- I. All slab penetrations shall be sealed with a UL-listed fire safing and waterstop system and all rated partition penetrations shall be sealed with a UL-listed fire safing system, in accordance with applicable state and local requirements.

11. WIRING DEVICES

- A. Duplex receptacles shall be Decora face, specification grade type and shall match the base building standards, where applicable. Typical receptacle types shall be as follows, or an approved equal:

Office/Lab/General Use

Simplex, NEMA 5-20R, white	_____	Leviton 16351-W
Duplex, NEMA 5-15R, white	_____	Leviton 16252-W
Duplex, NEMA 5-20R, white	_____	Leviton 16352-W
Duplex, NEMA 5-20R, data processing, gray	_____	Leviton 16352-GY
Duplex, NEMA 5-20R, data processing, isolated ground, gray	_____	Leviton 16362-IGG
Duplex NEMA 5-20R, TVSS, isolated ground, audible/visual indicator, white	_____	Leviton 8380-IGW
Duplex, NEMA 5-20R GFCI, white	_____	Leviton #6899-W

- B. Duplex receptacles shall be specification grade type and shall match the base building standards, where applicable. Typical receptacle types shall be as follows, or an approved equal:

Wet Areas

Simplex, NEMA 5-20R, white	_____	Leviton 5361-W
Duplex, NEMA 5-15R, white	_____	Leviton 5262-W
Duplex, NEMA 5-20R, white	_____	Leviton 5362-W
Duplex, NEMA 14-30R, white	_____	Leviton 278
Duplex, NEMA 6-30R, white	_____	Leviton 5372

- C. Where only one wiring device is installed on a 20 ampere branch circuit, then a 20 ampere wiring device must be used.

- D. Switches shall be rocker type, Decora face, specification grade type, rated at 120/277 volts, 20 amps, and shall match the base building standards, where applicable. Typical switch types shall be as follows, or an approved equal:

Office/Lab/General Use

Single pole, white _____	Leviton 5621-2W
Two pole, white _____	Leviton 5622-2W
Three-way, white _____	Leviton 5623-2W
Four way, white _____	Leviton 5624-2W
Single pole, white, pilot light _____	Leviton 5658-2W
Momentary, white _____	Leviton 5657-2W

- E. Switches shall be specification grade type, rated at 120/277 volts, 20 amps, and shall match the base building standards, where applicable. Typical switch types shall be as follows, or an approved equal:

Wet Areas

Single pole, white _____	Leviton 1221-2W
Two pole, white _____	Leviton 1222-2W
Three-way, white _____	Leviton 1223-2W
Four way, white _____	Leviton 1224-2W
Single pole, white, pilot light _____	Leviton 1221-PLC
Momentary, white _____	Leviton 1257-W

- F. Wall box dimmers with linear slide and positive on/off switch, dimmers shall be Lightolier Sunrise series, Prescolite Horizon dimmers maximum 1000 watts or an approved equal. Matching switches shall be provided where noted on the drawings. Wall box dimmers shall be white, unless noted otherwise. Ganged dimmers and switches shall be provided with a common coverplate.
- G. Wall mounted passive room occupancy sensor with off-auto switch, capable of controlling fluorescent electronic ballast or incandescent loads, white, 1200 watts at 277v and 600 watts at 120v. Leviton #6775-w or equal by Watt Stopper or Lightolier.
- H. Matching white thermoplastic coverplates shall be provided for all wiring devices located in office areas. Wiring devices shall be ganged with a common coverplate, whenever possible.
- I. Stainless Steel coverplates shall be provided for all wiring devices located in Lab and General Use areas. Wiring devices shall be ganged with a common coverplate, whenever possible.
- J. Die-cast zinc weather-resistant covers shall be provided for all wiring devices located in Wet areas. Wiring devices shall be ganged with a common coverplate, whenever possible.
- K. Poke-thru floor outlets shall be UL-listed for use in the floor slab where they are used and shall have the devices or features noted or scheduled on the drawings. Poke-thru floor outlets shall be as manufactured by Square D, Raceway Components, Inc., Hubbell or Nelson Electric.
- L. Flush floor outlet boxes shall be furnished complete with all required trim and accessories. Cast iron floor boxes shall be used in concrete slabs with a vapor barrier and galvanized steel floor boxes shall be used in all other concrete slabs.

12. ELECTRICAL EQUIPMENT

- A. All electrical equipment used on the project shall, to the maximum extent possible, be the product of a single manufacturer. All new electrical equipment shall be fully compatible with existing equipment. Where new components are added to existing electrical equipment, they shall be manufactured by the existing equipment manufacturer. All outdoor panels shall be nema 3-R.
- B. Safety switches shall be heavy duty type, fuse or nonfused, as noted, and with a solid neutral bus where a neutral is present. Switches shall have a NEMA 1 enclosure for indoor use and a NEMA 3R enclosure for outdoor use.
- C. Fuses up to 600 amperes shall be Bussmann "Low Peak", Class RK1 current limiting fuses, LPS-R (600 volt) or LPN-R (250 volt). Fuses 601 amperes and larger shall be Bussmann KRPC type current limiting fuses.
- D. Each piece of electrical equipment shall have a screw secured, engraved plastic nameplate. Nameplates shall indicate equipment type, designation, voltage and equipment served, as applicable. Typed panel schedules indicating circuit numbers, loads served and connected loads for all circuits shall be installed behind a lexan cover inside each new and existing panelboard which serves the lease space.

13. VOICE AND DATA OUTLETS

- A. Individual voice and data outlets shall consist of a drywall mounting ring with a grommet in the wall top plate and a pull string up to an accessible ceiling space. Where voice and data outlets are located in areas with inaccessible ceiling spaces and elsewhere where noted on the drawings, voice and data outlets shall consist of a wall outlet box with a 3/4", minimum, conduit with pullstring to an accessible ceiling space or a voice or data terminal board as noted on the drawings.
- B. Voice and data cable shall be furnished, installed and terminated by the tenant.

14. MISCELLANEOUS

- A. Electrical connections to tenant and contractor-furnished equipment shall be the responsibility of this contractor, unless noted otherwise. This contractor shall verify the rough-in requirements for equipment as furnished and shall provide rough-in and final connections as required.
- B. Miscellaneous electrical controls and equipment shall be furnished and installed as noted on the drawings. This contractor shall be responsible for furnishing all miscellaneous control power connections to equipment furnished by this contractor or the tenant, general contractor or other contractors.
- C. HVAC temperature controls, control devices and control wiring shall be furnished and installed by the mechanical contractor. This contractor shall be responsible for furnishing 120 volt power connections to the HVAC temperature controls as shown on the drawings and as required.
- D. Furnish and install security systems provisions, where shown on the drawings. Prior to installation, coordinate the exact rough-in requirements with the selected security vendor.
- E. Provide all material and equipment to make the final connections to all equipment, appliances and furniture including any flexible conduit for furniture connections not furnished with furniture.

- F. Furnish access doors to the general contractor, for installation by the appropriate trades, in locations where access is required to electrical equipment which would otherwise be inaccessible. Care should be taken in locating electrical equipment to minimize the number of access doors required. Final locations of access doors in finished areas shall be approved by the architect. Access doors shall be as specified by the architect. Where no architectural access door specification exists, then access doors shall be as follows:

Drywall partitions _____	Inryco/Milcon Style DW
Drywall ceilings _____	Inryco/Milcon Style DW or Style WB-PL as directed by the architect
Plaster walls or ceilings _____	Inryco/Milcon style WB-PL

15. MOUNTING HEIGHTS

- A. Mounting heights for electrical devices shall be as follows, unless noted otherwise on the electrical or architectural drawings or required to match existing installations or handicapped codes:

Wall switches _____	45" above finished floor
Wall receptacles _____	18" above finished floor with long axis vertical. Above counter receptacles 6" above counters without backsplashes or 4" above backsplash for counters with backsplashes, with long axis horizontal
Voice and data outlets _____	18" above finished floor
Wall telephone outlets _____	45" above finished floor
Panelboards _____	72" above finished floor to top of panel
Fire alarm pull stations _____	45" above finished floor
Fire alarm wall signals _____	80" above finished floor or 6" below finished ceiling, whichever is lower.

END OF SPECIFICATIONS