

**DOCUMENT 00 90 00
ADDENDUM**

ADDENDUM NO. [1] Date: July 15, 2019

**RE: WITC – NEW RICHMOND CAMPUS
 VETERINARY TECHNICIAN ADDITION REBID
 1019 SOUTH KNOWLES AVE
 NEW RICHMOND, WI 54017
 HSR PROJECT NO. 18043-6**

**FROM: HSR Associates, Inc.
 100 Milwaukee Street
 La Crosse, WI 54603
 (608) 784-1830**

To: Prospective Bidders

This addendum forms a part of the Contract Documents and modifies the original Bidding Documents dated July 2019. Acknowledge receipt of this Addendum in the space provided on the bid form. Failure to do so may subject the Bidder to disqualification.

This Addendum consists of (22) 30x42 sheets and (302) 8.5x11 pages which include the Prequalification Application and MEP Specification documents.

CHANGES TO BIDDING REQUIREMENTS AND CONDITIONS OF THE CONTRACT:

1. CONTRACTOR PREQUALIFICATION

- a. The Owners Prequalification Application is attached hereto for General Contractors and Subcontractors that have not previously applied for the 2019 construction season. As stated in the document, the **application is due no later than 3:00 p.m. July 19**, but we would encourage applicants to return them ASAP so that all Contractors can be made aware of eligible Contractors as soon as possible.

2. CHANGES TO SPECIFICATIONS:

- a. Delete Section 09 67 00 Fluid Applied Flooring
- b. Add Divisions 21, 22, 23, 26, 27 and 28. These divisions are attached hereto See the included TOC for sections included.

3. CHANGES TO DRAWINGS:

- a. FIRE PROTECTION: Add Fire Protection full size sheet FP101 attached hereto.
- b. PLUMBING: Add Plumbing full size sheets P001, P100, P101, P111, P112, P121, P201, P301, and P401 attached hereto.
- c. MECHANICAL: Add Mechanical full size sheets M001, M101, M111, M501, and M601 attached hereto.
- d. ELECTRICAL: Add Electrical full size sheets E001, E101, E110, E111, E120, E121, and E601 attached hereto.

END OF DOCUMENT 00 90 00

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WITC

WISCONSIN
INDIANHEAD
TECHNICAL
COLLEGE

Contractor
Prequalification
Application

VET-TECH-CW-
PREQUAL



HSR Associates
100 Milwaukee Street
La Crosse, WI 54603
608.784.1830
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PREQUALIFICATION PROCEDURES

The District Board of Wisconsin Indianhead Technical College has determined that general, roofing, mechanical, plumbing, electrical and low voltage trades intending to submit bids for the New Richmond Veterinary Tech building addition that will be constructed during fiscal year 2019 (FY19) must be prequalified.

This prequalification opportunity is only for this project. Projects for 2020 will require Contractors attention when those prequalification documents are released.

Projects:

WITC New Richmond July 2019:

Veterinary Tech Program Addition and Renovation

Owner:

Wisconsin Indianhead Technical College (WITC)
Administrative Office
505 Pine Ridge Drive
Shell Lake, WI 54871

Architect:

HSR Associates, Inc.
100 Milwaukee Street
La Crosse, WI 54603

Project Descriptions and Schedules:

Maintaining this very aggressive schedule is extremely critical to College operations. The schedule dates listed however, are proposed dates only and may be subject to change.

WITC New Richmond:

I. Veterinary Tech Program Addition and/or Renovation

<i>Bidding:</i>	<i>July 25, 2019</i>
<i>Award:</i>	<i>Approx. Aug 8, 2019</i>
<i>Start Work:</i>	<i>Aug 2019</i>
<i>Subst. Completion:</i>	<i>Feb 3, 2020</i>

A building addition to house the new Veterinary Tech Program, including all site and utility modifications. A portion or all may also be renovations of existing space.

Submittal Requirements

Prequalification is required for General Contractors, Roofing Contractors, and the following trades:

- Plumbing
- Heating, Ventilation, and Air Conditioning
- Electrical
- Low Voltage

To obtain a submittal packet, please contact HSR Associates, Inc. at 608-784-1830, or email Toni Furlano tfurlano@hsrassociates.com.

Submission

To be considered, interested contractors must submit a full and complete packet marked "VETTECH- CW- PREQUAL" on the envelope, ASAP, but no later than **3:00 PM July 19, 2019** to:

Wisconsin Indianhead Technical College
Administrative Office
505 Pine Ridge Drive
Shell Lake, WI 54871

In addition to the mailed copy, WITC will accept an emailed PDF copy of the packet. Packets should be emailed to proposals@witc.edu. Include in the subject line "VET-TECH-CW-PREQUAL-COMPANY NAME"

Late proposals will be returned unopened

Bids will not be accepted from any contractor that did not timely submit a completed prequalification questionnaire and supporting documents to the District Board. Financial statements may be requested and must be available upon request. Omission of requested information, falsification of information, or failing to use the forms provided by the District may result in a finding of "not prequalified."

ALL CONTRACTORS PREVIOUSLY ON THE PREQUALIFIED LIST FOR FY18 NEED ONLY SUBMIT THE FOLLOWING DOCUMENTS: (Contractors on the current FY19 prequalified list can disregard this package.)

- Contractor Prequalification Application (Page 6, Paragraphs A & C only)
- Contractor's Certification (Page 13)
- Certification from Surety of Bonding Capacity
- List of any Claims and Suits (Include: Judgments, Claims, Arbitration Proceedings or Suits Pending and any Law Suits or Arbitrations requested from your Firm in the last year)

Essential Bidding Requirements

Any mechanical (HVAC), plumbing, electrical, and low voltage subcontractors required for any Project must be prequalified pursuant to these prequalification forms and requirements.

All general contractors and roofing contractors must use the approved, prequalified mechanical (HVAC), plumbing, electrical and low voltage subcontractors.

If a listed mechanical (HVAC), plumbing, electrical and low voltage subcontractor in any general contractor bid is not prequalified, that bid will not be accepted.

The District Board reserves the right to amend the prequalification packet at any time. The District Board reserves the right to waive minor irregularities and omissions in the information contained in the prequalification application submitted and to make all final determinations. Additionally, a determination by the District Board that a contractor is prequalified does not amount to a final determination that such contractor is responsible or responsive for purposes of bid evaluation. The District Board reserves the right to reject a prequalified contractor's bid, and the District Board may additionally reject all bids if it determines such action is in its best interest.

Contractors determined to be qualified to bid the project(s) will be notified after the proposals are reviewed and listed in the Project Manuals as approved contractors.

Questions regarding these projects, or the prequalification process, may be directed to Daniel Blumer, HSR Associates, Inc., 608-784-1830.

Questionnaires and Certifications

The questionnaires and certifications consist of the following items:

- Contractor Prequalification Application
- List of six (6) Projects
- Contractor Certification
- AIA Document A305 Contractor's Qualification Statement (not included)
- Certification from Surety of Bonding Capacity (not included)

All questions in the questionnaire must be answered. If a question is not applicable, then indicate a response of "N/A." "You" or "Yours" as used herein refers to the prospective bidders' firm and any of its owners, officers, principals and qualifying individuals. If two or more business entities submit a bid on a project as a Joint Venture, or expect to submit a bid as part of a Joint Venture, each entity within the Joint Venture must be separately qualified to bid.

Questionnaire must be signed under penalty of perjury in the manner designated at the end of the form, by an individual who has the legal authority to bind the contractor on whose behalf that person is signing. If any information provided by a contractor becomes inaccurate, the contractor must immediately notify the District Board and provide updated accurate information in writing, under penalty of perjury. Each prospective bidder shall have a duly authorized owner, officer or principal complete the questionnaire and verify the truth of the information provided therein and in the financial statement.

Financial Statement (Upon Request)

In addition to completing the attached questionnaire, each prospective bidder must have available, upon request, its most current reviewed or year-end audited financial statement, which must have been prepared by a certified public accountant within twelve (12) months of each prospective bidder's submission of the prequalification package. Each prospective bidder must also, upon request, provide its most current financial statement, which must have been prepared within three (3) months of each prospective bidder's submission of the prequalification package.

Financial statements requested shall not be prepared by any individual who is in the regular employ of the firm submitting the statement, nor by any individual or entity who has more than a ten percent (10%) financial interest in the firm's business. If the individual or entity that prepared a financial statement requested by the District Board has financial interest in the firm's business, the firm shall notify the District Board of such financial interest in a separate signed statement accompanying this financial statement package.

The questionnaire answers and financial statements included in the prequalification packages submitted by contractors are not public records and are not open to public inspection. All such information provided will be kept confidential to the extent permitted by law, although the contents may be disclosed to third parties for the purpose of verification, investigation of substantial allegations, and in the process of any subsequent proceedings.

CONTRACTOR PREQUALIFICATION APPLICATION

A. General Information:

Contractor's name as it appears on license:

CIRCLE ONE: Corporation Partnership Sole Proprietorship

Contact Person: _____

Street Address (P.O. Box is not acceptable):

Telephone: _____ Fax: _____

E-mail address: _____

Contractor's applicable trade(s) (check all that apply)

- ___ General Contractor
- ___ Roofing Contractor
- ___ Mechanical (HVAC) Contractor
- ___ Plumbing Contractor
- ___ Electrical Contractor
- ___ Low Voltage Contractor

***Electrical Contractors that self-perform low voltage must check the low voltage box to complete prequalification process.

B. In addition to the information required by AIA A305, qualification evaluations will also consider each Contractor's ability to satisfy the following criteria:

1. Minimum 10 years' experience as a contractor in the trades checked above (Low-voltage contractor's minimum of 5 years' experience). Our firm has _____ years of experience in the applicable trades.
2. Successful completion of six (6) projects with three (3) of the projects being educational only, and all being of similar value (construction cost) in the past 7-years. Roofing contractors must provide a minimum of one (1) project constructed as a fully adhered roof system. Similar value is defined as:

	<u>Minimum Preferred</u>
General Contractor:	\$ 500,000.00
Roofing Contractor:	\$ 150,000.00
Mechanical (HVAC) Contractor:	\$ 300,000.00
Plumbing Contractor:	\$ 75,000.00
Electrical Contractor:	\$ 300,000.00
Low Voltage Contractor:	\$ 50,000.00

For general contractor applicants: Only list projects your firm performed as the general contractor in charge of all trades for the construction of a building.

For subcontractor applicants: Only list projects your firm performed as the prime contractor if a single trade job or as a subcontractor on a multiple trade contract. For multiple trade contracts, indicate the general contractor's name and contact information.

C. Bonding Capacity:

1. Each prospective bidder must submit a notarized statement from an admitted surety insurer which states your current bonding capacity.

Project Number 1

Project Name: _____

Location: _____

Owner: _____

Owner Contact (name and current phone number): _____

Architect or Engineering firm: _____

Architect or Engineer Contact (name and current phone number): _____

Construction Manager (name and current phone number): _____

Description of Project, Scope of Work Performed:

Total Value of Construction (including change orders): _____

Date Construction Commenced: _____

Original Contractual Completion Deadline: _____

Adjusted Completion Deadline Based on Time Extensions Granted by Owner: _____

Actual Date of Completion: _____

General Contractor's Project Manager (lead contact in office) _____

General Contractor's Superintendent (lead contact on project site) _____

Project Number 2

Project Name: _____

Location: _____

Owner: _____

Owner Contact (name and current phone number): _____

Architect or Engineering firm: _____

Architect or Engineer Contact (name and current phone number): _____

Construction Manager (name and current phone number): _____

Description of Project, Scope of Work Performed:

Total Value of Construction (including change orders): _____

Date Construction Commenced: _____

Original Contractual Completion Deadline: _____

Adjusted Completion Deadline Based on Time Extensions Granted by Owner: _____

Actual Date of Completion: _____

General Contractor's Project Manager (lead contact in office) _____

General Contractor's Superintendent (lead contact on project site) _____

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Project Number 3

Project Name: _____

Location: _____

Owner: _____

Owner Contact (name and current phone number): _____

Architect or Engineering firm: _____

Architect or Engineer Contact (name and current phone number): _____

Construction Manager (name and current phone number): _____

Description of Project, Scope of Work Performed:

Total Value of Construction (including change orders): _____

Date Construction Commenced: _____

Original Contractual Completion Deadline: _____

Adjusted Completion Deadline Based on Time Extensions Granted by Owner: _____

Actual Date of Completion: _____

General Contractor's Project Manager (lead contact in office) _____

General Contractor's Superintendent (lead contact on project site) _____

Project Number 4 (Education Only)

Project Name: _____

Location: _____

Owner: _____

Owner Contact (name and current phone number): _____

Architect or Engineering firm: _____

Architect or Engineer Contact (name and current phone number): _____

Construction Manager (name and current phone number): _____

Description of Project, Scope of Work Performed:

Total Value of Construction (including change orders): _____

Date Construction Commenced: _____

Original Contractual Completion Deadline: _____

Adjusted Completion Deadline Based on Time Extensions Granted by Owner: _____

Actual Date of Completion: _____

General Contractor's Project Manager (lead contact in office) _____

General Contractor's Superintendent (lead contact on project site) _____

Project Number 5 (Education Only)

Project Name: _____

Location: _____

Owner: _____

Owner Contact (name and current phone number): _____

Architect or Engineering firm: _____

Architect or Engineer Contact (name and current phone number): _____

Construction Manager (name and current phone number): _____

Description of Project, Scope of Work Performed:

Total Value of Construction (Including change orders): _____

Date Construction Commenced: _____

Original Contractual Completion Deadline: _____

Adjusted Completion Deadline Based on Time Extensions Granted by Owner: _____

Actual Date of Completion: _____

General Contractor's Project Manager (lead contact in office) _____

General Contractor's Superintendent (lead contact on project site) _____

Project Number 6 (Education Only)

Project Name: _____

Location: _____

Owner: _____

Owner Contact (name and current phone number): _____

Architect or Engineering firm: _____

Architect or Engineer Contact (name and current phone number): _____

Construction Manager (name and current phone number): _____

Description of Project, Scope of Work Performed:

Total Value of Construction (including change orders): _____

Date Construction Commenced: _____

Original Contractual Completion Deadline: _____

Adjusted Completion Deadline Based on Time Extensions Granted by Owner: _____

Actual Date of Completion: _____

General Contractor's Project Manager (lead contact in office) _____

General Contractor's Superintendent (lead contact on project site) _____

CONTRACTOR CERTIFICATION

Applications submitted by corporations must be signed with the legal name of the corporation, followed by the name of the state of incorporation and by the signature and designation of the chairman of the board, president or any vice president, and then followed by a second signature by the secretary, assistant secretary, the chief financial officer or assistant treasurer. All persons signing must be authorized to bind the corporation in the matter. The name of each person signing shall also be typed or printed below the signature.

Each person signing below makes the following representations:

The submitter of the foregoing answers to the application has read the same and the matters stated therein are true of his or her own personal knowledge. This information is provided for the purpose of qualifying to bid on the Project, and any individual, company or other agency named herein is hereby authorized to supply the District Board with any information necessary to verify the prospective bidder's statements. By signing below, the submitter and the named contractor hereby grant permission to the District Board to contact any or all of the above listed persons or entities to confirm facts or otherwise investigate the above facts and issues.

The submitter understands that any statement which is proven to be false shall be grounds for immediate disqualification from bidding on the Project. The submitter whose signature appears below represents and warrants that he or she has authority to bind the named contractor.

I, the undersigned, certify and declare that I have read all the foregoing answers to this prequalification application and know their contents. The matters stated in the application answers are true of my own knowledge and belief, except as to those matters stated on information and belief, and as to those matters I believe them to be true. I declare under penalty of perjury under the laws of the State of Wisconsin, that the foregoing is correct.

Executed this _____ day of _____, 20____, at _____

Signature

Typed Name

Contractor

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28 31 00	FIRE DETECTION AND ALARM

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SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SCOPE

A. This section includes information common to two or more technical fire protection specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Continuity of Existing Services.
 - g. Protection of Finished Surfaces.
 - h. Sleeves and Openings.
 - i. Sealing and Firestopping.
 - j. Codes.
 - k. Design Criteria.
 - l. Certificates and Inspections.
 - m. Submittals.
 - n. Operating and Maintenance Instructions.
 - o. Training of Owner Personnel.
 - p. Record Drawings.
2. PART 2 – PRODUCTS.
 - a. Access Panels and Doors.
 - b. Identification.
 - c. Sealing and Firestopping.
3. PART 3 – EXECUTION.
 - a. Concrete Work.
 - b. Cutting and Patching.
 - c. Building Access.
 - d. Equipment Access.
 - e. Coordination.
 - f. Identification.
 - g. Lubrication.
 - h. Sleeves and Openings.
 - i. Sealing and Firestopping.
 - j. Owner Training.

1.2 RELATED WORK

- A. This section applies to all Division 22 sections of fire suppression.
- B. Section 07 84 00 - Firestopping

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:
1. AGA American Gas Association.
 2. ANSI American National Standards Institute.
 3. ASME American Society of Mechanical Engineers.
 4. ASPE American Society of Plumbing Engineers.
 5. ASTM American Society for Testing and Materials.
 6. AWWA American Water Works Association.
 7. AWS American Welding Society.
 8. CGA Compressed Gas Association.
 9. CS Commercial Standards, Products Standards Sections, Office of Engineering Standards Service, NBS.
 10. EPA Environmental Protection Agency.
 11. FM FM Global
 12. FS Federal Specifications, Superintendent of Documents, U.S. Government Printing Office.
 13. IAPMO International Association of Plumbing & Mechanical Officials.
 14. IEEE Institute of Electrical and Electronics Engineers.
 15. ISA Instrument Society of America.
 16. DSPS State of Wisconsin Dept. of Safety and Professional Services.
 17. MCA Mechanical Contractors Association.
 18. MICA Midwest Insulation Contractors Association.
 19. MSS Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
 20. NBS National Bureau of Standards.
 21. NEC National Electric Code.
 22. NEMA National Electrical Manufacturers Association.
 23. NFPA National Fire Protection Association.
 24. STI Steel Tank Institute.
 25. UL Underwriters Laboratories Inc.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.
- C. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

1.6 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval from the Owner's Project Representative. When interruption is required, coordinate scheduling of down-time with the Owner to minimize disruption to his activities. Unless specifically

stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

1.7 PROTECTION OF FINISHED SURFACES

A. Refer to Division 1, General Requirements for Protection of Finished Surfaces.

1.8 SLEEVES AND OPENINGS

A. Refer to Division 1, General Requirements for Sleeves and Openings.

1.9 SEALING AND FIRESTOPPING

A. Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the Contractor whose work penetrates the opening. The Contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Section 07 84 00 - Fire Stopping.

1.10 CODES

A. Comply with requirements of Wisconsin Administrative Code, Dept. of Safety and Professional Services, NFPA Standards and local Fire Chief or Fire Marshal (AHJ, Authority Having Jurisdiction) regarding design, materials and installation.

1.11 DESIGN CRITERIA

A. Design fire protection systems in accordance with codes, standards and regulations noted above.

B. Hydraulically design system for the most remote area based on the following:

<u>Location</u>	<u>Occupancy Classification</u>	<u>Area (SqFt)</u>	<u>Density (GPM/SqFt)</u>
Lower Level	Ordinary Group I	1500	0.15
Classroom Area, Commons Spaces	Light Hazard	1500	0.10
Combustible Concealed Spaces	Light Hazard	1500	0.10

1.12 CERTIFICATES AND INSPECTIONS

A. Refer also to the General Conditions for Permits, Regulations, Utilities and Taxes.

B. Obtain and pay for all required State or local installation inspections except those provided by the Engineer. Deliver originals of NFPA test certificates and test reports to the Division's construction representative. Include copies of the certificates and reports in the Operating and Maintenance Instructions.

1.13 SUBMITTALS

A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop drawing submittals are to be bound, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate

specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.

- C. The specific items that will be required for submittals shall be coordinated with the Owner, the Engineer, and the General Prime Contractor for inclusion in the project submittal log.
- D. Plan submittal for review and approval to the Department of Safety and Professional services is required for all state buildings with the exception of the replacement in kind of equipment and projects that include 20 or fewer sprinkler heads. Submittals shall be sent to the local Fire Chief or Fire Marshal for review prior to the Engineer. Include copy of all review/approval letters in submission to Engineer.
- E. Submit plans indicating water supply location and size, piping layout and size, sprinkler locations and type, hanger locations and type, equipment locations and type, valve locations and type, occupancy classes, hydraulic reference points, design areas and discharge densities.
- F. Submit hydraulic calculations for water supply and sprinkler systems. Include summary sheet and detailed work sheets. Describe characteristics of water supply and location of effective point used in calculations. Include graph illustration of water supply, hose demand, sprinkler demand and in-rack sprinkler demand. Where a fire pump is used, graph primary rating point, secondary rating point and churn pressure of pump and combined water supply.

1.14 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section Division 1, General Requirements.

1.15 TRAINING OF OWNER PERSONNEL

- A. Instruct Owner's personnel in the proper operation, maintenance and testing of systems and equipment provided as part of this project. Include not less than 2 hours of instruction, using the Operating and Maintenance manuals and record drawings during this instruction. Demonstrate testing, startup and shutdown procedures for all equipment. All training to be during normal working hours. Video record all instructions and provide Owner with copy.

1.16 RECORD DOCUMENTS

- A. Refer to Division 1, General Requirements for Record Documents.
- B. In addition to the data indicated in the General Requirements, maintain fire protection layout record drawings and hydraulic calculations on originals prepared by the installing Contractor/Subcontractor. Include copies of these record drawings and calculations with the Operating and Maintenance manuals.

PART 2 PRODUCTS

2.1 ACCESS PANELS AND DOORS

- A. Lay-in Ceilings:
 - 1. Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Division 09 are sufficient; no additional access provisions are required unless specifically indicated.

- B. Concealed Spline Ceilings:
 - 1. Removable sections of ceiling tile held in position with metal slats or tabs compatible with the ceiling system used will be provided under Division 09.
- C. Metal Pan Ceilings:
 - 1. Removable sections of ceiling tile held in position by a pressure fit will be provided under Division 09.
- D. Plaster Walls and Ceilings:
 - 1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

2.2 IDENTIFICATION

- A. STENCILS:
 - 1. Not less than 1/2 inch high letters for pipe sizes 1" through 2-1/2" and 1 inch high letters/numbers for pipe sizes 3" and above for marking pipe and equipment. Apply flow arrows to piping.
- B. ADHESIVE LABELS:
 - 1. Pressure-sensitive, adhesive backed, vinyl pipe markers with applicable labeling, 3/4" min. size for lettering and surrounding tape on both ends. With flow arrows on piping. Conforming to ANSI, ANSI and NFPA standards. Clean piping before application.
 - 2. Manufacturers:
 - a. Seton; Opti-Code: www.seton.com.
 - b. MSI: www.msi-signs.com.
 - c. Brady: www.bradyid.com.
 - d. Brimar Industries, Inc.: www.pipemarker.com.
 - e. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- C. SNAP-AROUND MARKERS:
 - 1. One-piece, pre-formed, vinyl construction, snap-around or strap-around pipe markers with applicable labeling, 3/4 inch min. size for lettering. Provide nylon ties on each end of pipe marker.
 - 2. Manufacturers:
 - a. Seton; Setmark: www.seton.com.
 - b. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- D. SIGNS:
 - 1. Metal construction, baked porcelain enamel finish signs, sizes conforming to NFPA no. 13 and 7-1.2, with holes and s-hooks/chains for hanging or securing. With applicable labeling.
 - 2. Manufacturers:
 - a. MSI: www.msi-signs.com.
 - b. Seton: www.seton.com.
 - c. W.H. Brady: www.bradyid.com.
 - d. Brimar Industries, Inc.: www.safetysign.com.

- e. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- E. ENGRAVED NAME PLATES:
- 1. White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting.
 - 2. Manufacturers:
 - a. Seton Name Plate Company; Setonply Style 2060: www.seton.com.
 - b. EMED Co.; Emedolite Style EIP: www.emedco.com.
 - c. Brimar Industries, Inc.: www.pipemarker.com.
 - d. Or equal by W. H. Brady: www.bradyid.com.
- F. VALVE TAGS:
- 1. Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains with brass "S" hooks or one piece nylon ties around the valve stem.
 - 2. Manufacturers:
 - a. EMED Co.: www.emedco.com.
 - b. Seton Name Plate Company: www.seton.com.
 - c. MSI: www.msi-signs.com.
 - d. W.H. Brady: www.bradyid.com.
 - e. Brimar Industries, Inc.: www.pipemarker.com.
 - f. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.3 SEALING AND FIRESTOPPING

- A. FIRE AND/OR SMOKE RATED PENETRATIONS:
- 1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Section 07 84 00 - Firestopping.
- B. NON-RATED PENETRATIONS:
- 1. Pipe Penetrations Through Below Grade Walls:
 - a. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. The operating bolts of the mechanical type seal shall be accessible from the building interior.
 - 2. Pipe Penetrations:
 - a. At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required, use urethane caulk in annular space between pipe insulation and wall material.

PART 3 EXECUTION

3.1 CONCRETE WORK

- A. Cast-in-place concrete within the building will be performed by the Division 3 Contractor. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support or installation of plumbing piping, fixtures, specialties and equipment. Coordinate locations of equipment, pipe penetrations in wet areas, etc. with the Division 3 Contractor.

3.2 CUTTING AND PATCHING

- A. Refer to Division 1, General Requirements for Cutting and Patching.

3.3 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.4 EQUIPMENT ACCESS

- A. Install all piping, conduit and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Fire Protection Contractor and installed by the General Contractor.
- B. Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

3.5 COORDINATION

- A. Coordinate all work with other Contractors prior to installation. Any work that is not coordinated and that interferes with other Contractor's work shall be removed or relocated at the installing Contractor's expense.
- B. Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

3.6 IDENTIFICATION

- A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.
- B. Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C. Identify interior piping mains not less than once every 25 feet, not less than once in each room, adjacent to each access door or panel, and on both sides of the partition where exposed piping passes through walls or floors. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background, or approved pipe marking label systems, or provide snap-around type pipe markers as specified in Part 2 – Products.
- D. Identify valves with signs per NFPA rulings.
- E. Provide hydraulic design information sign of permanently marked weatherproof metal or engraved nameplate material. Secure to alarm valve with brass chain. Information to include location of the design areas, discharge densities, required flow and residual pressure at the base of riser, hose stream demand and sprinkler demand.

3.7 LUBRICATION

- A. Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by the Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.8 SLEEVES AND OPENINGS

- A. Pipe penetrations in new poured concrete horizontal construction requiring F and T rating: Form opening using hole form or core drill opening. Alternatively provide cast in place fire stopping devices/sleeves. Pipe penetrations in new poured concrete horizontal construction requiring F rating but no T rating: Same as pipe penetrations in new poured concrete construction requiring F and T ratings except that schedule 40 steel sleeves may also be used.
- B. Pipe penetrations in new poured concrete horizontal construction that do not require F or T ratings: Provide schedule 40 steel pipe sleeve, form opening using hole form or core drill opening.
- C. Pipe penetrations in existing concrete floors: Core drill openings.
- D. Pipe penetrations through existing floors located in food service areas that do not require a T rating: Core drill sleeve opening large enough to insert schedule 40 sleeve, extend sleeve 2 inches above the floor and grout area around sleeve with hydraulic setting, non-shrink grout. Size sleeve to allow insulated pipe to run through sleeve and paint the sleeve.
- E. Where penetrating pipe or conduit weight is supported by floor, provide manufactured product or structural bearing collar designed to carry load.

3.9 SEALING AND FIRESTOPPING

- A. FIRE AND/OR SMOKE RATED PENETRATIONS:
 - 1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Section 07 84 00 - Fire Stopping.
- B. NON-RATED PARTITIONS:
 - 1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions. The bolt heads for the mechanical seal shall face the inside of the building to facilitate repair or replacement of the seal.
 - 2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.
- C. PENETRATIONS SUBJECT TO WATER INTRUSION:
 - 1. For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:
 - a. Pipe penetration where steel pipe sleeve is used extend steel sleeve 2 inches above the floor.

- b. Pipe penetration where cast in place fire stopping device/sleeve is used, extend device/sleeve 2 inches above the floor (provided it meets the device's UL listing).
 - c. Pipe penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2" x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8 inch on center. Seal corners watertight with urethane caulk.
 - d. Duct penetrations. Provide 2" x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8 inch on center. Seal corners watertight with urethane caulk.
2. Floors subject to water intrusion or rooms housing electrical equipment include the following locations:
- a. Restrooms.
 - b. Janitor Rooms w/ Sinks.
 - c. Mechanical/Plumbing Equipment Rooms.
 - d. Data/Telecommunications Rooms.
 - e. Electrical Equipment Rooms.
- D. Provide waterproof caulk sealant top coating on fire stopping system (or other approved means to protect the fire stopping system from water) in areas subject to wash down such as Food Service and Dish Washing Areas.

3.10 OWNER TRAINING

- A. All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under Division 1.

END OF SECTION 21 05 00

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SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for support of all fire suppression equipment and materials as well as piping system anchors. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Shop Drawings.
 - h. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Structural Supports.
 - c. Pipe Hangers and Supports.
 - d. Beam Clamps.
 - e. Concrete Inserts.
 - f. Corrosive Atmosphere Coatings.
 - 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Hanger and Support Spacing.
 - c. Riser Clamps.

1.2 RELATED WORK

- A. Division 3 - Concrete.
- B. Section 21 10 00 - Water-Based Fire-Suppression System.
- C. Section 21 30 00 - Fire Pumps.

1.3 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this section.

1.4 REFERENCE STANDARDS

- A. MSS SP-58.
- B. NFPA 13 Installation of Sprinkler Systems (Latest prevailing edition).
- C. NFPA 14 Installation of Standpipe and Hose Systems (Latest prevailing edition).
- D. NFPA 20 Installation of centrifugal fire pumps (Latest prevailing edition).
- E. UL Underwriters' Laboratories Listed.
- F. FM Factory Mutual Approved.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials Refer to Section 01 60 00 - Product Requirements.

1.6 DESCRIPTION

- A. Provide all supporting devices as required for the installation of fire suppression equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for building piping.
- B. Do not hang any fire suppression system item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.
- C. Fasteners depending on soft lead for holding power or requiring explosive powder actuation will not be accepted.
- D. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

1.7 SHOP DRAWINGS

- A. Refer to section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Schedule all hanger and support devices indicating attachment method and type of device for each pipe size and type of service. Provide details on the working drawings submitted for approval with all pertinent information listed.

1.8 DESIGN CRITERIA

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application and Installation unless noted otherwise.
- B. Materials and application of pipe hangers and supports shall be in accordance with NFPA rulings and be UL/FM listed and approved.
- C. Piping connected to pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. B-Line; TOLCO: www.bline.com.
- B. Anvil: www.anvilintl.com.
- C. Erico: www.erico.com.
- D. Afcon: www.afcon.org.
- E. Roof Products & Systems: www.rpscursbs.com.

2.2 STRUCTURAL SUPPORTS

- A. Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the drawings.

2.3 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1/2" through 4":
 - 1. Carbon steel, adjustable swivel ring with 3/8" min. UL/FM approved hanger rods. B-Line B3170NF, Anvil 69 or 70.
 - 2. Carbon steel, adjustable clevis, standard, with UL/FM approved size hanger rods. B-Line B3100, Anvil 260.
- B. Hangers for Pipe Sizes 4" Through 8":
 - 1. Carbon steel adjustable swivel ring with 1/2" min. UL/FM approved hanger rods. B-Line B3170NF, Anvil 69 or 70.
 - 2. Carbon steel, adjustable clevis, standard with UL/FM approved size hanger rods. B-Line B3100, Anvil 260.
- C. Hangers For Pipe Sizes 10" and Up:
 - 1. Carbon steel, adjustable clevis, standard with UL/FM approved size hanger rods. B-Line B3100, Anvil 260.
- D. Multiple or Trapeze Hangers:
 - 1. Manufactured steel channel system with manufacturers slotted interlocking pipe clamps with screw/nut securing and threaded hanger rods or steel channels with welded spacers and threaded hanger rods.
- E. Wall Support:
 - 1. Carbon steel welded bracket with hanger. B-Line 3060 Series, Anvil 190 Series.
 - 2. Steel channels with pipe clamps.
- F. Vertical Support:
 - 1. Carbon steel riser clamp. B-Line B3373, Anvil 261 for above floor use.
- G. Floor Support:
 - 1. Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.
- H. Pipe Hanger Rods:
 - 1. Steel Hanger Rods:
 - a. Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
 - b. Size rods for individual hangers and trapeze support as indicated in the following schedule.

<u>Pipe Size</u>	<u>Diam. Of Rod</u>
Up to and Including 4"	3/8" or 9.5 mm min.
5", 6" and 8"	1/2" or 12.7 mm min.
10" and 12"	5/8" or 15.9 mm min.

2.4 BEAM CLAMPS

- A. MSS SP-58 Types 19 & 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8 inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Anvil 86/92.
- B. MSS SP-58 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter. B-Line B3054, Anvil 228.

2.5 CONCRETE INSERTS

- A. Drilled Fasteners:
 - 1. Concrete Construction:
 - a. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor.
 - b. Manufacturers:
 - 1) Hilti: www.hilti.com.
 - 2) Rawl: www.rawl.com.
 - 3) Redhead: www.ramset-redhead.com.
 - 2. Wood Construction:
 - a. Side or bottom mount lag thread by rod thread one piece hanger attachment installed per the Manufacturers standard and carrying capacity limit.
 - b. Manufacturers:
 - 1) Powers Fastener; Vertigo: www.powers.com.
 - 2) Erico; Hangermate: www.erico.com.

2.6 CORROSIVE ATMOSPHERE COATINGS

- A. Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface each side. Mechanical galvanize threaded products, ASTM B695 Class 50, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Size, apply and install supports and anchors in compliance with manufacturers recommendations.
- B. Install supports to provide for free expansion of the piping system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- C. Coordinate hanger and support installation to properly group piping of all trades.
- D. Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used and all data is submitted for prior approval.
- E. Perform welding in accordance with standards of the American Welding Society.

3.2 HANGER AND SUPPORT SPACING

- A. Use hangers with minimum vertical adjustment.
- B. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- C. Support riser piping independently of connected horizontal piping.
- D. Adjust hangers to obtain the slope specified in the piping section of these specifications.
- E. Space hangers for pipe as follows:

Pipe Material	Pipe Size	Max. Horiz. Spacing	Max. Vert. Spacing
Steel	1" through 1-1/4"	12'-0"	15'-0"
Steel	1-1/2" through 8"	15'-0"	15'-0"
CPVC	1" through 1-1/4"	6'-0"	10'-0"
CPVC	1-1/2"	7'-0"	10'-0"
CPVC	2"	8'-0"	10'-0"
CPVC	2-1/2"	9'-0"	10'-0"
CPVC	3"	10'-0"	10'-0"

- F. Hangers, supports and hanger spacing for CPVC plastic piping systems shall conform to the requirements of NFPA 13 and the manufacturer's requirements. Contractor shall provide details on the installation drawings for all proposed means of support.
- G. Restraint hangers shall be installed at all sprinkler head location within 1'-0" for a single restraint and within 5'-0" for two points of restraint. The requirements for hanger restraint for systems in excess of 100 PSI pressure shall be followed.
- H. Hangers for CPVC systems shall not compress, distort, cut or abrade the piping and shall allow free movement of the pipe to permit thermal expansion and contraction.
- I. Unsupported length from the last hanger and an end sprinkler for steel piping systems shall be as follows:

1" piping	Not greater than 36"
1-1/4" piping	Not greater than 48"
1-1/2" piping	Not greater than 60" or larger.

3.3 RISER CLAMPS

- A. Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor. Use method of securing the vertical risers to the building structure below in stairwell locations.

END OF SECTION 21 05 29

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SECTION 21 10 00

WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 GENERAL

1.1 SCOPE

- A. This section contains specifications for fire suppression pipe and pipe fittings for this project. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 - 2. PART 2 – PRODUCTS.
 - a. Fire Suppression Piping.
 - b. Unions and Flanges.
 - c. Mechanical Grooved Pipe Connections.
 - d. Sprinkler Heads.
 - e. Pressure Gauges.
 - f. Valves.
 - 3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Copper Pipe Joints.
 - e. Welded Pipe Joints.
 - f. Threaded Pipe Joints.
 - g. Mechanical Grooved Pipe Connections.
 - h. Unions and Flanges.
 - i. Piping System Leak Tests.
 - j. Underground Water Main Flushing
 - k. Installation.

1.2 RELATED WORK

- A. Section 21 05 00 - Common Work Results for Fire Suppression.
- B. Section 21 05 29 - Hangers and Supports for Fire-Suppression Piping and Equipment.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI A21.4.

- B. ANSI A21.11.
- C. ANSI A21.51.
- D. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
- E. ANSI B16.3 Malleable and Ductile Iron Threaded Fittings.
- F. ANSI B16.4 Cast Iron Threaded Fittings.
- G. ANSI B16.5 Pipe Flanges and Flanged Fittings.
- H. ANSI B16.9 Factory Made Wrought Steel Buttweld Fittings.
- I. ANSI B16.11 Forged Steel Fittings, Socket Welded and Threaded.
- J. ANSI B16.18 Cast Bronze Solder Joint Pressure Fittings.
- K. ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
- L. ANSI B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- M. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- N. ASTM A105 Forgings, Carbon Steel, for Piping Components.
- O. ASTM A126 Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
- P. ASTM A135 Electric Resistance Welded Steel Pipe.
- Q. ASTM A181 Forgings, Carbon Steel for General Purpose Piping.
- R. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- S. ASTM A536 Ductile Iron Castings.
- T. ASTM A795 Black and Hot Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- U. ASTM B88 Seamless Copper Water Tube.
- V. AWS A5.8 Brazing Filler Metal.
- W. AWS D10.9 Qualification of Welding Procedures and Welders for Piping and Tubing, Level AR3.
- X. NFPA 13 Installation of Sprinkler Systems. (Latest prevailing edition).
- Y. NFPA 14 Installation of Standpipe and Hose Systems. (Latest prevailing edition).
- Z. UL Underwriters' Laboratories Listing.
- AA. FM Factory Mutual Approval.

1.5 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.

- B. Schedule from the Contractor indicating the ANSI/ASTM specification number of the pipe being proposed along with its type and grade, if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.

1.6 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. Order all copper and steel pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.
- C. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.8 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B. Construct all piping systems for the highest pressures and temperatures in the respective system but not less than 175 psig.
- C. Where weld fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- D. Where mechanical grooved fittings are used, use only ASTM standard radius fittings, short radius grooved fittings is not allowed.
- E. Where ASTM A53 or A795 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where ASTM A135 grade A pipe is specified, grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F. Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

1.9 WELDER QUALIFICATIONS

- A. Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe

Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.

- B. The Engineer reserves the right to test the work of any welder employed on the project, at the Owner's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project and all defective welds replaced.

PART 2 PRODUCTS

2.1 FIRE SUPPRESSION PIPING

- A. Steel Pipe:
 - 1. Black steel pipe welded and seamless, Type F, Grade A, ASTM A53; black welded and seamless steel pipe for fire protection use, Type F, ASTM A795; electric resistance welded steel pipe, Grade A, ASTM A135.
 - 2. Pipe wall Thickness:
 - a. Threaded pipe shall have a minimum wall thickness of schedule 40.
 - b. All other pipe shall have a minimum wall thickness of schedule 10.
 - c. Piping 2" and under shall be minimum schedule 40 unless stated otherwise herein.
 - 3. Fittings: Cast iron threaded fittings, Class 125 or 250, ASTM A126/ANSI B16.4. Malleable and ductile iron threaded fittings, Class 150 or 300, ASTM A197/ANSI B16.3. Standard weight seamless carbon steel weld fittings, ASTM A234 grade, ANSI B16.9. Mechanical grooved fittings with EPDM gaskets, ASTM A536 ductile iron, ASTM A47 malleable iron or ASTM A53 fabricated steel. For wet pipe systems mechanical tee fittings with full iron back equal to Grinnell Figure 730 will be allowed only as needed for connection to existing systems. Mechanical tees with U-bolt back or other fastening means are not allowed.
 - 4. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

2.2 UNIONS AND FLANGES

- A. 2" and Smaller Steel:
 - 1. ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Grooved couplings may be used in lieu of unions.
- B. 2" and Smaller Copper:
 - 1. ANSI B16.18 cast bronze union coupling or ANSI B15.24 Class 150 cast bronze flanges.
- C. 2-1/2" and Larger:
 - 1. ASTM A181 or A105, Class 150, grade 1 hot forged steel flanges of threaded, welding neck, or slip-on pattern on black steel and threaded only on galvanized steel. ANSI B16.1 or ANSI B16.5, Class 150 cast iron threaded flanges. Use raised face flanges ANSI B16.5 for mating with other raised face flanges or equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

- D. 2-1/2" and Larger Copper:
 - 1. ANSI B16.24, Class 150 cast bronze flanges with raised face.

2.3 MECHANICAL GROOVED PIPE CONNECTIONS

- A. Mechanical grooved pipe couplings and fittings, ASTM F1476, as manufactured by Victaulic, Anvil or Grinnell may be used with steel pipe. Mechanical grooved components and assemblies to be rated for minimum 175 psi working pressure unless noted otherwise.
- B. All mechanical grooved pipe material including gaskets, couplings, fittings and flange adapters shall be from the same manufacturer.
- C. Couplings and fittings to be malleable iron, ASTM A47, or ductile iron A536 with painted finish. Fittings used on galvanized steel pipe to have galvanized finish, ASTM A153.
- D. Gaskets to be EPDM, ASTM D2000. Gaskets for dry systems to be flush seal design. Heat treated carbon steel oval neck track bolts and nuts, ASTM A-183, with zinc electroplated finish.
- E. Flange adapters to be ductile iron, ASTM A536; except at lug type butterfly valves where standard threaded flanges shall be used.
- F. Credit for the inherent flexibility of mechanical grooved pipe connections when used for expansion joints or flexible connectors may be allowed upon specific application by the Contractor. Three flexible couplings at first three connection points both upstream and downstream of pumps may be used in lieu of flexible connectors. Request for expansion joints shall be made in writing and shall include service, location, line size, proposed application and supporting calculations for the intended service.

2.4 SPRINKLER HEADS

- A. Manufacturer: Sprinkler head model numbers establish type and style of head. Products of the following manufacturers determined to be equal by the Engineer will be accepted:
 - 1. Tyco: www.tycofire.com.
 - 2. Reliable: www.reliablesprinkler.com.
 - 3. Victaulic: www.victaulic.com.
 - 4. Viking: www.vikingfire.com.
- B. Standard coverage sprinkler heads are to be the basis for design unless noted otherwise on the plans or within these specifications.
- C. Fusible link or glass bulb type, cast brass or bronze construction. Provide heads with nominal 1/2" or 17/32" discharge orifice except where greater than normal density requires large orifice.
- D. Select fusible link or glass bulb temperature rating to not exceed maximum ambient temperature rating allowed under normal conditions at installed location. Provide ordinary temperature (155 to 165 degree) fusible link or glass bulb type except at skylights, sealed display windows, unventilated attics and roof spaces, over cooking equipment, adjacent to diffusers, unit heaters, uninsulated heating pipes or ducts, mechanical rooms, storage rooms, or where otherwise indicated.

- E. Provide quantity of spare heads as noted below and 1 wrench for each type of head and each temperature range installed. Provide 6 spare heads per 300 or less installed heads, 12 per 1000 or less and 24 for more than 1000. Provide steel cabinet for storage of heads and wrenches. Provide an equal number of concealed cover plates and/or sprinkler escutcheons for each spare sprinkler head.
 - 1. Quick Response Upright: Viking Microfast M (QR), brass finish.
 - 2. Quick Response Vertical Sidewall: Viking Microfast M, chrome finish.
 - 3. Quick Response Pendant: Viking Microfast M, chrome plated finish and escutcheon.
 - 4. Quick Response Sidewall: Viking Microfast M, chrome plated finish and escutcheon.
 - 5. Concealed sprinkler: Viking Mirage (Quick Response), with adjustable concealed cover plate. Cover plate finish to be selected by the Engineer from the manufacturer's standard finish selections.

2.5 VALVES

- A. Manufacturers:
 - 1. Kennedy: www.kennedyvalve.com.
 - 2. Milwaukee: www.milwaukeevalve.com.
 - 3. Nibco: www.nibco.com.
 - 4. Stockham: www.stockham.com.
 - 5. Victaulic: www.victaulic.com.
 - 6. Watts: www.watts.com.
- B. Butterfly Valves:
 - 1. 2" and smaller: Bronze body butterfly valve, 175 psig, geared operator, visible position indicator, normally open tamper switch with double wire leads, Buna or Viton seat, stainless steel disc and stem.
 - 2. 2" and larger: Cast or ductile iron body butterfly valve, lug style or grooved, 175 psig, geared operator, visible position indicator, normally open tamper switch with double wire leads, EPDM resilient seat, EPDM seals, nickel plated ductile iron disc. Valve assembly to be bubble tight to 175 psig with no downstream flange/pipe attached. Use cap screws for removal of downstream piping while using the valve for system shutoff.
- C. Supervisory/Tamper Switches:
 - 1. For O S & Y valve or butterfly valve installations, UL/FM listed/approved, to monitor position of valve, tamper resistant cover screws, single or double SPDT switch contacts, corrosion resistant, for indoor or outdoor use, NEMA 4 & 6P enclosures.
- D. Check Valves:
 - 1. 3" and smaller: Bronze body, threaded end, Y-pattern, regrindable bronze seat, renewable bronze disc, 175 psig, suitable for installation in a horizontal or vertical line with flow upward.
 - 2. 2-1/2" and larger: Cast or ductile iron body, flanged or grooved ends, bronze trim, bolted cap, renewable bronze seat and disc, 175 psig, suitable for installation in a horizontal or vertical line with flow upward.
 - 3. Provide 1/2" automatic drip drain on inlet of fire dept. connection check valve.

- E. Drain Valves:
 - 1. 3/4" minimum two piece bronze body ball valve; threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 400 psig WOG, with hose thread outlet and cap.

PART 3 EXECUTION

3.1 GENERAL

- A. Install pipe fittings, and other fire suppression system components in accordance with reference standards, manufacturer recommendations and recognized industry practices.

3.2 PREPARATION

- A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

- A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of fire protection piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, ceiling grid layout, light fixtures and grilles before installing piping.
- B. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C. Provide 3/32" min. thickness steel nailing plates behind or on either side of piping where the possibility of penetration from nails or drywall screws exists.
- D. Maintain piping in clean condition internally during construction.
- E. Provide clearance for access to valves and piping specialties.
- F. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G. Install piping so that system can be drained. Where possible, slope to main drain valve. Slope dry pipe and pre-action systems subject to freezing at minimum 1/4"/10' on mains and 1/2"/10' on branches. Where piping not susceptible to freezing cannot be fully drained, install nipple and cap for drainage of less than 5 gallons or ball valve with hose thread outlet and cap for drainage over 5 gallons. Pipe main drain valve to grade or to air gap sewer receptor.
- H. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- I. Do not route piping within exterior walls.
- J. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- K. Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance.

Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.4 WELDED PIPE JOINTS

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable. "Weldolets" and "Threadolets" may be used up to following sizes:

<u>Maximum Weldolet/ Threadolet Diameter</u>	<u>Main Pipe Diameter</u>
3/4"	1-1/4"
1"	1-1/2"
1-1/4"	2"
1-1/2"	2-1/2"
2"	3"
3"	4"
4"	6"
6"	8"

3.5 THREADED PIPE JOINTS

- A. Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.6 MECHANICAL GROOVED PIPE CONNECTIONS

- A. Use pipe factory grooved in accordance with the coupling manufacturer's specifications or field grooved pipe in accordance with the same specifications using specially designed tools available for the application. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with the coupling manufacturer's specifications.

3.7 UNIONS AND FLANGES

- A. Install a union, flange or grooved coupling combination at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union or grooved coupling combination connections on the equipment side of the valve. Concealed unions, flanges or couplings are not acceptable.

3.8 PIPING SYSTEM LEAK TESTS

- A. Conduct pressure test with test medium of water. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
- B. Test piping in sections or entire system as required by sequence of construction. Do not conceal pipe until it has been successfully tested. If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Entire test must be witnessed by the Owner's representative.
- C. Use clean water and remove air from the piping being tested where possible. Measure and record test pressure at the high point in the system.

- D. Test system at 200 psi for 2 hours showing no leakage. Where system design is in excess of 150 psig, test at a pressure 50 psig above system design pressure.
- E. All pressure tests are to be documented on NFPA Contractor's Material and Test Certificate forms.

3.9 INSTALLATION

- A. Install fire protection system components in accordance with NFPA rulings, listings and manufacturers recommendations. Locate where accessible for servicing and replacement.
- B. Sprinkler Heads: Locate sprinkler heads as indicated on fire protection plan and reflected ceiling plan maintaining minimum clearances from obstructions, ceilings and walls. Install sprinkler heads level in locations not subject to spray pattern interference. Provide fire sprinkler head installations below ductwork, soffits, etc.
- C. Valves: Properly align piping before installation of valves. Do not support weight of piping system on valve ends. Mount valves in locations which allow access for operation, servicing and replacement. Install all valves with the stem in the upright or horizontal position. Valves installed with the stems down will not be accepted. Provide a riser shutoff valve and a capped hose thread drain valve at the bottom of each riser. Provide capped hose thread drain valves to allow draining of each portion of piping.

END OF SECTION 21 10 00

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SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SCOPE

A. This section includes information common to two or more technical plumbing specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Standards.
 - e. Lead Free Requirements
 - f. Quality Assurance.
 - g. Continuity of Existing Services.
 - h. Protection of Finished Surfaces.
 - i. Sleeves and Openings.
 - j. Sealing and Firestopping.
 - k. Equipment Furnished By Others.
 - l. Provisions for Future.
 - m. Off Site Storage.
 - n. Codes.
 - o. Request and Certification for Payment.
 - p. Certificates and Inspections.
 - q. Submittals.
 - r. Operating and Maintenance Data.
 - s. Training Of Owner Personnel.
 - t. Record Drawings.
2. PART 2 – PRODUCTS.
 - a. Access Panels and Doors.
 - b. Identification.
 - c. Bedding and Backfill.
 - d. Sealing and Firestopping.
3. PART 3 – EXECUTION.
 - a. Demolition.
 - b. Excavation and Backfill.
 - c. Sheeting, Shoring and Bracing.
 - d. Dewatering.
 - e. Rock Excavation.
 - f. Surface Repair.
 - g. Concrete Work.
 - h. Cutting and Patching.
 - i. Building Access.
 - j. Equipment Access.
 - k. Coordination.
 - l. Identification.

- m. Lubrication.
- n. Sleeves.
- o. Sealing and Firestopping.
- p. Owner Training.

1.2 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.
- B. This section applies to all Division 22 sections of plumbing.

1.3 STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

- | | |
|------------|---|
| 1. ABMA | American Boiler Manufacturers Association. |
| 2. ACPA | American Concrete Pipe Association. |
| 3. AGA | American Gas Association. |
| 4. AMCA | Air Movement and Control Association. |
| 5. ANSI | American National Standards Institute. |
| 6. AHRI | Air-Conditioning, Heating and Refrigeration Institute. |
| 7. ASME | American Society of Mechanical Engineers. |
| 8. ASPE | American Society of Plumbing Engineers. |
| 9. ASSE | American Society of Sanitary Engineering. |
| 10. ASTM | American Society for Testing and Materials. |
| 11. AWWA | American Water Works Association. |
| 12. AWS | American Welding Society. |
| 13. CISPI | Cast Iron Soil Pipe Institute. |
| 14. CGA | Compressed Gas Association. |
| 15. CS | Commercial Standards, Products Standards Sections, Office of Eng. Standards Service, NBS. |
| 16. EPA | Environmental Protection Agency. |
| 17. FS | Federal Specifications, Superintendent of Documents, U.S. Government Printing Office. |
| 18. GAMA | Gas Appliance Manufacturers Association. |
| 19. IAPMO | International Association of Plumbing & Mechanical Officials. |
| 20. IEEE | Institute of Electrical and Electronics Engineers. |
| 21. ISA | Instrument Society of America. |
| 22. MCA | Mechanical Contractors Association. |
| 23. MICA | Midwest Insulation Contractors Association. |
| 24. MSS | Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc. |
| 25. NBS | National Bureau of Standards. |
| 26. NEC | National Electric Code. |
| 27. NEMA | National Electrical Manufacturers Association. |
| 28. NFPA | National Fire Protection Association. |
| 29. NSF | National Sanitation Foundation. |
| 30. PDI | Plumbing and Drainage Institute. |
| 31. SMACNA | Sheet Metal and Air Conditioning Contractors' National Association. Inc. |
| 32. STI | Steel Tank Institute. |
| 33. UL | Underwriters Laboratories Inc. |

B. Standards referenced in this section:

1. ACI 614 Recommended Practice for Measuring, Mixing and Placing of Concrete.
2. ASTM D1557 Standard Test Method for Moisture-Density Relations of Soils.
3. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
5. D.O.T. Standard Specifications for Road and Bridge Construction, State of Wisconsin Dept. of Transportation.
6. UL1479 Fire Tests of Through-Penetration Firestops.
7. UL723 Surface Burning Characteristics of Building Materials.

1.4 LEAD FREE REQUIREMENTS

- A. All materials that contact potable water shall be lead free. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per the Federal Safe Drinking Water Act as amended January 4, 2011 Section 1417.
- B. This requirement applies to all of the subsequent Plumbing Specification Sections and Plumbing Drawings and supersedes any part or model number that may conflict with this requirement.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. All products and materials used are to be new, undamaged, clean and in good condition. Existing products and materials are not to be reused unless specifically indicated.
- C. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

1.6 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval from the Owner's Project Representative. When interruption is required, coordinate scheduling of down-time with the Owner to minimize disruption to his activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

1.7 PROTECTION OF FINISHED SURFACES

- A. Refer to Division 1, General Requirements for Protection of Finished Surfaces.

1.8 SLEEVES AND OPENINGS

- A. Refer to Division 1, General Requirements for Sleeves and Openings.

1.9 SEALING AND FIRESTOPPING

- A. Sealing and firestopping of sleeves/openings between piping, etc. and the sleeve or structural opening shall be the responsibility of the Contractor whose work penetrates the opening. The Contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

1.10 CODES

- A. Comply with requirements of Wisconsin Code.

1.11 REQUEST AND CERTIFICATION FOR PAYMENT

- A. Refer to the General Conditions for Request and Certification for Payment.

1.12 CERTIFICATES AND INSPECTIONS

- A. Refer also to the General Conditions for Permits, Regulations, Utilities and Taxes.

1.13 SUBMITTALS

- A. Refer to section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Not more than two weeks after award of contract but before any shop drawings are submitted, Contractor to submit the following plumbing system data sheet. List piping material type for each piping service on the project, ASTM number, schedule or pressure class, joint type, manufacturer and model number where appropriate. List valves and specialties for each piping service, fixture and equipment with manufacturer and model number. The approved plumbing system data sheet(s) will be made available to the Owner's Project Representative for their use on this project.

PLUMBING SYSTEM DATA SHEET

<u>Item</u>	<u>Pipe Service/Sizes</u>	<u>Manufacturer/Model No.</u>	<u>Remarks</u>
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Pipe

Fittings

Unions

Valves:

Ball

Balancing

Check

Pipe Specialties:

Thermometers

Press Gauges

Strainers

Building Penetrations

Hangers & Supports

Insulation

Plbg. Specialties:

Floor/Roof Drains

Cleanouts

Water Hammer Arrestors

18043-6

WITC New Richmond

Vet Tech

22 05 00 - 4

Backflow Preventers
Wall Hydrants
Hose Bibbs
Wash Machine Boxes

Plbg. Fixtures
Plbg. Equipment

- C. Shop drawing submittals are to be bound, labeled, contain the project manual cover page and a material index list page showing item designation, manufacturer and additional items supplied with the installation. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Include wiring diagrams of electrically powered equipment.

1.14 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.
- B. In addition to the general content specified under Section 01 78 00 - Closeout Submittals supply the following additional documentation:
1. Records of tests performed to certify compliance with system requirements.
 2. Manufacturer's wiring diagrams for electrically powered equipment.
 3. Certificates of inspection by regulatory agencies.
 4. Valve schedules.
 5. Lubrication instructions, including list/frequency of lubrication.
 6. Parts list for fixtures, equipment, valves and specialties.
 7. Manufacturer's installation, operation and maintenance recommendations for fixtures, equipment, valves and specialties.
 8. Additional information as indicated in the technical specification sections.

1.15 TRAINING OF OWNER PERSONNEL

- A. Instruct Owner's personnel in the proper operation and maintenance of systems and equipment provided as part of this project. Include not less than 2 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup, operation and shutdown procedures for all equipment. All training to be during normal working hours. Videotape all instructions and provide Owner with copy.

1.16 RECORD DRAWINGS

- A. Refer to Division 1, General Requirements for Record Drawings.

PART 2 PRODUCTS

2.1 ACCESS PANELS AND DOORS

- A. Lay-in Ceilings:
1. Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Division 09 are sufficient; no additional access provisions are required unless specifically indicated.

- B. Plaster Walls and Ceilings:
 1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public or secured areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the item needing service; minimum size is 12" by 12".

2.2 IDENTIFICATION

- A. Stencils:
 1. Not less than 1 inch high letters/numbers for marking pipe and equipment.
- B. ENGRAVED NAME PLATES:
 1. White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting.
 2. Manufacturers:
 - a. Setonply Style 2060 by Seton Name Plate Company: www.seton.com.
 - b. Emedolite Style EIP by EMED Co.: www.emedco.com.
 - c. Brimar Industries, Inc.: www.pipemarker.com.
 - d. Or equal by W. H. Brady: www.bradyid.com.
- C. SNAP-AROUND PIPE MARKERS:
 1. One-piece, preformed, vinyl construction, snap-around or strap-around pipe markers with applicable labeling and flow direction arrows, 3/4" min. size for lettering. Provide nylon ties on each end of pipe markers.
 2. Manufacturers:
 - a. Seton Setmark: www.seton.com.
- D. VALVE TAGS:
 1. Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains, brass "S" hooks or one piece nylon ties around the valve stem.
 2. Manufacturers:
 - a. EMED Co.: www.emedco.com.
 - b. Seton Name Plate Company: www.seton.com.
 - c. W. H. Brady: www.bradyid.com.
 - d. Brimar Industries, Inc.: www.pipemarker.com.

2.3 BEDDING AND BACKFILL

- A. Bedding up to a point 12" inches above the top of the pipe shall be thoroughly compacted sand or crushed stone chips meeting the following gradations:

<u>Gradation for Bedding Sand</u>		<u>Gradation for Crushed Stone Chip Bedding</u>	
<u>Sieve Size</u>	<u>% Passing (by Wt)</u>	<u>Sieve Size</u>	<u>% Passing (by Wt)</u>
1 inch	100	1/2 inch	100
No. 16	45 - 80	No. 4	75 - 100
No. 200	2 - 10	No. 100	10 - 25

- B. Backfill above the bedding in lawn areas shall be thoroughly compacted excavated material free of large stones, organic, perishable, and frozen materials.
- C. Backfill above the bedding under existing and future utilities, paving, sidewalks, curbs, roads and buildings shall be granular materials, pit run sand, gravel, or crushed stone, free from large stones, organic, perishable, and frozen materials.

2.4 SEALING AND FIRESTOPPING

A. FIRE AND/OR SMOKE RATED PENETRATIONS:

- 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Hilti: www.hilti.com.
 - c. Rectorseal: www.rectorseal.com.
 - d. STI/SpecSeal: www.stifirestop.com.
 - e. Tremco: www.tremcosealants.com.
- 2. All firestopping systems shall be provided by the same manufacturer.
- 3. Fire stop systems shall be UL listed or tested by an independent testing laboratory approved by the Department of Commerce.
- 4. Submittals: Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.
- 5. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.
- 6. Use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

B. NON-RATED PENETRATIONS:

- 1. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. The operating bolts of the mechanical type seal shall be accessible from the interior of the building.
- 2. At pipe penetrations of non-rated interior partitions, floors and exterior walls, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work necessary to accomplish indicated plumbing systems installation. Excavate to bottom of pipe and structure bedding, 4" in stable soils, 6" in rock or wet trenches and 8" in unstable soil. Finish bottoms of excavations to true, level surface.

- B. At no time place excavated materials where they will impede surface drainage unless such drainage is being safely rerouted away from the excavation.
- C. Excavate whatever materials are encountered as required to place at the elevations shown, all pipe, manholes, and other work. Remove debris and rubbish from excavations before placing bedding and backfill material.
- D. Remove surplus excavated materials from site.
- E. Verify the locations of any water, drainage, gas, sewer, electric, telephone or steam lines which may be encountered in the excavation. Underpin and support all lines. Cut off service connections encountered which are to be removed at the limits of the excavation and cap.
- F. Provide and maintain all fencing, barricades, signs, warning lights, and/or other equipment necessary to keep all excavation pits and trenches and the entire subgrade area safe under all circumstances and at all times. No excavation shall be left unattended without adequate protection.
- G. Elevations shown on the plans are subject to such revisions as may be necessary to fit field conditions. No adjustment in compensation will be made for adjustments up to two (2) feet above or below the grades indicated on the plans.
- H. Install lines passing under foundations with minimum of 1-1/2 inch clearance to concrete and ensure there is no disturbance of bearing soil.
- I. Bed pipe up to a point 12" above the top of the pipe. Take care during bedding, compaction and backfill not to disturb or damage piping.
- J. Mechanically compact bedding and backfill to prevent settlement. The initial compacted lift to not exceed 24" compacted to 95% density per Modified Proctor Test (ASTM D-1557). Subsequent lifts under pavements, curbs, walks and structures are not to exceed 12" and be compacted to 95% density per Modified Proctor Test. In all other areas where construction above the excavation is not anticipated within 2 years, mechanically compact backfill in lifts not exceeding 24" to 90% density per Modified Proctor Test. Route the equipment over each lift of the material so that the compaction equipment contacts all areas of the surface of the lift.

3.2 CONCRETE WORK

- A. Cast-in-place concrete within the building will be performed by the Division 3 Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support or installation of plumbing piping, fixtures, specialties and equipment. Coordinate locations of equipment, pipe penetrations in wet areas, etc. with the Division 3 Contractor.
- B. Plumbing related cast-in-place concrete on the exterior of the building to be provided by this Contractor in conformance with requirements of Division 3. This includes piping thrust restraints, pipe supports, hydrant supports, manholes, catch basins, grease traps, septic tanks, distribution boxes, valve pits, meter pits, cleanout cover pads, yard hydrant pads, etc.

3.3 CUTTING AND PATCHING

- A. Refer to Division 1, General Requirements for Cutting and Patching.

3.4 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance or removal of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.5 EQUIPMENT ACCESS

- A. Install all piping, conduit and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Plumbing Contractor and installed by the General Contractor.
- B. Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

3.6 COORDINATION

- A. Coordinate all work with other Contractors prior to installation. Any work that is not coordinated and that interferes with other Contractor's work shall be removed or relocated at the installing Contractor's expense.
- B. Verify that all devices are compatible for the type of construction and surfaces on which they will be used.

3.7 IDENTIFICATION

- A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion.
- B. Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C. Identify interior piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where accessible piping passes through walls or floors. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background.
- D. Identify all exterior buried piping for entire length with underground warning tape except for sewer piping which is routed in straight lines between manholes or cleanouts. Place tape 6"-12" below finished grade along entire length of pipe. Extend tape to surface at building entrances, meters, hydrants and valves. Where existing underground warning tape is broken during excavation, replace with new tape identifying appropriate service and securely spliced to ends of existing tape.
- E. Identify valves with brass tags bearing a system identification and a valve sequence number. Identify medical gas and vacuum valves with brass tags and wall or cabinet mounted color coded engraved nameplate with the following "(Type of Gas) Shutoff Valve for (Location or Zone)". Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device, located in another room or not visible from device. Provide a typewritten valve schedule and pipe identification schedule indicating the valve number and the equipment or areas supplied by each

valve and the symbols used for pipe identification; locate schedules in mechanical room and in each Operating and Maintenance manual. Schedule in mechanical room to be framed under clear plastic.

3.8 LUBRICATION

- A. Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by the Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.9 SLEEVES

- A. Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall. In existing poured concrete walls where penetration is core drilled, pipe sleeve is not required.
- B. Pipe sleeves are not required in interior non-rated drywall, plaster or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.
- C. Pipe sleeves in new poured concrete construction shall be schedule 40 steel pipe (sized to allow insulated pipe to run through sleeve), cast in place.
- D. In all piping floor penetrations, fire rated and non-fire rated, top of sleeve shall extend 1 inch above the adjacent finished floor. In existing floor penetrations, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting, non-shrink grout. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to existing floor structure.
- E. For floor penetrations through existing floors in mechanical and wet locations listed below, core drill opening and provide 1-1/2" x 1-1/2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from entering the penetration. Provide urethane caulk between angles and floor and fasten angles to floor a minimum of 8" on center. Seal corners watertight with urethane caulk. Or, core drill sleeve openings large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout/cement.
- F. Wet locations include:
 - 1. Parking ramps.
 - 2. Sanitary pumping stations.
 - 3. Swim pool equipment rooms.
 - 4. Chemical storage and hazardous waste storage rooms.
- G. For pipe penetrations through existing floors in food service areas, core drill sleeve opening large enough to insert schedule 40 sleeve and grout area around sleeve with hydraulic setting non-shrink grout/cement. Size sleeve to allow insulated pipe to pass through sleeve and paint the sleeve.

- H. Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms, food service areas or wet locations listed above.

3.10 SEALING AND FIRESTOPPING

A. FIRE AND/OR SMOKE RATED PENETRATIONS:

1. Install approved product in accordance with the manufacturer's instructions where a pipe penetrates a fire/smoke rated surface. When pipe is insulated, use a product which maintains the integrity of the insulation and vapor barrier.
2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support substantial weight.

B. NON-RATED PARTITIONS:

1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions.
2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

3.11 OWNER TRAINING

- A. All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under Division 1.

END OF SECTION 22 05 00

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SECTION 22 05 14

PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for floor drains, roof drains, cleanouts, backflow preventers, water hammer arrestors and other miscellaneous plumbing specialties.
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Documents.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 - 2. PART 2 – PRODUCTS.
 - a. Floor Drains.
 - b. Trap Guards.
 - c. Roof Drains.
 - d. Cleanouts.
 - e. Subsoil Drain Tile Receivers.
 - f. Water Hammer Arrestors.
 - g. Backflow Preventers.
 - h. Wall Hydrants.
 - i. Safings.
 - j. Vent Flashings.
 - k. Washing Machine Wall Boxes.
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.2 RELATED DOCUMENTS

- A. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
- B. Section 22 11 00 - Facility Water Distribution.
- C. Section 22 13 00 - Facility Sanitary Sewerage.
- D. Section 22 14 00 - Facility Storm Drainage.

1.3 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI A112.14.1 - Backwater Valves.
- B. ANSI A112.21.1 - Floor Drains.
- C. ANSI A112.21.2 - Roof Drains.
- D. ANSI A112.26.1/PDI WH-201 - Water Hammer Arrestors.

- E. ASSE 1001 - Pipe Applied Atmospheric Type Vacuum Breakers.
- F. ASSE 1010 - Water Hammer Arrestors.
- G. ASSE 1011 - Hose Connection Vacuum Breakers.
- H. ASSE 1012 - Backflow Preventers with Intermediate Atmospheric Vent.
- I. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.
- J. ASSE 1018 - Trap Seal Primer Valves.
- K. ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining, Anti-Backflow Type.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. Plumbing products requiring approval by the State of Wisconsin must be approved or have pending approval at the time of shop drawing submission.

1.6 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

1.8 FLOOR DRAINS

- A. Manufacturer:
 - 1. Josam: www.josam.com.
 - 2. Smith: www.jrsmith.com.
 - 3. Wade: www.wadedrains.com.
 - 4. Watts: www.watts.com.
 - 5. Zurn: www.zurn.com.
- B. 3" min. enameled cast iron two piece body with double drainage flange, weep holes, reversible clamping adjustable collar, adjustable 6"x6" min. square or round polished nickel-bronze strainer with threaded collar, bottom outlet.

1.9 TRAP GUARDS

- A. Manufacturer: ProSet Systems Trap Guard or approved equal.
- B. Flexible elastomeric PVC construction diaphragm trap guard for installation in new and existing floor drains, hub drains, and trench drains. Trap guard to prevent trap evaporation and waste backflow. Size as applicable to the drain outlet size, up to 4" size.

1.10 ROOF DRAINS

- A. Manufacturer:
 - 1. Josam: www.josam.com.
 - 2. Smith: www.jrsmith.com.

3. Wade: www.wadedrains.com.
4. Watts: www.watts.com.
5. Zurn: www.zurn.com.

B. 4" min. bottom outlet roof drain, enameled cast iron body with flashing collar and gravel stop, cast iron dome strainer, adjustable extension, underdeck clamp, 15" diameter.

1.11 CLEANOUTS

A. Manufacturer:

1. Josam: www.josam.com.
2. Smith: www.jrsmith.com.
3. Wade: www.wadedrains.com.
4. Watts: www.watts.com.
5. Zurn: www.zurn.com.

B. INTERIOR CONCRETE FLOOR AREAS: Enameled cast iron body with round or adjustable scoriated polished nickel bronze cover, tapered threaded ABS closure plug.

C. INTERIOR CERAMIC TILE FLOOR AREAS: Enameled cast iron body with square adjustable scoriated nickel bronze cover, tapered threaded ABS closure plug.

D. INTERIOR VINYL TILE FLOOR AREAS: Enameled cast iron body with round adjustable scoriated nickel bronze cover, tapered threaded ABS closure plug.

E. INTERIOR CARPETED FLOOR AREAS: Enameled cast iron body with round adjustable scoriated nickel bronze cover and secured carpet marker, tapered threaded ABS closure plug.

F. INTERIOR FINISHED WALL AREAS: Line type cleanout tee with tapered threaded ABS cleanout plug, round polished stainless steel access cover secured with machine screw.(Note: Screw shall not pass completely through the ABS plug, trim screw as necessary).

1.12 EXTERIOR UNPAVED AREAS: CAST IRON HUB OR PLUG WITH TAPERED THREADED ABS OR PVC CLOSURE PLUG, CAST IRON OR PVC FROST SLEEVE AND COVER SET IN 24" SQUARE BY 4" MIN. THICK REINFORCED CONCRETE PAD TOP. WATER HAMMER ARRESTORS

A. Manufacturer:

1. PPP Industries: www.pppinc.com.
2. Sioux Chief: www.siouxchief.com.
3. Wade: www.wadedrains.com.
4. Watts: www.watts.com.

B. ANSI A112.26.1, ASSE 1010; sized in accordance with PDI WH-201, precharged piston type constructed of hard drawn Type K copper, threaded brass adapter, brass piston with o-ring seals, FDA approved silicone lubricant, suitable for operation in temperature range 35 to 150 degrees F, maximum 250 psig working pressure, 1500 psig surge pressure.

1.13 BACKFLOW PREVENTERS

A. Manufacturers:

1. Beeco: www.bykowskiequipment.com.

2. Cla-Val: www.cla-val.com.
3. Conbraco: www.conbraco.com.
4. Febco: www.febcoonline.com.
5. Watts: www.watts.com.
6. Wilkins: www.zurn.com.

- B. HOSE CONNECTION VACUUM BREAKERS: ASSE 1011, brass or bronze construction, EPDM diaphragm and seat, rated for 125 psig and 180°F. Watts 8 (interior application).
- C. LAB FAUCET VACUUM BREAKERS: ASSE 1035, brass or bronze construction, chrome plated, EPDM diaphragm and seat, stainless steel internals, rated for 125 psig and 160°F. Watts NLF9.
- D. INTERMEDIATE ATMOSPHERIC VENTED BACKFLOW PREVENTERS: ASSE 1012, same size as pipe, with intermediate atmospheric vent between independent check valves, bronze body with union ends, stainless steel springs, rated for 175 psig and 210°F..

1.14 WALL HYDRANTS

- A. Manufacturer:
1. Josam: www.josam.com.
 2. Smith: www.jrsmith.com.
 3. Wade: www.wadedrains.com.
 4. Watts: www.watts.com.
 5. Woodford: www.woodfordmfg.com.
 6. Zurn: www.zurn.com.
- B. Freezeproof automatic draining wall hydrant with exposed chrome plated bronze wall plate, 3/4" inlet, 3/4" hose thread ASSE 1019-93 backflow preventer outlet, copper or bronze casing, loose key operator.

1.15 HOSE BIBBS

- A. Bronze or brass construction hose faucet/valve, cast iron handwheel, replaceable disc, hose thread spout, with ASSE 1011 backflow preventer outlet, 3/4" size.

1.16 SAFINGS

- A. Manufacturers:
1. Noble: www.noblegroupusa.com.
 2. Oatey: www.oatey.com.
- B. Chlorinated polyethylene sheeting, 40 mils thick, ASTM D4068, joined with CPE solvent; or 3 lb./sq. ft. sheet lead.

1.17 VENT FLASHINGS

- A. Manufacturers:
1. Semco : www.semcoinc.com.
 2. Oatey: www.oatey.com.
- B. Formed 3 lb./sq. ft. lead flashing with minimum base size of 15"x17".

- C. Single Ply Membrane Roofs: Flashing boot of material compatible with roofing membrane with base flange for adhering to membrane and stainless steel drawband for securing to vent pipe.

1.18 WASHING MACHINE WALL BOXES

- A. Manufacturers:
 - 1. Guy Gray: www.ipscorp.com/guygray.
 - 2. Oatey: www.oatey.com.
- B. Epoxy paint coated steel recessed wall box with face flange, overflow lip, fastening tabs, 1/2" hot and cold bronze washing machine 1/4 turn shutoff valves rated for 125 psi and 180 degrees F, long shank valve fittings for replacement of valves within box, 2" drain outlet fitting.

PART 2 EXECUTION

2.1 INSTALLATION

- A. Coordinate location and setting of plumbing specialties with adjacent construction. Install in accordance with manufacturers recommendations.
- B. Set floor drains, roof drains, trench drains and cleanouts level and plumb adjusted to finished floor elevation, roof elevation or finished wall location. Locate where serviceable. Allow minimum of 18" clearance around cleanouts for rodding. Lubricate threaded cleanout plugs with graphite and oil, teflon tape or waterproof grease. Install trap primer connections where indicated. Provide deep seal traps on floor drains and hub drains installed in mechanical rooms, penthouses or rooms with excessive positive or negative pressure.
- C. Floor drains and hub drains installed in public restrooms, locker rooms, seldom used rooms, and areas with minute drainage flow shall have installations of combination trap evaporation/backflow preventer diaphragm installations.
- D. Install subsoil drain tile receivers where indicated. Adjust receiver height to drain tile inlet and outlet elevations and cleanout to finished floor elevation. Secure subsoil drain tile with mechanical or solvent weld connections. Backfill with granular material.
- E. Install backflow preventers in accordance with the State of Wisconsin requirements maintaining minimum clearance distances for servicing and testing. Provide indirect waste piping with air gap installation from relief opening to above hub drain or floor drain.
- F. Install lab faucet vacuum breakers with Loctite 242 "blue" on threads.
- G. Where backflow preventers requiring the State of Wisconsin registration are installed, provide initial registration, testing and report filing required by the State of Wisconsin. List the name and address of the building that the backflow preventer installations occur in.
- H. Mount wall hydrants recessed in exterior wall construction with valve plug extended beyond interior side of building insulation. Slope to drain to exterior. Install so discharge is 18" min. above finished grade. Set wall box in grout or caulk and fill exterior wall penetration with insulation.
- I. Mount hose bibbs securely fastened to wall where indicated. Provide water hammer arrestor in line to hose bibb.

- J. Install safing at floor drains above grade. Extend 12" beyond drains in all directions. Cover entire floor in showers and extend 6" up in walls above curbs and to a height of 6' (3" wide each direction) in corners. Install on concrete floor that is smooth and free of debris. Seal all joints and connect to drain body clamp. Safing is subject to standing water leak test. Install safing at all built-up shower installations. (Note: spray-on and brush applied liquid safing is not acceptable).
- K. Flash vent penetrations through roof. Turn down top of lead flashing into vent pipe. Tighten drawband of membrane boot to vent pipe. Adhere base flashing to deck or membrane. Provide waterproof patch around penetration on existing roofs.
- L. Install washing machine boxes in wall construction, secured to structure, directly behind proposed washing machine location. Provide water hammer arrestors in supply piping. Mount box a min. of 36" above floor.

END OF SECTION 22 05 14

SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SCOPE

- A. This section includes valve specifications for all Plumbing systems except where indicated under Related Work. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Lead Free Requirements
 - e. Quality Assurance.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Water System Valves:
 - 1) Ball Valves.
 - 2) Butterfly Valves.
 - 3) Spring Loaded Check Valves.
 - 4) Balance Valves.
 - 5) Drain Valves.
 - b. Natural Gas Systems:
 - 1) Shut-off Valves.
 - 2) Gas Pressure Regulators.
 3. PART 3 – EXECUTION.
 - a. General.
 - b. Shut-off Valves.
 - c. Balancing Valves.
 - d. Drain Valves.
 - e. Spring Loaded Check Valves.
 - f. Gas Pressure Regulators.

1.2 RELATED WORK

- A. Section 22 05 00 - Common Work Results for Plumbing.
B. Section 22 05 14 - Plumbing Specialties.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 LEAD FREE REQUIREMENTS

- A. All materials that contact potable water shall be lead free. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per the Federal Safe Drinking Water Act as amended January 4, 2011 Section 1417.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 – Product Requirements.

1.6 SUBMITTALS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 – Closeout Submittals.

1.8 DESIGN CRITERIA

- A. ANSI Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.
- B. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.
- C. Where valve types (ball, butterfly, etc.) are specified for individual plumbing services (i.e. domestic water, gas, etc.), each valve type shall be of the same manufacturer unless prior written approval is obtained from the Owner.
- D. Valves to be line size unless specifically noted otherwise.

PART 2 PRODUCTS

2.1 WATER SYSTEM VALVES

- A. All water system valves to be rated at not less than 125 water working pressure at 240 degrees F unless noted otherwise.
- B. BALL VALVES:
 - 1. 3" and smaller: Two piece bronze body; sweat or threaded ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 600 psig WOG. Provide valve stem extensions for valves installed in all piping with insulation.
 - a. Manufacturers:
 - 1) Apollo 70LF-200: www.apollovalves.com.
 - 2) Hammond UP8511: www.hammondvalve.com.
 - 3) Milwaukee UPBA150: www.milwaukeevalve.com.
 - 4) Nibco S580-80-LF: www.nibco.com.
 - 5) Watts LFB-6081G2: www.watts.com.
 - 2. Provide 10 position locking lever handle actuators for valves 6" and smaller. Provide worm gear operators with external position indication for valves 8" and larger.
- C. SPRING LOADED CHECK VALVES:
 - 1. 2" and smaller: Bronze body, sweat or threaded ends, bronze trim, stainless steel spring, stainless steel center guide pin, Class 125, teflon seat unless only bronze available.

- a. Manufacturers:
 - 1) ConBraCo 61 series: www.conbraco.com.
 - 2) Nibco S480-Y-LF: www.nibco.com.
 - 3) Val-Matic S1400 series: www.valmatic.com.
 - 4) Watts LF600: www.watts.com.

D. BALANCE VALVES:

- 1. 2" and smaller: Two piece bronze body ball valve, sweat or threaded ends, chrome plated brass ball, glass filled teflon seat, threaded packing nut, with adjustable memory stop position indicator and extended handle stem, suitable for 400 psig water working pressure at 240 degrees F.

- a. Manufacturers:
 - 1) Nibco S580-80-LF: www.nibco.com.
 - 2) Hammond UP8501-02 or UP8511-02: www.hamondvalve.com.
 - 3) Milwaukee UPBA-100MS or UPBA-150MS: www.milwaukeevalve.com.
 - 4) Watts: www.watts.com.
 - 5) Apollo: www.apollovalves.com.

E. DRAIN VALVES:

- 1. 3/4 inch ball valve with integral threaded hose adapter, sweat or threaded inlet connections, with threaded cap and chain on hose threads.

- a. Manufacturers:
 - 1) Apollo70LF-200-HC: www.apollovalves.com.
 - 2) Milwaukee BA-100H or BA-150H: www.milwaukeevalve.com.
 - 3) Hammond 8501H or 8511H: www.hamondvalve.com.
 - 4) Nibco: www.nibco.com.
 - 5) Watts: www.watts.com.

2.2 NATURAL GAS SYSTEMS

A. SHUT-OFF VALVES:

- 1. 4" and smaller: Ball or eccentric plug valve, bronze or cast iron body, 2" and under threaded ends, 2-1/2" and over flanged ends, chrome plated bronze ball, bronze or nickel plated cast iron plug, TFE or Hycar seats and seals, lever handle, 175 psi W.O.G., U.L listed for use as natural gas shut-off.

- a. Manufacturers:
 - 1) Apollo; 80-100: www.apollovalves.com.
 - 2) DeZurik; 425: www.dezurik.com.
 - 3) Milwaukee: www.milwaukeevalve.com.
 - 4) Nibco: www.nibco.com.
 - 5) Watts: www.watts.com.

B. GAS PRESSURE REGULATORS:

- 1. 2" and smaller: Cast iron body, aluminum spring and diaphragm, Nitrile diaphragm, threaded ends, 150 psi W.O.G., -20 degrees F to 150 degrees F.

PART 3 EXECUTION

3.1 GENERAL

- A. Properly align piping before installation of valves. Install and test valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.

- B. Mount valves in locations which allow access for operation, servicing and replacement.
- C. Provide valve handle extensions for all valves installed in insulated piping.
- D. Install all valves with the stem in the upright or horizontal position. If possible, install butterfly valves with the stem in the horizontal position. Valves installed with the stems down will not be accepted.
- E. Prior to flushing of piping systems, place all valves in the full-open position.

3.2 SHUT-OFF VALVES

- A. Install shut-off valves at each piece of equipment, at each branch take-off from mains for isolation or repair and elsewhere as indicated.

3.3 BALANCING VALVES

- A. Install where indicated on the drawings and details for balancing of flow in pumped hot water recirculation piping systems.
- B. Upon project completion, adjust each valve and set position stop. Balance system to minimum flow in return piping branches needed to maintain even supply water temperature throughout building.

3.4 DRAIN VALVES

- A. Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, downstream of riser isolation valves, equipment locations specified or detailed, other locations required for drainage of systems and elsewhere as indicated.

3.5 SPRING LOADED CHECK VALVES

- A. Install a spring loaded check valve in each circulating pump discharge line, each clear water sump pump discharge line and elsewhere as indicated.

3.6 GAS PRESSURE REGULATORS

- A. When the gas pressure regulator is equipped with a vent connection, run a connection size vent to outside air in accordance with codes. Use a larger size vent when required by the manufacturer's installation instructions.

END OF SECTION 22 05 23

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING AND PIPING EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for supports of all plumbing equipment and materials as well as piping system anchors. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Shop Drawings.
 - h. Design Criteria.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Pipe Hangers and Supports.
 - c. Pipe Hanger Rods.
 - d. Beam Clamps.
 - e. Concrete Inserts.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Hanger and Support Spacing.
 - c. Riser Clamps.

1.2 RELATED WORK

- A. Section 03 10 00 - Concrete formwork for equipment pads.
B. Section 03 30 00 - Cast-in-place concrete for equipment pads.
C. Section 22 07 00 - Plumbing Insulation for insulation protection at support devices.

1.3 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this section.

1.4 REFERENCE STANDARDS

- A. MSS SP-58.
B. MSS SP-69.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 – Product Requirements.

1.6 DESCRIPTION

- A. Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for building piping.

- B. Do not hang any mechanical item directly from a metal deck or run piping so its rests on the bottom chord of any truss or joist.
- C. Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.
- D. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.
- E. Protect insulation at all hanger points; see Related Work above.

1.7 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Schedule of all hanger and support devices indicating attachment methods and type of device for each pipe size and type of service.

1.8 DESIGN CRITERIA

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.
- B. Piping connected to pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Anvil: www.anvilintl.com.
- B. B-Line: www.bline.com.
- C. Pate: www.patecurbs.com.
- D. Piping Technology: www.pipingtech.com.
- E. Roof Products & Systems: www.commercialproductsgroup.com.

2.2 PIPE HANGERS AND SUPPORTS

- A. HANGERS FOR PIPE SIZES 1/2" THROUGH 2":
 - 1. Carbon steel, adjustable swivel ring. B-Line B3170NF, Anvil 69 or 70.
 - 2. Carbon steel, adjustable clevis, standard. B-Line B3100, Anvil 260.
- B. HANGERS FOR PIPE SIZES 2" AND LARGER:
 - 1. Carbon steel, adjustable clevis, standard. B-Line B3100, Anvil 260.
- C. MULTIPLE OR TRAPEZE HANGERS:
 - 1. Steel channels with welded spacers and hanger rods.
- D. WALL SUPPORT:
 - 1. Carbon steel welded bracket with hanger. B-Line 3068 Series, Anvil 194 Series.

2. Perforated, epoxy painted finish, 16-12 gauge, min., steel channels securely anchored to wall structure, with interlocking, split-type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type PS 200 H with PS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil PS 1400 series.

E. VERTICAL SUPPORT:

1. Carbon steel riser clamp. B-Line B3373, Anvil 261 for above floor use.

F. FLOOR SUPPORT:

1. Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.

G. COPPER PIPE SUPPORTS:

1. All supports, fasteners, clamps, etc. directly connected to copper piping shall be copper plated or polyvinylchloride coated. Where steel channels are used, provide isolation collar between supports/clamps/fasteners and copper piping.

2.3 PIPE HANGER RODS

A. STEEL HANGER RODS:

1. Threaded both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
2. Size rods for individual hangers and trapeze support as indicated in the following schedule.
3. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1-1/4

2.4 BEAM CLAMPS

- A. MSS SP-69 Types 19 & 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick with a retaining ring and threaded rod of 3/8, 1/2, and 5/8 inch diameter. Furnish with a hardened steel cup point set screw. B-Line B3036L/B3034, Anvil 86/92.
- B. MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter. B-Line B3054, Anvil 228.

2.5 CONCRETE INSERTS

A. DRILLED FASTENERS:

1. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor.

18043-6

WITC New Richmond
Vet Tech

22 05 29 - 3

2. Manufacturers:
 - a. Hilti: www.hilti.com.
 - b. Rawl: www.rawl.com.
 - c. Redhead: www.ramset-redhead.com.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Size, apply and install supports and anchors in compliance with manufacturers recommendations.
- B. Install supports to provide for free expansion of the piping system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- C. Coordinate hanger and support installation to properly group piping of all trades.
- D. Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes or continuous insert channels for the supporting steel. Where continuous insert channels are used, pipe supporting devices made specifically for use with the channels may be substituted for the specified supporting devices provided that similar types are used and all data is submitted for prior approval.
- E. Size and install hangers and supports, except for riser clamps, for installation on the exterior of piping insulation. Where a vapor barrier is not required, hangers may be installed either on the exterior of pipe insulation or directly on piping.
- F. Perform welding in accordance with standards of the American Welding Society.

3.2 HANGER AND SUPPORT SPACING

- A. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- B. Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.
- C. Use hangers with 1-1/2 inch minimum vertical adjustment.
- D. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- E. Support riser piping independently of connected horizontal piping.
- F. Adjust hangers to obtain the slope specified in the piping section of these specifications.
- G. Space hangers for pipe as follows:

<u>Pipe Material</u>	<u>Pipe Size</u>	<u>Max. Horiz. Spacing</u>	<u>Max. Vert. Spacing</u>
Cast Iron	2" and larger	5'-0"	15'-0"
Copper	1/2" through 3/4"	5'-0"	10'-0"
Copper	1" through 1-1/4"	6'-0"	10'-0"
Copper	1-1/2" through 2-1/2"	8'-0"	10'-0"
Plastic	Drain and Vent	4'-0"	10'-0"

3.3 RISER CLAMPS

- A. Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor.

END OF SECTION 22 05 29

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SECTION 22 07 00

PLUMBING INSULATION

PART 1 GENERAL

1.1 SCOPE

- A. This section includes insulation specifications for plumbing piping and equipment. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference Standards.
 - d. Quality Assurance.
 - e. Description.
 - f. Definitions.
 - g. Shop Drawings.
 - h. Operation and Maintenance Data.
 2. PART 2 – PRODUCTS.
 - a. Materials.
 - b. Insulation & Jackets.
 - c. Insulation Inserts and Pipe Shields.
 - d. Accessories.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Piping, Valve and Fitting Insulation.
 - c. Equipment Insulation.

1.2 RELATED WORK

- A. Section 22 05 00 - Common Work Results for Plumbing.
- B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
- C. Section 22 11 00 - Facility Water Distribution.
- D. Section 22 13 00 - Facility Sanitary Sewerage.
- E. Section 22 14 00 - Facility Storm Drainage.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate.
- B. ASTM C165 Test Method for Compressive Properties of Thermal Insulations.
- C. ASTM C177 Heat Flux and Thermal Transmission Properties.
- D. ASTM C195 Mineral Fiber Thermal Insulation Cement.
- E. ASTM C240 Cellular Glass Insulation Block.
- F. ASTM C302 Density of Preformed Pipe Insulation.

- G. ASTM C303 Density of Preformed Block Insulation.
- H. ASTM C449 Mineral Fiber Hydraulic Setting Thermal Insulation Cement.
- I. ASTM C518 Heat Flux and Thermal Transmission Properties.
- J. ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation.
- K. ASTM C534 Preformed Flexible Elastomeric Thermal Insulation.
- L. ASTM C547 Mineral Fiber Preformed Pipe Insulation.
- M. ASTM C552 Cellular Glass Block and Pipe Thermal Insulation.
- N. ASTM C553 Mineral Fiber Blanket and Felt Insulation.
- O. ASTM C578 Preformed, Block Type Cellular Polystyrene Thermal Insulation.
- P. ASTM C591 Preformed Rigid Cellular Polyurethane Thermal Insulation.
- Q. ASTM C610 Expanded Perlite Block and Thermal Pipe Insulation.
- R. ASTM C612 Mineral Fiber Block and Board Thermal Insulation.
- S. ASTM C921 Properties of Jacketing Materials for Thermal Insulation.
- T. ASTM C1136 Flexible Low Permeance Vapor Retarders for Thermal Insulation.
- U. ASTM E84 Surface Burning Characteristics of Building Materials.
- V. MICA National Commercial & Industrial Insulation Standards.
- W. NFPA 225 Surface Burning Characteristics of Building Materials.
- X. UL 723 Surface Burning Characteristics of Building Materials.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 – Product Requirements.
- B. Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

1.6 DESCRIPTION

- A. Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:
 - 1. Pipe Insulation.
 - 2. Equipment Insulation.
- B. Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the Owner.

1.7 DEFINITIONS

- A. Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

1.8 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

1.9 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Materials or accessories containing asbestos will not be accepted.
- B. Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:
 - 1. Insulation which is not located in an air plenum shall have a flame spread rating not over 25 and a smoke developed rating no higher than 150.

2.2 INSULATION AND JACKETS

- A. Manufacturers:
 - 1. Armstrong: www.armstronginternational.com.
 - 2. Certainteed: www.certainteed.com.
 - 3. Manson: www.imanson.com.
 - 4. Childers: fosterproducts.com.
 - 5. Dow: www.dow.com.
 - 6. Extol: www.extol.com.
 - 7. Halstead: www.rembco.com.
 - 8. H.B. Fuller: www.hbfuller.com
 - 9. Imcoa: www.nomacoinsulation.com.
 - 10. Knauf: www.knaufusa.com.
 - 11. Owens-Corning: www.owenscorning.com.
 - 12. Pittsburgh Corning: www.foamglasinsulation.com.
 - 13. Rubatex: www.rubatex.com.
 - 14. Johns-Mansville: www.jm.com.
- B. Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.
- C. RIGID FIBERGLASS INSULATION:
 - 1. Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.
 - 2. White kraft reinforced foil vapor barrier all service jacket, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

D. PVC FITTING COVERS AND JACKETS:

1. White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be .02 inch (20 mil).

E. METAL JACKETS:

1. .016 inch thick aluminum or .010 inch thick stainless steel with safety edge.

2.3 INSULATION INSERTS AND PIPE SHIELDS

A. Manufacturers:

1. B-Line: www.bline.com.
2. Pipe Shields: www.pipeshieldinc.com.
3. Value Engineered Products: www.valueng.com.

B. Construct inserts with calcium silicate, minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom of supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

C. Where Contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered pre-manufactured product described above. On low temperature systems, extruded polystyrene shall be substituted for calcium silicate provided insert and shield length and gauge are increased to compensate for lower insulation compressive strength.

D. Pre-compressed 20# density molded fiberglass blocks, Hamfab or equal, of same thickness as adjacent insulation shall be substituted for calcium silicate inserts with one 1"x 6" block for piping through 2-1/2" and three 1" x 6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/pre-manufactured product described above.

E. Wood blocks will not be accepted.

2.4 ACCESSORIES

A. All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.

B. Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.

C. Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch for aluminum and .010 inch for stainless steel.

D. Tack fasteners to be stainless steel ring grooved shank tacks.

E. Staples to be clinch style.

F. Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

G. Finishing cement to be ASTM C449.

- H. Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.
- I. Bedding compounds to be non-shrinking and permanently flexible.
- J. Vapor barrier coatings to be non-flammable, fire resistant, polymeric resin.
- K. Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install insulation, jackets and accessories in accordance with manufacturer instructions and under ambient temperatures and conditions recommended by manufacturer. Surfaces to be insulated must be clean and dry.
- B. Do not insulate systems or equipment which is specified to be pressure tested or inspected, until testing, inspection and any necessary repairs have been successfully completed.
- C. Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Cover and seal exposed fiberglass insulation when insulation is terminated, no raw fiberglass insulation is allowed. Provide neat and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates. Install with longitudinal joints facing wall or ceiling.
- D. Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.
- E. Use full-length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.
- F. Insulation shall be continuous through sleeves and openings. Vapor barriers shall be maintained continuous through all penetrations.
- G. Provide a complete vapor barrier for insulation on the following systems:
 - 1. Cold water (potable and non-potable).
 - 2. Storm Water.
 - 3. Equipment piping with a surface temperature below 65 degrees F.

3.2 PIPING, VALVE, AND FITTING INSULATION

- A. GENERAL:
 - 1. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive. Additionally secure with staples along seams and butt joints. Coat staples with vapor barrier mastic on systems requiring vapor barrier.
 - 2. Water supply piping insulation shall be continuous throughout the building and installed adjacent to and within building walls to a point directly behind the fixture that is being supplied.
 - 3. Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required, hangers and supports shall be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.

B. INSULATION INSERTS AND PIPE SHIELDS:

1. Provide insulation inserts and pipe shields at all hanger and support locations. Inserts shall be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

C. FITTINGS AND VALVES:

1. Fittings, valves, unions, flanges, couplings and specialties shall be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Cover insulation with fabric reinforcing and mastic or where temperatures do not exceed 150 degrees, PVC fitting covers. Secure PVC fitting covers with tack fasteners and 1-1/2" band of mastic over ends, throat, seams or penetrations. On systems requiring vapor barrier, use vapor barrier mastic.

D. PIPE INSULATION SCHEDULE:

1. Provide insulation on new and existing remodeled piping as indicated in the following schedule:

Service	Insulation Types	Insulation Thickness by Pipe Size				
		1" and smaller	1-1/4" to 2"	2-1/2" to 4"	5" to 6"	8" and larger
Hot Water Supply	Rigid Fiberglass	1"	1"	1.5"	1.5"	1.5"
Hot Water Circulating	Rigid Fiberglass	1"	1"	1.5"		
Cold Water	Rigid Fiberglass	0.5"	0.5"	1"	1"	1"
All Horizontal Storm Piping and 4'-0" of vertical Piping thereafter, & Roof Drain bodies	Rigid Fiberglass	0.5"	0.5"	0.5"	0.5"	0.5"

E. The following piping and fittings are not to be insulated:

1. Chrome plated exposed supplies and stops (except where specifically noted).
2. Water hammer arrestors.
3. Piping unions and flanges for systems not requiring a vapor barrier.

END OF SECTION 22 07 00

SECTION 22 10 13
FACILITY FUEL PIPING

PART 1 GENERAL

1.1 SCOPE

- A. This section contains specifications for fuel pipe and fuel pipe fittings for this project. Included are the following topics:
1. PART 1 - GENERAL
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 2. PART 2 - PRODUCTS
 - a. Natural Gas.
 - b. Vents and Relief Valves.
 - c. Unions and Flanges.
 3. PART 3 - EXECUTION
 - a. Preparation.
 - b. Erection.
 - c. Welded Pipe Joints.
 - d. Threaded Pipe Joints.
 - e. Natural Gas.
 - f. Vents and Relief Valves.
 - g. Unions and Flanges.
 - h. Piping System Leak Tests.
 4. APPENDIX.
 - a. Piping System Test Report.

1.2 RELATED WORK

- A. Section 22 05 14 - Plumbing Specialties.
- B. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
- C. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
- D. Section 22 07 00 - Plumbing Insulation.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI B16.3 Malleable Iron Threaded Fittings.
- B. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

- C. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- D. ANSI B31.9 Pipe Material Requirements.

1.5 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.

1.6 SHOP DRAWINGS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
- C. TYPE E OR S STEEL PIPE:
 - 1. Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

1.7 QUALITY ASSURANCE

- A. Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.
- B. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place.
- C. Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.9 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B. Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.
- C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in occupied spaces and ventilation plenum spaces, including plenum ceilings.

- D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

1.10 WELDER QUALIFICATIONS

- A. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code and/or the National Certified Pipe Welding Bureau.
- B. Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- C. The Engineer or Owner reserves the right to test the work of any welder employed on the project, at the Contractor's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project.

PART 2 PRODUCTS

2.1 NATURAL GAS

- A. 2" and Smaller: ASTM A53, type E or S, standard weight (schedule 40) black steel pipe with ASTM A197/ANSI B16.3 class 150 black malleable iron threaded fittings or ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
- B. 2-1/2" and Larger: ASTM A53, type E or S, standard weight black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

2.2 VENTS AND RELIEF VALVES

- A. Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

2.3 UNIONS AND FLANGES

- A. 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.
- B. 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove all foreign material from interior and exterior of pipe and fittings.

3.2 ERECTION

- A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- C. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- D. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
- E. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- F. Install all valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.3 WELDED PIPE JOINTS

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
- B. Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.4 THREADED PIPE JOINTS

- A. Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.5 NATURAL GAS

- A. Pitch horizontal piping down 1" in 60 feet in the direction of flow. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top or side of the main. Teflon tape is acceptable for use on natural gas lines.
- B. Do not install gas pipe in a ventilation air plenum.
- C. If an above ground vent terminates in an area subject to snow accumulation, terminate the line at least five feet above grade.
- D. Install a shut off valve at each appliance. Provide a valve connection at the main for equipment and appliances furnished by others.

- E. Piping through a roof shall be run through an approved roof penetration with flashing and counter flashing.
- F. Each gas pressure reducing valve vent and relief valve vent shall be run separately to a point outside of the building, terminated with a screened vent cap, and located according to gas utility regulations.
- G. Clean all welded piping before all regulators and control valves. Test by placing target cloth over piping and blow with compressed air. Clean piping until target cloth is clean and free of debris.

3.6 VENTS AND RELIEF VALVES

- A. Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

3.7 UNIONS AND FLANGES

- A. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.8 PIPING SYSTEM LEAK TESTS

- A. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.
- B. Provide all piping, fittings, blind flanges, and equipment to perform the testing.
- C. Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Division's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
- D. Do not insulate pipe until it has been successfully tested.
- E. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- F. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

- G. Measure natural gas system test pressure with a water manometer or an equivalent device calibrated in increments not greater than 0.1 inch water column. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.
- H. Conduct fuel oil system test so as not to impose a pressure of more than 10 psig on the tank. Instead of a pressure test, suction lines may be tested under a vacuum of not less than 20 inches of mercury maintained for at least one hour.

<u>System</u>	<u>Pressure</u>	<u>Medium</u>	<u>Duration</u>
Natural gas	100 psig	Air	24 hr

- I. All pressure tests are to be documented on a form included in this specification.
- J. On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Die penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system.

END OF SECTION 22 10 13

PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

- HVAC Refrigeration Controls
- Power Plant Plumbing Fire Sprinkler

Test Medium: Air Water Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours Specified Test Pressure _____ PSIG

System Identification: _____

Describe Location: _____

Test Date: _____

Start Test Time: _____ *Initial Pressure:* _____ PSIG

Stop Test Time: _____ *Final Pressure:* _____ PSIG

Tested By: _____

Witnessed By: _____

Title: _____

Title: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

Comments: _____

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SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.1 SCOPE

- A. This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 - 2. PART 2 – PRODUCTS.
 - a. Domestic Water.
 - b. Dielectric Unions and Flanges.
 - c. Unions and Flanges.
 - d. Mechanical Grooved Pipe Connections.
 - 3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Copper Pipe Joints.
 - e. Domestic Water.
 - f. Dielectric Unions and Flanges.
 - g. Unions and Flanges.
 - h. Piping System Leak Tests.
 - 4. APPENDIX.
 - a. Piping System Test Report.

1.2 RELATED WORK

- A. Section 22 05 14 - Plumbing Specialties.
- B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI A21.4.
- B. ANSI A21.11.
- C. ANSI A21.51.

D.	ANSI B16.3	Malleable Iron Threaded Fittings.
E.	ANSI B16.4	Cast Iron Threaded Fittings.
F.	ANSI B16.5	Pipe Flanges and Flanged Fittings.
G.	ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
H.	ANSI B16.29	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.
I.	ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
J.	ASTM A105	Forgings, Carbon Steel, for Piping Components.
K.	ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
L.	ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
M.	ASTM B32	Solder Metal.
N.	ASTM B88	Seamless Copper Water Tube.
O.	ASTM B280	Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
P.	ASTM B813	Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
Q.	ASTM D1785	Poly Vinyl Chloride (PVC) Plastic Pipe.
R.	ASTM D2241	Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
S.	ASTM D2464	Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
T.	ASTM D2466	Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
U.	ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
V.	ASTM D2564	Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
W.	ASTM D2657	Heat Fusion Joining of Polyolefin Pipe and Fittings.
X.	ASTM D2774	Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
Y.	ASTM D2855	Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
Z.	ASTM D3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
AA.	ASTM D3222	Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
BB.	ASTM D4101	Propylene Plastic Injection and Extrusion Materials.

CC. ASTM F437	Threaded Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
DD. ASTM F438	Socket Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.
EE. ASTM F441	Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80.
FF. ASTM F493	Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings.
GG. ASTM F656	Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
HH. AWS A5.8	Brazing Filler Metal.
II. AWWA C104	Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water.
JJ. AWWA C105	Polyethylene Encasement for Ductile Iron Piping for Water.
KK. AWWA C110	Ductile Iron and Gray Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids.
LL. AWWA C111	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
MM. AWWA C151	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
NN. AWWA C153	Ductile Iron Compact Fittings, 3 In. Through 48 In., for Water and Other Liquids.
OO. AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances.
PP. AWWA C651	Disinfecting Water Mains.
QQ. AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.

1.5 SHOP DRAWINGS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Schedule from the Contractor indicating the ASTM, AWWA or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.
- C. Statement from manufacturer on his letterhead that pipe furnished meets the ASTM, AWWA or CISPI specification contained in this section.

1.6 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.

- C. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.8 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, AWWA or CISPI specifications as listed in this specification.
- B. Construct all piping for the highest pressures and temperatures in the respective system.
- C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.
- D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E. Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F. Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

1.9 WELDER QUALIFICATIONS

- A. Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- B. Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- C. The Engineer reserves the right to test the work of any welder employed on the project, at the Owner's expense. If the work of the welder is found to be

unsatisfactory, the welder shall be prevented from doing further welding on the project and all defective welds replaced.

PART 2 PRODUCTS

2.1 DOMESTIC WATER

A. ABOVE GROUND:

1. Type L copper water tube, H (drawn) temper, ASTM B88; wrought copper pressure fittings, ASME B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP. Copper mechanical grooved fittings and couplings on roll grooved pipe may be used in lieu of soldered fittings. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for branch takeoffs up to one-half (1/2) the diameter of the main.

a. Alternative Fittings: Mechanical press sealed fittings. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18, ASME B16.22 or ASME B16.51 and performance criteria of IAPMO PS 117. Fittings shall be NSF/ANSI 61 approved and utilize EPDM sealing elements. Sealing elements shall be factory installed.

1) Manufacturers:

a) Viega Propress: www.viega.us.

b) Mueller Industries Sreamline PRS: www.muellerindustries.com.

c) Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.2 DIELECTRIC UNIONS AND FLANGES

A. Manufacturers:

1. Watts Regulator Company: www.wattsregulator.com.

2. Lochinvar: www.lochinvar.com.

3. Wilkins: www.zurn.com.

4. EPCO Sales, Inc.: www.epcinc.com.

B. Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, having a pressure rating of not less than 175 psig at 180 degrees.

2.3 UNIONS AND FLANGES

A. Unions, flanges and gasket materials to have a pressure rating of not less than 150 psig at 180 degrees. Gasket material for flanges and flanged fittings shall be teflon type. Treated paper gaskets are not acceptable.

B. 2" AND SMALLER COPPER:

1. ANSI B16.18 cast bronze union coupling or ANSI B15.24 Class 150 cast bronze flanges.

C. 2-1/2" AND LARGER COPPER:

1. ANSI B15.24 Class 150 cast bronze flanges with full face teflon gaskets.

PART 3 EXECUTION

3.1 GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturers recommendations and recognized industry practices.

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Vet Tec

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3.2 PREPARATION

- A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

- A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C. Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.
- D. Maintain piping in clean condition internally during construction.
- E. Provide clearance for installation of insulation, access to valves and piping specialties.
- F. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- H. Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.4 COPPER PIPE JOINTS

- A. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux and assemble joint to socket stop. Apply flame to fitting until solder melts when placed at joint. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

3.5 WELDED PIPE JOINTS

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

3.6 THREADED PIPE JOINTS

- A. Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.7 DOMESTIC WATER

- A. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.
- B. Install exterior water piping below predicted frost level in accordance with COMM Table 82.30-6, but in no case less than 6' bury depth to top of pipe. Maintain minimum of 8' horizontal distance between 2-1/2" and larger water piping and sanitary sewer piping. Maintain minimum of 30" horizontal and 12" vertical distance, water on top, between 2" and smaller water piping and sanitary sewer piping. Where water piping crosses a sanitary sewer, provide minimum 18" vertical clearance and waterproof PVC water pipe sleeve (reference sanitary sewer materials) sealed at both ends for distance of 10' from sewer in both directions.
- C. Provide thrust restraints for 3" and larger exterior water piping joints, hydrants, caps, plugs, fittings and bends of 22-1/2 degrees or more. Field apply continuous anti-corrosion coating to rodded restraint components. Protect mechanical joints, nuts and bolts from concrete cover. Cover with 8 mil sheet or tube polyethylene material sleeve.
- D. Install interior water piping with drain valves where indicated and at low points of system to allow complete drainage. Install shutoff valves where indicated and at the base of risers to allow isolation of portions of system for repair. Do not install water piping within exterior walls.
- E. Prior to use, isolate and fill system with potable water. Allow to stand 24 hours. Flush each outlet proceeding from the service entrance to the furthest outlet for minimum of 1 minute and until water appears clear. Fill system with a solution of water and chlorine containing at least 50 parts per million of chlorine and allow to stand for 24 hours. Alternately a solution containing at least 200 parts per million of chlorine may be used and allowed to stand for 3 hours. Flush system with potable water until chlorine concentration is no higher than source water level.
- F. Wait 24 hours after final flushing. Take samples of water for lab testing. The number and location of samples shall be representative of the system size and configuration and are subject to approval by Engineer. Test shall show the absence of coliform bacteria. If test fails, repeat disinfection and testing procedures until no coliform bacteria are detected. Submit test report indicating date and time of test along with test results.

3.8 DIELECTRIC UNIONS AND FLANGES

- A. Install dielectric unions or flanges at each point where a copper-to-steel pipe connection is required in domestic water systems.

3.9 UNIONS AND FLANGES

- A. Install a union or flange at each connection to each piece of equipment and at other items which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.10 PIPING SYSTEM LEAK TESTS

- A. Isolate or remove components from system which are not rated for test pressure. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.
- B. If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.
- C. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- D. Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.
- E. Entire test must be witnessed by the Owner’s representative. All pressure tests are to be documented on forms to be provided to the Contractor.

System	Test Medium	Initial Test		Final Test	
		Pressure	Duration	Pressure	Duration
Above Ground - Domestic Water	Water	N/A		100 psig	8 hr

* Leakage on exterior mains 3" and larger may not exceed leakage calculated as follows:

$$\text{GPH Allowable Leakage} = \frac{(\text{Feet of Pipe}) (\text{Inches Dia. of Pipe}) (\text{Test Pressure})^5}{133,200}$$

END OF SECTION 22 11 00

PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

- Plumbing
- Fire Sprinkler

Test Medium: Air Water Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours Specified Test Pressure _____ PSIG

System Identification: _____

Describe Location: _____

<i>Test Date:</i> _____	
<i>Start Test Time:</i> _____	<i>Initial Pressure:</i> _____ PSIG
<i>Stop Test Time:</i> _____	<i>Final Pressure:</i> _____ PSIG

Tested By: _____

Witnessed By: _____

Title: _____

Title: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

Comments: _____

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SECTION 22 13 00

FACILITY SANITARY SEWERAGE

PART 1 GENERAL

1.1 SCOPE

- A. This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Sanitary Waste and Vent.
 - 3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Threaded Pipe Joints.
 - e. Solvent Welded Pipe Joints.
 - f. Sanitary Waste and Vent.
 - g. Piping System Leak Tests.

1.2 RELATED WORK

- A. Section 22 05 14 - Plumbing Specialties.
- B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI A21.4.
- B. ANSI A21.11.
- C. ANSI A21.51.
- D. ANSI B16.3 Malleable Iron Threaded Fittings.
- E. ANSI B16.4 Cast Iron Threaded Fittings.
- F. ANSI B16.5 Pipe Flanges and Flanged Fittings.
- G. ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.

- H. ANSI B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.
- I. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- J. ASTM A74 Cast Iron Soil Pipe and Fittings.
- K. ASTM A105 Forgings, Carbon Steel, for Piping Components.
- L. ASTM A126 Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
- M. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- N. ASTM A861 High Silicon Iron Pipe and Fittings.
- O. ASTM A888 Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- P. ASTM B32 Solder Metal.
- Q. ASTM B306 Copper Drainage Tube (DWV).
- R. ASTM B813 Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
- S. ASTM C76 Reinforced Concrete Culvert, Storm Drain and Sanitary Pipe.
- T. ASTM C564 Standard Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- U. ASTM C1540 Standard Specifications for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- V. ASTM D1785 Poly Vinyl Chloride (PVC) Plastic Pipe.
- W. ASTM D2241 Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
- X. ASTM D2466 Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
- Y. ASTM D2564 Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
- Z. ASTM D2665 Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
- AA. ASTM D2729 Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
- BB. ASTM D2774 Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
- CC. ASTM D2855 Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
- DD. ASTM D3034 Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
- EE. ASTM D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- FF. ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

- GG. ASTM D3222 Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
- HH. ASTM D3311 Drain, Waste and Vent (DWV) Plastic Fitting Patterns.
- II. AWS A5.8 Brazing Filler Metal.
- JJ. CISPI 301 Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
- KK. CISPI 310 Couplings For Use In Connection With Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste And Vent Piping Applications.

1.5 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Schedule from the Contractor indicating the ASTM, or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.
- C. Statement from manufacturer on his letterhead that pipe furnished meets the ASTM, or CISPI specification contained in this section.

1.6 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.
- C. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.8 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, or CISPI specifications as listed in this specification.

- B. Construct all piping for the highest pressures and temperatures in the respective system.
- C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.
- D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E. Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F. Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

PART 2 PRODUCTS

2.1 SANITARY WASTE AND VENT

- 1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
- B. PRESSURIZED INTERIOR ABOVE GROUND:
 - 1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
- C. INTERIOR BELOW GROUND:
 - 1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

PART 3 EXECUTION

3.1 GENERAL

- A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

3.2 PREPARATION

- A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

- A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.

- C. Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.
- D. Maintain piping in clean condition internally during construction.
- E. Provide clearance for installation of insulation, access to valves and piping specialties.
- F. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- H. Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.4 THREADED PIPE JOINTS

- A. Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.5 SOLVENT WELDED PIPE JOINTS

- A. Install in accordance with ASTM D2855 "Making Solvent Cemented Joints with PVC Pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Remove dust, drips, moisture, grease and other superfluous materials from pipe interior and exterior. Check dry fit of pipe and fittings. Reject materials which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.
- B. Maintain pipe, fittings, primer and cement between 40 and 100 degrees during application and curing. Apply primer and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about 1/2 the size of the pipe diameter. Apply primer to the fitting socket and pipe surface with a scrubbing motion. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths. Apply solvent cement to the fitting socket and pipe in an amount greater than needed to fill any gap. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to the bottom of the socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4" and larger. Hold joint for 30 seconds or until set. Reference manufacturer's recommendations for initial set time before handling and for full curing time before pressure testing. Cold weather solvent/cement may be utilized only under unusual circumstances and when specifically approved by the Owner.

3.6 SANITARY WASTE AND VENT

- A. Verify invert elevations and building elevations prior to installation. Install exterior piping pitched to drain at indicated elevations and slope. Install interior piping pitched to drain at minimum slope of 1/4" per foot where possible and in no case less than 1/8" per foot for piping 3" and larger.

- B. Install exterior piping below predicted frost level and not less than 5' bury depth to top of pipe wherever possible. Where piping is located above predicted frost level, provide frost protection in accordance with SPS 382.30(11)(c).
- C. Flush piping inlets (floor drains, hub drains, mop basins, fixtures, etc.) with high flow of water at completion of project to demonstrate full flow capacity. Remove blockages and make necessary repairs where flow is found to be impeded.

3.7 PIPING SYSTEM LEAK TESTS

- A. Isolate or remove components from system which are not rated for test pressure. Perform final testing for medical and lab gas with all system components in place. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.
- B. If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.
- C. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- D. For air or nitrogen tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.
- E. Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.
- F. Entire test must be witnessed by the Owner's representative. All pressure tests are to be documented on forms to be provided to the Contractor.

System	Test Medium	Initial Test		Final Test	
		Pressure	Duration	Pressure	Duration
Sanitary Waste & Vent	Water	N/A		10' water	2 hr
Pressurized Sanitary Waste & Vent	Water	N/A		100 psig	2 hr

END OF SECTION 22 13 00

SECTION 22 14 00

FACILITY STORM DRAINAGE

PART 1 GENERAL

1.1 SCOPE

- A. This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Shop Drawings.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Storm and Clear Water Waste and Vent.
 - b. Subsoil Drain.
 - 3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Threaded Pipe Joints.
 - e. Solvent Welded Pipe Joints.
 - f. Storm and Clearwater Waste and Vent.
 - g. Subsoil Drain.
 - h. Piping System Leak Tests.

1.2 RELATED WORK

- A. Section 22 05 14 - Plumbing Specialties.
- B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI A21.4.
- B. ANSI A21.11.
- C. ANSI A21.51.
- D. ANSI B16.3 Malleable Iron Threaded Fittings.
- E. ANSI B16.4 Cast Iron Threaded Fittings.
- F. ANSI B16.5 Pipe Flanges and Flanged Fittings.

G.	ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
H.	ANSI B16.29	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.
I.	ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
J.	ASTM A74	Cast Iron Soil Pipe and Fittings.
K.	ASTM A105	Forgings, Carbon Steel, for Piping Components.
L.	ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
M.	ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
N.	ASTM A861	High Silicon Iron Pipe and Fittings.
O.	ASTM A888	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
P.	ASTM B32	Solder Metal.
Q.	ASTM B88	Seamless Copper Water Tube.
R.	ASTM B306	Copper Drainage Tube (DWV).
S.	ASTM B813	Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
T.	ASTM C76	Reinforced Concrete Culvert, Storm Drain and Sanitary Pipe.
U.	ASTM C443	Joints for Circular Concrete Pipe Sewer and Culvert Pipe Using Rubber Gaskets.
V.	ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
W.	ASTM C1540	Heavy Duty Shielded Couplings for Joining Hubless Cast Iron Soil Pipe and Fittings.
X.	ASTM D1785	Poly Vinyl Chloride (PVC) Plastic Pipe.
Y.	ASTM D2321	Underground Installation of Flexible Thermoplastic Sewer Pipe.
Z.	ASTM D2241	Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
AA.	ASTM D2464	Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
BB.	ASTM D2466	Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
CC.	ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
DD.	ASTM D2564	Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
EE.	ASTM D2657	Heat Fusion Joining of Polyolefin Pipe and Fittings.
FF.	ASTM D2665	Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.

GG.	ASTM D2729	Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
HH.	ASTM D2774	Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
II.	ASTM D2855	Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
JJ.	ASTM D3034	Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
KK.	ASTM D3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
LL.	ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
MM.	ASTM D3311	Drain, Waste and Vent (DWV) Plastic Fitting Patterns.
NN.	ASTM D4101	Propylene Plastic Injection and Extrusion Materials.
OO.	ASTM F405	Corrugated Polyethylene (PE) Tubing and Fittings.
PP.	ASTM F437	Threaded Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
QQ.	ASTM F438	Socket Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.
RR.	ASTM F441	Chlorinated Poly Vinyl Chloride (CPVC Plastic Pipe, Schedules 40 and 80.
SS.	ASTM F656	Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
TT.	CISPI 301	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
UU.	CISPI 310	Couplings For Use In Connection With Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste And Vent Piping Applications.

1.5 SHOP DRAWINGS

- A. Schedule from the Contractor indicating the ASTM, AWWA or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.
- B. Statement from manufacturer on his letterhead that pipe furnished meets the ASTM, AWWA or CISPI specification contained in this section.

1.6 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 40 00 - Quality Requirements.
- B. Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.

- C. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.8 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM, AWWA or CISPI specifications as listed in this specification.
- B. Construct all piping for the highest pressures and temperatures in the respective system.
- C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.
- D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E. Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F. Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

PART 2 PRODUCTS

2.1 STORM AND CLEARWATER WASTE AND VENT

- A. Interior Above Ground:
 - 1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
- B. Pressurized Interior Above Ground:
 - 1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.
- C. Interior Below Ground 15" and Smaller:
 - 1. PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

2.2 SUBSOIL DRAIN

- A. PVC sewer pipe and fittings, perforated, Class 12454-B (PVC 1120), ASTM D2729; primer, ASTM F656; solvent cement, ASTM 2564; with polypropylene fabric filter cover.

PART 3 EXECUTION

3.1 GENERAL

- A. Install pipe and fittings in accordance with reference standards, manufacturers recommendations and recognized industry practices.

3.2 PREPARATION

- A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

- A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C. Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.
- D. Maintain piping in clean condition internally during construction.
- E. Provide clearance for installation of insulation, access to valves and piping specialties.
- F. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- H. Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.4 THREADED PIPE JOINTS

- A. Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.5 SOLVENT WELDED PIPE JOINTS

- A. Install in accordance with ASTM D2855 "Making Solvent Cemented Joints With PVC Pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Remove dust, drips, moisture, grease and other superfluous materials from pipe interior and exterior. Check dry fit of pipe and fittings. Reject materials which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.
- B. Maintain pipe, fittings, primer and cement between 40 and 100 degrees during application and curing. Apply primer and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about 1/2 the size of the pipe diameter. Apply primer to the fitting socket and pipe surface with a scrubbing motion. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths. Apply solvent cement to the fitting socket and pipe in an amount greater than needed to fill any gap. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to the bottom of the socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4" and larger. Hold joint for 30 seconds or until set. Reference manufacturers recommendations for initial set time before handling and for full curing time before pressure testing. Cold weather solvent/cement may be utilized only under unusual circumstances and when specifically approved by the Owner.

3.6 STORM AND CLEARWATER WASTE AND VENT

- A. Verify invert elevations and building elevations prior to installation. Install exterior piping pitched to drain at indicated elevations and slope. Install interior piping pitched to drain at minimum slope of 1/8" per foot where possible and in no case less than 1/16" per foot for piping 3" and larger.
- B. Install exterior piping below predicted frost level and not less than 5' bury depth to top of pipe wherever possible. Where piping is located above predicted frost level, provide frost protection in accordance with SPS 382.30(11)(c).

3.7 SUBSOIL DRAIN

- A. Verify invert elevations and building elevations prior to installation. Install piping sloped to drain to locations indicated. Where subsoil drains are required to penetrate foundation work, sleeve subsoil drains or use nonperforated sections of piping and place prior to foundation work.
- B. Secure joints and piping where corrugated polyethylene is used to prevent movement during laying and backfill. Route piping in straight lines. Plug dead ends of pipe with pipe caps or concrete plugs. Extend filter fabric cover over all piping and fittings with fabric cover joints overlapping and banded.
- C. Bed piping on and backfill around subsoil drains with pea gravel or No. 2 coarse aggregate (DOT 501.3.6.4.5) to a level 12" above or as indicated.

3.8 PIPING SYSTEM LEAK TESTS

- A. Isolate or remove components from system which are not rated for test pressure. Perform final testing for medical and lab gas with all system components in place. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.
- B. If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.
- C. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- D. For air or nitrogen tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.
- E. Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.
- F. Entire test must be witnessed by the Owner's representative. All pressure tests are to be documented on forms to be provided to the Contractor.

System	Test Medium	Initial Test		Final Test	
		Pressure	Duration	Pressure	Duration
Storm and Clearwater Waste	Water	N/A		10' water	2 hr
Pressurized Storm/ Clearwater Waste	Water	N/A		100 psig	2 hr

END OF SECTION

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SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for water heaters, water softeners, pumps and other equipment used for plumbing applications. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Documents.
 - c. Reference.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 - 2. PART 2 – PRODUCTS.
 - a. Sumps.
 - b. Sump Pumps.
 - c. Sewage Ejector Pumps.
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.2 RELATED DOCUMENTS

- A. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
- B. Section 22 07 00 - Plumbing Insulation.
- C. Division 26 - Electrical.

1.3 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this section.

1.4 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

1.5 SHOP DRAWINGS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Include data concerning dimensions, capacities, materials of construction, ratings, certifications, weights, pump curves with net positive suction head requirements, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

1.6 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.1 SUMPS

- A. Fiberglass sump basin constructed of 25-30% fiberglass and 70-75% polyester resin with no fillers; minimum design safety factor of four; complete with tapped top flange; side hub fittings; bolted galvanized steel, aluminum, or fiberglass gasketed cover with inspection access plate, access plate with discharge pipe flange for each pump and control and vent flange where required. Minimum sump wall thickness as follows:

Diameter	Wall Thickness (Inches)						
	24	30	36	42	48	60	72
Max. 10' Depth	3/16	1/4	1/4	1/4	5/16	5/16	3/8
Max. 15' Depth	1/4	5/16	5/16	5/16	3/8	3/8	7/16
Max. 20' Depth	5/16	5/16	3/8	3/8	7/16	1/2	1/2

2.2 SUMP PUMPS

- A. Manufacturer:
1. Gould: www.goulds.com.
 2. Little Giant: www.little-giantpump.com.
 3. Liberty Pumps
 4. Weil: www.weilpump.com.
 5. Zoeller: www.zoellerpumps.com.
- B. Type: Submersible pumps constructed of epoxy coated cast iron shell, cast iron volute, two vane enclosed semi-open, or recessed vortex non-clog cast iron, bronze or thermoplastic impeller, stainless steel shaft, stainless steel fasteners, upper and lower ball bearings, oil lubricated or factory sealed grease lubricated, and ceramic mechanical seal.
- C. Motor: Hermetically sealed, capacitor start, with built-in thermal overload protection sized for non-overloading over the entire pump curve.
- D. CONTROLS:
1. Single On/Off float switch, UL listed.
 2. NEMA 1 indoor alarm panel with warning light, horn, silence switch, test switch and high level alarm switch, UL listed.
- E. ACCESSORIES:
1. 20' power cord.
 2. Discharge check valve, fullport ball valve and union for each pump.

2.3 SEWAGE EJECTOR PUMPS

- A. Manufacturer:
1. Gould: www.goulds.com.
 2. Liberty Pumps
 3. Weil: www.weilpump.com.
 4. Zoeller: www.zoellerpumps.com.
- B. Type: Submersible sewage ejector pumps constructed of epoxy coated cast iron shell, cast iron volute, semi-open or recessed vortex non-clog bronze or cast iron impeller with top pump out vanes, stainless steel shaft, stainless steel fasteners, upper and

lower ball bearings oil lubricated or factory sealed grease lubricated, and ceramic mechanical seal.

C. Motor: Hermetically sealed, capacitor start, Class B insulation, with built-in thermal overload protection sized for non-overloading over the entire pump curve.

D. CONTROLS:

1. Electrical pump alternator and alarm panel with combination magnetic starter for each pump, fused disconnect switch, HOA switch for each pump, run light for each pump, resettable overload heaters, warning light, horn, silence switch, test switch, labeled terminal switch and devices, auxiliary dry contact for remote alarm, UL listed components, NEMA 1

E. ACCESSORIES:

1. 20' power cord.
2. Discharge cast iron weighted check valve, fullport ball or gate valve and union or flange for each pump.
3. Dual mechanical seals, seal leak detector probe and warning light in control panel.
4. Dual stainless steel lift out guide rails with stainless steel or cast iron wall, pump and sump brackets, bronze and neoprene quick disconnect fitting and corrosion proof pull chain or cable.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install plumbing equipment where indicated in accordance with manufacturer's recommendations. Coordinate equipment location with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Locate equipment and arrange plumbing piping to provide access space for servicing all components.

B. Set sumps on compacted granular backfill adjusting for plumb and level. Backfill in even layers around sump with granular backfill.

C. Connect equipment to water and drain piping using unions or flanges and isolation valves.

D. Startup and test equipment adjusting operating and safety controls for proper operation.

END OF SECTION 22 30 00

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SECTION 22 42 00

COMMERCIAL PLUMBING FIXTURES

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for plumbing fixtures, faucets and trim.
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 - g. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Plumbing Fixtures.
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.2 RELATED WORK

- A. Section 22 05 14 - Plumbing Specialties.
- B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
- C. Section 22 11 00 - Facility Water Distribution.
- D. Section 22 13 00 - Facility Sanitary Sewerage.

1.3 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this section.

1.4 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. Plumbing products requiring approval by the State of Wisconsin Dept. of Safety and Professional Services must be approved or have pending approval at the time of shop drawing submission.

1.5 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Include data concerning sizes, utility sizes, rough in-dimensions, capacities, materials of construction, ratings, weights, trim, finishes, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

1.6 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

1.7 DESIGN CRITERIA

- A. ANSI A112.6.1M-88 Supports for Off-the Floor Plumbing Fixtures for Public Use.
- B. ANSI A112.18.1-94 Finished and Rough Brass Plumbing Fixture Fittings.
- C. ANSI A112.19.1-90 Enameled Cast Iron Plumbing Fixtures.
- D. ANSI A112.19.2M-82 Vitreous China Plumbing Fixtures.
- E. ANSI A112.19.5-79 (R1990) Trim for Water Closet Bowls, Tanks and Urinals.
- F. ANSI Z124.1-87 Plastic Bathtub Units.
- G. ANSI Z124.2-87 Plastic Shower Receptors and Shower Stalls.
- H. AHRI-1010-94 Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- I. ASSE 1011-93 Hose Connection Vacuum Breakers.
- J. ASSE 1014-90 Handheld Showers.
- K. ASSE 1035-93 Laboratory Faucet Backflow Preventers.

PART 2 PRODUCTS

2.1 PLUMBING FIXTURES

2.2 REFER TO PLUMBING FIXTURE SCHEDULE ON SHEET P001 FOR MORE INFORMATION.

- A. Manufacturers: Fixture descriptions establish fixture type, quality, materials, features and size. Products of the following manufacturers determined to be equal by the Engineer will be accepted.
 - 1. Water Closets:
 - a. American Standard: www.americanstandard-us.com.
 - b. Kohler: www.kohler.com.
 - c. Zurn: www.zurn.com.
 - 2. Water Closet Seats:
 - a. Bemis: www.bemisseats.com.
 - b. Beneke: www.unique-toilet-seat.com.
 - c. Centoco: www.centoco.com.
 - d. Olsonite Sperzel: www.olsonite.com.
 - 3. Urinals:
 - a. American Standard: www.americanstandard-us.com.
 - b. Kohler; www.kohler.com.
 - c. Zurn, www.zurn.com.
 - 4. Lavatories:
 - a. American Standard: www.americanstandard-us.com.
 - b. Kohler: www.kohler.com.
 - c. Zurn: www.zorn.com.
 - 5. Faucets:
 - a. Chicago Faucet: www.chicagofaucet.com.
 - b. Kohler: www.kohler.com.
 - c. Speakman: www.speakmancompany.com.
 - d. Symmons: www.symmons.com.

- e. Zurn: www.zurn.com.
- 6. Drains:
 - a. Chicago Faucet: www.chicagofaucet.com.
 - b. Engineered Brass Co.: www.justmfg.com.
 - c. Kohler: www.kohler.com.
 - d. McGuire: www.mcguiremfg.com.
- 7. Stops and Supplies (Heavy Duty Type Only):
 - a. Chicago Faucet Co.: www.chicagofaucet.com.
 - b. T&S Brass: www.tsbrass.com.
 - c. McGuire: www.mcguiremfg.com.
- 8. Flush Valves:
 - a. Coyne & Delany: www.delanyproducts.com.
 - b. Sloan Royal: www.sloanvalve.com.
 - c. Zurn AV: www.zurnproducts.com.
- 9. Traps (17 gauge Min.):
 - a. Kohler: www.kohler.com.
 - b. McGuire: www.mcguiremfg.com.
 - c. Dearborn: www.dearbornbrass.com.
 - d. Engineered Brass Co.: www.justmfg.com.
- 10. Carriers and Supports:
 - a. Josam: www.josam.com.
 - b. Smith: www.jrsmith.com.
 - c. Wade: www.wadedrains.com.
 - d. Watts Drainage: www.watts.com.
 - e. Zurn: www.zurn.com.
- 11. Sinks:
 - a. American Standard: www.americanstandard-us.com.
 - b. Elkay: www.elkay.com.
 - c. Just: www.justmfg.com.
 - d. Kohler: www.kohler.com.
- 12. Mop Basins:
 - a. Fiat: www.fiat.ca.
 - b. Mustee: www.mustee.com.
 - c. Stern-Williams: www.sternwilliams.com.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install plumbing fixtures in accordance with manufacturer's instructions. Set level and plumb. Secure in place to counters, floors and walls providing solid bearing and secure mounting. Bolt fixture carriers to floor and wall. Secure rough-in fixture piping to prevent movement of exposed piping.
- B. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.
- C. Install barrier free fixtures in compliance with IBC 1108 and 3408, COMM 52, 69 and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above floor to avoid contact by wheelchair users.
- D. Provide unions at water connections to drinking fountains and electric water coolers.

- E. Each fixture shall have a stop valve installation to control the fixture. Stop valves shall be heavy duty type with brass stems and screwed or sweat inlet connections. Compression type inlets are not acceptable.
- F. Cover pipe penetrations with escutcheons. Exposed traps, stops, piping and escutcheons to be chrome plated brass, same items in concealed locations may be of rough brass finish.
- G. Set floor mounted water closets, floor mounted service sinks; counter mounted lavs and sinks; lav and sink faucets and drains with full setting bed of flexible non-staining plumber's putty. Cover exposed water closet bolts with bolt covers.
- H. Set mop basins to floor and wall with grout or silicone sealant.
- I. Seal openings between walls, floors and fixtures with mildew-resistant silicone sealant same color as fixture.
- J. Test fixtures to demonstrate proper operation. Replace malfunctioning units or components. Adjust valves for intended water flow rate to fixtures without splashing, noise or overflow. Adjust self-closing lavatory faucets to 15 second cycle. Adjust shower valve temperature limit stops to 110 degree maximum outlet temperature.
- K. Protect fixtures during construction. At completion clean plumbing fixtures and trim using manufacturer's recommended cleaning methods and materials.

END OF SECTION 22 42 00

SECTION 22 46 00

SUBDRAINAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Building Perimeter, Retaining Wall, and Under-Slab Drainage Systems.
- B. Drainage Pipe, Filter aggregate and fabric and bedding.

1.2 REFERENCE STANDARDS

- A. ASTM D 2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe drainage products and pipe accessories. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the work of this section.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

- A. Polyvinyl Chloride Pipe (PVC):
 - 1. AASHTO M278, Perforated and non-perforated schedule 40 or 80 PVC pipe of a size shown on the Drawings, with 2 rows of 3/8 inch pre-drilled perforations in the 4 inch size, and 4 rows of 3/8 inch pre-drilled perforations in the 6 through 10 inch sizes, spaced every 3 inches on center.
- B. Perforated Polyethylene Pipe: AASHTO M252 or ASTM F405 Corrugated for coupled joints with required fittings.
- C. Use perforated pipe at sub drainage system; unperforated through sleeved walls and sewer connections.
- D. Provide required fittings and welding materials.

2.2 AGGREGATE AND BEDDING

- A. Filter Aggregate and Bedding Material:
 - 1. Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2 inch sieve and 0 to 5 percent passing a No. 8 sieve.
- B. Impervious Fill:
 - 1. Clayey gravel and sand mixture capable of compacting to a dense state.

2.3 ACCESSORIES

- A. Pipe Couplings: Solid plastic.
- B. Filter Fabric: Mirafi 140N or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout Drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations.
- B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

3.3 INSTALLATION

- A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.
- B. Place drainage pipe on clean cut subsoil.
- C. Lay pipe to slope gradients noted on Drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Place pipe with perforations facing down. Install pipe couplings.
- E. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches.
- F. Place filter fabric over leveled top surface of aggregate cover prior to subsequent backfilling operations.
- G. Place aggregate in maximum 4 inch lifts, consolidating each lift.
- H. Do not displace or damage pipe when compacting.
- I. Place impervious fill over drainage pipe aggregate cover and compact.
- J. Connect to storm sewer system, sump or other location as indicated on drawings with unperforated pipe, through installed sleeves.

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspection and testing.
- B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.5 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION 22 46 00

SECTION 22 60 00

GAS AND VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 GENERAL

1.1 SCOPE

- A. This section contains specifications for plumbing pipe and pipe fittings for this project. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Reference.
 - c. Reference Standards.
 - d. Shop Drawings.
 - e. Operation and Maintenance Data.
 - f. Quality Assurance.
 - g. Delivery, Storage, and Handling.
 - h. Design Criteria.
 - i. Welder Qualifications.
 - 2. PART 2 – PRODUCTS.
 - a. Lab Vacuum.
 - b. Laboratory Gas.
 - 3. PART 3 – EXECUTION.
 - a. General.
 - b. Preparation.
 - c. Erection.
 - d. Copper Pipe Joints.
 - e. Threaded Pipe Joints.
 - f. Solvent Welded Pipe Joints.
 - g. Medical Gas, Lab Gas and Vacuum.
 - h. Piping System Leak Tests.
 - i. Construction Verification Items.
 - j. Owner Training.

1.2 RELATED WORK

- A. Section 22 05 14 - Plumbing Specialties.
- B. Section 22 05 23 - General Duty Valves For Plumbing Piping.
- C. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI A21.4.
- B. ANSI A21.11.
- C. ANSI A21.51.
- D. ANSI B16.3 Malleable Iron Threaded Fittings.

E.	ANSI B16.5	Pipe Flanges and Flanged Fittings.
F.	ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings.
G.	ANSI B16.29	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings DWV.
H.	ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
I.	ASTM A105	Forgings, Carbon Steel, for Piping Components.
J.	ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.
K.	ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
L.	ASTM A861	High Silicon Iron Pipe and Fittings.
M.	ASTM B32	Solder Metal.
N.	ASTM B88	Seamless Copper Water Tube.
O.	ASTM B280	Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
P.	ASTM B306	Copper Drainage Tube (DWV).
Q.	ASTM B813	Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
R.	ASTM B819	Seamless Copper Tube for Medical Gas Systems.
S.	ASTM D1785	Poly Vinyl Chloride (PVC) Plastic Pipe.
T.	ASTM D2241	Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
U.	ASTM D2464	Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
V.	ASTM D2466	Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
W.	ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
X.	ASTM D2564	Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
Y.	ASTM D2657	Heat Fusion Joining of Polyolefin Pipe and Fittings.
Z.	ASTM D2774	Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
AA.	ASTM D2855	Making Solvent Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
BB.	ASTM D3222	Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
CC.	ASTM D4101	Propylene Plastic Injection and Extrusion Materials.
DD.	ASTM F405	Corrugated Polyethylene (PE) Tubing and Fittings.

EE.	ASTM F437	Threaded Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
FF.	ASTM F438	Socket Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.
GG.	ASTM F441	Chlorinated Poly Vinyl Chloride (CPVC Plastic Pipe, Schedules 40 and 80.
HH.	ASTM F493	Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings.
II.	ASTM F656	Primers for Use in Solvent Cement Joints of Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.
JJ.	AWS A5.8	Brazing Filler Metal.
KK.	NFPA 99	Health Care Facilities.
LL.	CGA G-4.1	Equipment Cleaned for Oxygen Service.
MM.	CGA P-2.1	Standards for Medical-Surgical Vacuum Systems in Health Care Facilities.

1.5 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Schedule from the Contractor indicating the ASTM, AWWA or CISPI specification number of the pipe being proposed along with its type and grade if known at the time of submittal, and sufficient information to indicate the type and rating of fittings for each service.
- C. Statement from manufacturer on his letterhead that pipe furnished meets the ASTM, AWWA or CISPI specification contained in this section.

1.6 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 Closeout Submittals.

1.7 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Section 01 60 00 - Product Requirements.
- B. Order all copper, cast iron, steel, PVC and polyethylene pipe with each length marked with the name or trademark of the manufacturer and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier.
- C. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified,

take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

- C. Offsite storage agreements will not relieve the Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.9 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM Specifications as listed in this specification.
- B. Construct all piping for the highest pressures and temperatures in the respective system.
- C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in ventilation plenum spaces, including plenum ceilings.
- D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
- E. Where ASTM A53 type F pipe is specified, grade A type E or S, or grade B type E or S may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- F. Where ASTM B88, type L H (drawn) temper copper tubing is specified, ASTM B88, type K H (drawn) temper copper tubing may be substituted at Contractor's option.

1.10 WELDER QUALIFICATIONS

- A. Welding procedures, welders, and welding operators for all building service piping to be in accordance with certified welding procedures of the National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing. Before any metallic welding is performed, Contractor to submit his Standard Welding Procedure Specification together with the Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- B. Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.
- C. The Engineer reserves the right to test the work of any welder employed on the project, at the Contractor's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project and all defective welds replaced.

PART 2 PRODUCTS

2.1 REFER TO SHEET P001 FOR MORE INFORMATION REGARDING OXYGEN AND VACUUM EQUIPMENT.

2.2 VACUUM

- A. Type L seamless copper water tube, H (drawn) temper, ASTM B88, with wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux,

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ASTM B813 or copper phosphorous or copper-phosphorous-silver brazing alloy for copper-to-copper joints, AWS A5.8 BCuP; flux and silver brazing alloy AWS A5.8 BAg for copper-to-brass/bronze joints. Where vacuum piping and medical or laboratory gases are installed on the same project, the vacuum piping must either meet the medical or laboratory gas piping specification or it must be field labeled every 5' prior to installation to prevent use for those gases.

- B. For piping downstream of passive vacuum system PVC plastic pipe, Schedule 40, Class 12454-B (PVC 1120), ASTM D1785; PVC plastic drain, waste and vent pipe and fittings, ASTM D2665; socket fitting patterns, ASTM D3311; primer, ASTM F656; solvent cement, ASTM D2564.

2.3 LAB GAS

- A. Type L seamless copper tube for air conditioning, H (drawn) temper, ASTM B280 or Type L seamless copper medical gas tube, H (drawn) temper, ASTM B819; with wrought copper pressure fittings, ANSI B16.22; copper phosphorous or copper-phosphorous-silver brazing alloy for copper-to-copper joints, AWS A5.8 BCuP; flux and silver brazing alloy AWS A5.8 BAg for copper-to-brass/bronze joints. Clean piping and fittings at factory in accordance with CGA G-4.1. Cap, plug or seal piping to prevent contamination prior to assembly.

PART 3 EXECUTION

3.1 GENERAL

- A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

3.2 PREPARATION

- A. Cut pipe ends square. Ream ends of piping to remove burrs. Clean scale and dirt from interior and exterior of each section of pipe and fitting prior to assembly.

3.3 ERECTION

- A. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- B. Where copper or steel piping is embedded in masonry or concrete, provide protective sleeve covering of elastomeric pipe insulation.
- C. Install underground warning tape 6"-12" below finished grade above all exterior below ground piping. Where existing underground warning tape is encountered, repair and replace.
- D. Maintain piping in clean condition internally during construction.
- E. Provide clearance for installation of insulation, access to valves and piping specialties.

- F. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
- G. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- H. Install all valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to all equipment, fixtures and systems installed by others where same requires the piping services indicated in this section.

3.4 COPPER PIPE JOINTS

- A. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux and assemble joint to socket stop. Apply flame to fitting until solder melts when placed at joint. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

3.5 SOLVENT WELDED PIPE JOINTS

- A. Install in accordance with ASTM D2855 "Making Solvent Cemented Joints with PVC Pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if they are fitted with wheels designed for use with PVC/CPVC pipe that do not leave a raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Remove dust, drips, moisture, grease and other superfluous materials from pipe interior and exterior. Check dry fit of pipe and fittings. Reject materials which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.
- B. Maintain pipe, fittings, primer and cement between 40 and 100 degrees during application and curing. Apply primer and solvent using separate daubers (3" and smaller piping only) or clean natural bristle brushes about 1/2 the size of the pipe diameter. Apply primer to the fitting socket and pipe surface with a scrubbing motion. Check for penetration and reapply as needed to dissolve surface to a depth of 4-5 thousandths. Apply solvent cement to the fitting socket and pipe in an amount greater than needed to fill any gap. While both surfaces are wet, insert pipe into socket fitting with a quarter turn to the bottom of the socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4" and larger. Hold joint for 30 seconds or until set. Reference manufacturer's recommendations for initial set time before handling and for full curing time before pressure testing. Cold weather solvent/cement may be utilized only under unusual circumstances and when specifically approved by the Owner Project Representative.

3.6 MEDICAL GAS, LAB GAS AND VACUUM

- A. Examine piping and fittings internally for contamination prior to assembly. Do not install contaminated material. On-site cleaning may be performed only at joints contaminated prior to brazing by scrubbing in hot alkaline cleaner and water solution (sodium carbonate or trisodium phosphate, one pound to 3 gallons of water) and rinsing with clean hot water.

- B. Purge piping system with dry nitrogen during brazing operations. Use flux only where copper to brass/bronze joints are required and on soldered vacuum systems. Apply flux sparingly avoiding contamination of piping system. Wash exterior of finished joints with water and stainless steel brush. Use hot water on fluxed joints. Inspect joints for flux residue, oxidation, unmelted filler metal, failure to fully penetrate or surround joint with filler metal, cracks in fittings or filler metal or potential leaks. Replace defective fittings or pipe and repair defective joints. Replace defective joints requiring more than two repairs. Assemble threaded joints with teflon tape. Unions are not allowed in distribution pipeline system for gas systems and only on vacuum distribution piping where exposed and readily accessible.
- C. Do not run piping where subject to physical damage, excessive heat, corrosion or contact with oil. Do not interconnect piping serving patients with piping serving laboratories.
- D. **INSTALLER PERFORMANCE TESTING:** Blowout piping systems prior to connection of outlets, inlets or gauges with dry nitrogen to remove particulate contamination. Fill piping systems with dry nitrogen and perform initial pressure test. Complete installation of pressure sensitive components and perform final pressure test. Perform heavy, intermittent purging of pipeline with dry nitrogen until no discoloration is evident in white cloth held over outlets and inlets. Cross connect test one system at a time testing all inlets and outlets to verify that test gas is being dispensed only from the outlets or inlets of the system being tested.

3.7 PIPING SYSTEM LEAK TESTS

- A. Isolate or remove components from system which are not rated for test pressure. Perform final testing for medical and lab gas with all system components in place. Test piping in sections or entire system as required by sequence of construction. Do not insulate or conceal pipe until it has been successfully tested.
- B. If required for the additional pressure load under test, provide temporary restraints at fittings or expansion joints. Backfill underground water mains prior to testing with the exception of thrust restrained valves which may be exposed to isolate potential leaks.
- C. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.
- D. For air or nitrogen tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. System will not be approved until it can be demonstrated that there is no measurable loss of test pressure during the test period.
- E. Inspect system for leaks. Where leaks occur, repair the area with new materials and repeat the test; caulking will not be acceptable.
- F. Entire test must be witnessed by the Owner's representative. All pressure tests are to be documented on forms to be provided to the Contractor.

<u>System</u>	<u>Test Medium</u>	<u>Initial Test Pressure</u>	<u>Duration</u>	<u>Final Test Pressure</u>	<u>Duration</u>
Oxygen	Nitrogen	150 psig	2 hr	65 psig	24 hr

END OF SECTION 22 60 00

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED WORK

- A. Section 07 84 00 - Firestopping.
- B. Section 23 05 13 - Common Motor Requirements for HVAC.
- C. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
- D. Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.3 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in other sections are as follows:
 - 1. AABC Associated Air Balance Council.
 - 2. ADC Air Diffusion Council.
 - 3. AGA American Gas Association.
 - 4. AMCA Air Movement and Control Association.
 - 5. ANSI American National Standards Institute.
 - 6. AHRI Air-Conditioning, Heating and Refrigeration Institute.
 - 7. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers.
 - 8. ASME American Society of Mechanical Engineers.
 - 9. ASTM American Society for Testing and Materials.
 - 10. EPA Environmental Protection Agency.
 - 11. GAMA Gas Appliance Manufacturers Association.
 - 12. IEEE Institute of Electrical and Electronics Engineers.
 - 13. ISA Instrument Society of America.
 - 14. MCA Mechanical Contractors Association.
 - 15. MICA Midwest Insulation Contractors Association.
 - 16. MSS Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
 - 17. NBS National Bureau of Standards.
 - 18. NEBB National Environmental Balancing Bureau.
 - 19. NEC National Electric Code.
 - 20. NEMA National Electrical Manufacturers Association.
 - 21. NFPA National Fire Protection Association.
 - 22. SMACNA Sheet Metal and Air Conditioning Contractors' National Association. Inc.
 - 23. UL Underwriters Laboratories Inc.
 - 24. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 25. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 26. UL1479 Fire Tests of Through-Penetration Firestops.

1.4 QUALITY ASSURANCE

- A. Refer to Section 01 40 00 - Quality Requirements.
- B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

1.5 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval from the Owner Project Representative. When interruption is required, coordinate the down-time with the user agency to minimize disruption to their activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

1.6 PROTECTION OF FINISHED SURFACES

- A. Furnish one can of touch-up paint for each different color factory finish which is to be the final finished surface of the product. Deliver touch-up paint with other "loose and detachable parts" as covered in the Division 01 - General Requirements.

1.7 SEALING AND FIRESTOPPING

- A. Sealing and firestopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the Contractor whose work penetrates the opening. The Contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.
- B. Firestopping shall be UL listed and labeled for the actual application.
- C. Refer to Section 07 84 00 - Firestopping.

1.8 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Submittals must be reviewed and approved by submitting Contractor.
- C. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.
- D. Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Include a statement on the shop drawing transmittal to the Engineer that the equipment submitted, and the motor starter schedule is in agreement or indicate any discrepancies. See related comments in Section 23 05 13 - Common Motor Requirements for HVAC Equipment in Part 1 under Electrical Coordination.

E. Include wiring diagrams of electrically powered equipment.

1.9 OFF SITE STORAGE

- A. Prior approval by Owner and the Engineer will be needed. The Contractor shall carry insurance for full value, with Owner as beneficiary for consideration of offsite materials storage.
- B. Generally, ductwork, metal for making ductwork, duct lining, sleeves, pipe/pipe fittings and similar rough in material will not be accepted for offsite storage. For material that can be stored off site, no material will be accepted for offsite storage unless shop drawings for that material have been approved.

1.10 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Assemble material in three ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the Division 01 - General Requirements, include the following information:
 - 1. Copies of all approved shop drawings.
 - 2. Manufacturer's wiring diagrams for electrically powered equipment.
 - 3. Records of tests performed to certify compliance with system requirements.
 - 4. Certificates of inspection by regulatory agencies.
 - 5. Temperature control record drawings and control sequences.
 - 6. Parts list for manufactured equipment.
 - 7. Lubrication instructions, including list/frequency of lubrication done during construction.
 - 8. Warranties.
 - 9. Additional information as indicated in the technical specification sections.
- B. Provide a PDF file copy of all Operation and Maintenance (O&M) Manuals.

1.11 OWNER TRAINING

- A. Instruct personnel in the proper operation and maintenance of systems and equipment provided as part of this project; video tape all training sessions. Include not less than 16 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

1.12 RECORD DRAWINGS

- A. In addition to the data indicated in the Division 01 - General Requirements, maintain temperature control record drawings on originals prepared by the installing Contractor/Subcontractor. Include copies of these record drawings with the Operating and Maintenance manuals.

PART 2 PRODUCTS

2.1 ACCESS PANELS AND DOORS

- A. Lay-in Ceilings:
 - 1. Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Section 09 50 00 are sufficient; no additional access provisions are required unless specifically indicated.

- B. Plaster Walls and Ceilings:
 - 1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

2.2 IDENTIFICATION

- A. Stencils:
 - 1. Not less than 1 inch high letters/numbers for marking pipe and equipment.
- B. Engraved Name Plates:
 - 1. White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, or W. H. Brady.

2.3 SEALING AND FIRESTOPPING

- A. Refer to Section 07 84 00 - Firestopping.
- B. Fire and/or Smoke Rated Penetrations:
 - 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Hilti: www.hilti.com.
 - c. Rectorseal: www.rectorseal.com.
 - d. STI/SpecSeal: www.stifirestop.com.
 - e. Tremco: www.tremcosealants.com.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. All firestopping systems shall be provided by the same manufacturer.
- C. Submittals:
 - 1. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
 - 2. Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.
- D. Product:
 - 1. Fire stop systems shall be UL listed or tested by an independent testing laboratory.
 - 2. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.
 - 3. Contractor shall use firestop putty, caulk sealant, intumescent wrap strips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail. Do not use intumescent materials at fire damper, or smoke damper penetrations.

E. Non-Rated Penetrations:

1. Pipe Penetrations:

- a. At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

2. Duct Penetrations:

- a. Annular space between duct (with or without insulation) and the non-rated partition or floor opening shall not be larger than 2 inch. Where existing openings have an annular space larger than 2 inches, the space shall be patched to match existing construction to within 2 inch around the duct.
- b. Where shown or specified, pack annular space with fiberglass batt insulation or mineral wool insulation. Provide 4 inch sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.

PART 3 EXECUTION

3.1 DEMOLITION

- A. Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe or duct is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.
- B. All pipe, wiring and associated conduit, insulation, ductwork, and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor. All piping and ductwork specialties are to be removed from the site by the Contractor unless they are dismantled and removed or stored by the Owner. All designated equipment is to be turned over to the Owner for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

3.2 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work to accomplish indicated mechanical systems installation in accordance with Division 31 Earthwork. Blasting will not be allowed without written permission of the Engineer and the Owner.
- B. Install lines passing under foundations with minimum of 1-1/2 inch clearance to concrete and ensure there is no disturbance of bearing soil.

3.3 CONCRETE WORK

- A. All cast in place concrete will be performed by the Division 3 Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support of mechanical equipment.

3.4 CUTTING AND PATCHING

- A. Refer to Division 01.

3.5 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.6 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the owner, making sure that access is available for all equipment and specialties.
- B. Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

3.7 COORDINATION

- A. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, register, grilles, and recessed or semi recessed heating and/or cooling terminal units installed in/on architectural surfaces.
- B. Coordinate all work with other Contractors prior to installation. Any installed work that is not coordinated and that interferes with other Contractor's work shall be removed or relocated at the installing Contractor's expense.
- C. Cooperate with the test and balance agency in ensuring Section 23 05 93 specification compliance. Verify system completion to the test and balance agency (flushing, pressure testing, chemical treatment, filling of liquid systems, proper pressurization and air venting of hydronic systems, clean filters, clean strainers, duct and pipe systems cleaned, controls adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing work. Install dampers, shutoff and balancing valves, flow measuring devices, gauges, temperature controls, etc., required for functional and balanced systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency can perform its work.

3.8 IDENTIFICATION

- A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.
- B. Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C. Use engraved name plates to identify control equipment.

3.9 SLEEVES

- A. Pipe Sleeves:
 - 1. Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall.

2. Pipe sleeves are not required in interior non-rated drywall, plaster or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.

B. Duct Sleeves:

1. Duct sleeves are not required in non-rated partitions or floors.
2. Provide sleeve required for fire dampers in fire-rated partitions and floors. Reference fire damper details on drawings.

3.10 SEALING AND FIRESTOPPING

A. Fire and/or Smoke Rated Penetrations:

1. Install approved product in accordance with the manufacturer's instructions where pipes penetrate a fire/smoke rated surface. When pipe is insulated, use a product which maintains the integrity of the insulation and vapor barrier. Provide a UL label at each penetration.
2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support any substantial weight.

B. Non-Rated Partitions:

1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions.
2. At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.
3. Duct penetrations through non-rated partitions shall require sheet metal escutcheons with fiberglass or mineral wool insulation fill for spaces that include laboratories, clean rooms, animal rooms, kitchens, cart wash rooms, janitor closets, cart wash rooms, toilet rooms, mechanical rooms, conference rooms, private consultation rooms, and where noted on drawings elsewhere.

3.11 OWNER TRAINING

- A. All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under Division 01.

END OF SECTION 23 05 00

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SECTION 23 05 02

MECHANICAL DEMOLITION AND ALTERATIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Special Conditions, and Division-1 Specification sections, apply to work specified in this section.

1.2 JOB CONDITIONS

- A. Perform all demolition as needed to accomplish new work.
- B. Refer to Demolition Drawings for areas and equipment being remodeled.
- C. This Contractor is responsible for all charges, fees etc. incurred as a result of the mechanical portion of the demolition.
- D. Prior to demolition or alteration of structures, the following shall be accomplished:
 - 1. Coordinate sequencing with Owner and other Contractors.
 - 2. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.
 - 3. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.
 - 4. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.
 - 5. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.
 - 6. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
 - 7. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.
 - 8. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 DEMOLITION

- A. Existing mechanical equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all mechanical equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. Properly dispose or remove from site any piping, hangers, or other items not retained by Owner.

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- B. Where materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
- C. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary ducts, pipes, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any ductwork, piping or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.
- D. This Contractor shall remove all ductwork, piping, straps, and existing equipment, being discontinued or removed due to construction. Abandoned or removed services shall be disconnected and capped at the perimeter of the project or as required elsewhere in the documents.
- E. The existing building is to remain in operation during construction. This Contractor shall coordinate all work that will interfere with the present operation of the facility with the Owner and Construction Manager.
- F. All existing equipment that is to remain shall be cleaned. Touch up paint equipment in exposed areas.
- G. Ductwork systems indicated to remain shall be cleaned inside and out.
- H. Existing ductwork in remodeled area that is not being removed shall be sealed as necessary to comply with SMACNA standards and requirements of ductwork section of the specifications.
- I. All coring that is required for mechanical work shall be done by this Contractor.
- J. All cutting and patching required for mechanical work shall be by this Contractor.
- K. This Contractor shall provide required additional support for existing ductwork and piping in remodeled area that is not being removed and is not properly supported in accordance with Specification Section 23 37 13.
- L. When existing ductwork, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.
- M. Maintain construction zone at adequate negative pressure by providing exhaust by mechanical means until all work which creates dust or fumes is completed.

3.2 TESTING

- A. Existing equipment shall be tested before demolition begins to determine existing operating conditions and capacities. Upon completion of all new work, the existing equipment shall be rebalanced to serve the new areas and maintain existing capacities in existing areas.

END OF SECTION 23 05 02

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

- A. This section includes requirements for single and three phase motors that are used with equipment specified in other sections. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operating and Maintenance Data.
 - h. Electrical Coordination.
 - i. Product Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Single Phase, Single Speed Motors.
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.2 RELATED WORK

- A. Division 26 - Electrical.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. ANSI/IEEE 112 Test Procedure for Polyphase Induction Motors and Generators.
- B. ANSI/NEMA MG-1 Motors and Generators.
- C. ANSI/NFPA 70 National Electrical Code.

1.5 QUALITY ASSURANCE

- A. Refer to Division 1.

1.6 SHOP DRAWINGS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared by the Contractor specifically for this work.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

- B. In addition to the general content specified under Section 01 78 00 - Closeout Submittals supply the following additional documentation:
- C. Lubrication instructions, including list/frequency of lubrication
 - 1. Table noting full load power factor, service factor, NEMA design designation, insulation class and frame type for each motor provided

1.8 ELECTRICAL COORDINATION

- A. All starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are furnished and installed by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications.
- B. Electrical drawings and/or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the Engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this Contractor will be the responsibility of this Contractor. See related comments in Section 23 05 00 - Common Work Results for HVAC, under Shop Drawings.
- C. Electrical Contractor will provide all power wiring and control wiring, except temperature control wiring.
- D. Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

1.9 PRODUCT CRITERIA

- A. Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.
- B. Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

PART 2 PRODUCTS

2.1 SINGLE PHASE, SINGLE SPEED MOTORS

- A. Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors 1/3 HP and smaller.
- B. Use permanent split capacitor or capacitor start, induction run motors equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.

- B. Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use. Include this information in the maintenance manuals.

END OF SECTION 23 05 13

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SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for supports of all HVAC equipment and materials as well as piping system anchors. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Description.
 - g. Shop Drawings.
 - h. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Pipe Hanger and Support Manufacturers.
 - b. Structural Supports.
 - c. Pipe Hangers and Supports.
 - d. Beam Clamps.
 - e. Concrete Inserts.
 - f. Equipment Curbs.
 - g. Pipe Penetrations through Roof.
 - 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Hanger and Support Spacing.
 - c. Equipment Curbs.
 - d. Pipe Penetration through Roof.

1.2 RELATED WORK

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Section 23 07 00 - HVAC Insulation.

1.3 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this section.

1.4 REFERENCE STANDARDS

- A. MSS SP-58 Pipe Hangers and Supports - Materials, Design and Manufacture.
- B. MSS SP-59 Pipe Hangers and Supports - Selection and Application.

1.5 QUALITY ASSURANCE

- A. Refer to Division 1.

1.6 DESCRIPTION

- A. Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.
- B. Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.
- C. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.
- D. Protect insulation at all hanger points; see Related Work above.

1.7 SHOP DRAWINGS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference Section 23 05 00.

1.8 DESIGN CRITERIA

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.
- B. Piping connected to rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.
- C. Piping supported by laying on the bottom chord of joists or trusses will not be accepted.
- D. Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.
- E. Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.

PART 2 PRODUCTS

2.1 PIPE HANGER AND SUPPORT MANUFACTURERS

- A. Anvil, B-Line, Fee and Mason, Kindorf, Michigan Hanger, Unistrut, or approved equal. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

2.2 STRUCTURAL SUPPORTS

- A. Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.

2.3 PIPE HANGERS AND SUPPORTS

- A. Hangers For Steel Pipe Sizes 1/2" Through 2":
 - 1. Carbon steel, adjustable, clevis, black finish. Anvil figure 65 or 260.
- B. Copper Pipe Support:
 - 1. Carbon steel ring, adjustable, copper plated or polyvinylchloride coated.

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C. Insulation Protection Shields:

1. Galvanized carbon steel of not less than 18 gauge for use on insulated pipe 2-1/2 inch and larger. Minimum shield length is 12 inches. Equal to Anvil figure 167.

2.4 BEAM CLAMPS

- A. MSS SP-69 Type 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick for single threaded rods of 3/8, 1/2, and 5/8 inch diameter, for use with pipe sizes 4 inch and less. Furnish with a hardened steel cup point set screw. Anvil figure 86.
- B. MSS SP-69 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter but limited in application to pipe sizes 8 inch and less without prior approval. Anvil figure 228.

2.5 CONCRETE INSERTS

- A. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, Redhead.

2.6 EQUIPMENT CURBS

A. Prefabricated Metal Curb:

1. Constructed of not less than 18 gauge galvanized steel reinforced so it is structurally capable of supporting the intended load with no penetrations through the curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal two inch wood nailer, galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18 inch high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.

B. Wood Build Sleeper Curb:

1. Constructed of wood blocking and anchored to the deck. The curb must be structurally capable of supporting the intended load with no penetrations through the curb flashing. Galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18 inch high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.

2.7 PIPE PENETRATIONS THROUGH ROOF

A. Multiple Pipe Penetrations:

1. Refer to acceptable Equipment Curb types listed above for curb specifications. An 8" high (minimum) curb height is required. The coping cap shall be constructed from laminated acrylic clad thermoplastic (ABS) with graduated step boots to accommodate various size pipes, stainless steel fastening screws for cover, stainless steel band clamps for securing boots around the pipe, and stainless steel band clamp or mechanical locking seal for securing boots around the ABS coping cap flanges.

B. Single Pipe Penetrations:

1. A stack flashing penetration may be utilized for single pipe penetrations through built up roofs and single ply membrane roofs. Utilize high temperature sealant for

all high temperature applications. This includes but is not limited to steam condensate vent piping, steam safety relief piping, and flues.

2. A single pre-manufactured boot may be utilized for single pipe penetrations through single ply membrane roofs only.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install supports to provide for free expansion of the piping and duct system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- B. Piping shall be supported independently from ductwork and all other trades.
- C. Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes for the supporting steel.

3.2 HANGER AND SUPPORT SPACING

- A. Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.
- B. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- C. Support riser piping independently of connected horizontal piping.
- D. Adjust hangers to obtain the slope specified in the piping section of this specification.
- E. Space hangers for pipe as follows:

<u>Pipe Material</u>	<u>Pipe Size</u>	<u>Max. Spacing</u>
Steel	1/2" through 1-1/4"	6'-6"
Steel	1-1/2" through 6"	10'-0"
Steel	8" through 12"	14'-0"
Thermoplastic	All sizes	6'-0"
Copper	1/2" through 1-1/4"	5'-0"
Copper	1-1/2" and larger	8'-0"

3.3 EQUIPMENT CURBS

- A. Secure bottom of support flat on roof deck. Secure equipment to curb in accordance with equipment manufacturer's instructions. Flashing and counter flashing by the General Contractor.
- B. Fill the entire void space with compressible fiberglass insulation.

3.4 PIPE PENETRATION THROUGH ROOF

- A. Install at points where pipes penetrate roof. Install as shown on the drawings, as detailed and according to the manufacturer's installation instructions. Flashing and counter flashing by the General Contractor.

END OF SECTION 23 05 29

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SCOPE

- A. This section includes air and water testing, adjusting and balancing for the entire project. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Description.
 - f. Quality Assurance.
 - g. Submittals.
 2. PART 2 – PRODUCTS.
 - a. Instrumentation.
 3. PART 3 – EXECUTION.
 - a. Daily Reports.
 - b. Preliminary Procedures.
 - c. Performing Testing, Adjusting and Balancing.
 - d. VAV Supply and Exhaust Duct System Static Pressure Set Point.
 - e. Hydronic System Differential Pressure Control Set Point.
 - f. Deficiencies.

1.2 RELATED WORK

- A. Section 23 05 00 - Common Work Results for HVAC.

1.3 REFERENCE

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and General Requirements in Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. AABC National Standards for Total System Balance, Sixth Edition, 2002.
- B. ASHRAE ASHRAE Handbook, 2007 HVAC Applications, Chapter 37, Testing Adjusting and Balancing.
- C. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, Seventh Edition, 2005.

1.5 DESCRIPTION

- A. The Contractor will separately contract with an independent test and balance agency to perform all testing, adjusting, and balancing of air systems required for this project. Work related to the testing, adjusting, and balancing that must be performed by the installing mechanical Contractor is specified in other section of these specifications.

- B. Provide total mechanical systems testing, adjusting and balancing. Requirements include the balance of air distribution, adjustment of new and existing systems and equipment to provide design requirements indicated on the drawings, electrical measurement and verification of performance of all mechanical equipment, all in accordance with standards published by AABC or NEBB.
- C. Test, adjust and balance all air systems so that each room, piece of equipment or terminal device meets the design requirements indicated on the drawings and in the specifications.
- D. Accomplish testing, adjusting and balancing work in a timely manner that allows partial occupancy of major buildings, occupancy of one building when the project involves many buildings, and completion of the entire project in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.
- E. Verify that provisions are being made to accomplish the specified testing, adjusting and balancing work. If problems are found, handle as specified in Part 3 under Deficiencies.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. An independent Firm specializing in the Testing and Balancing of HVAC systems for a minimum of 3 years. A Firm not engaged in the commerce of furnishing or providing equipment or material generally related to HVAC work other than that specifically related to installing Testing and Balancing components necessary for work in this section such as, but not limited to sheaves, pulleys, and balancing dampers.
2. A certified member of AABC or certified by NEBB in the specific area of work performed. Maintain certification for the entire duration of the project. If certification of firm or any staff performing work is terminated or expires during the duration of the project, contact Owner immediately.
3. Technicians on this project must have satisfactorily completed work on a minimum of (3) three projects of at least 50% in size, and of similar complexity.
4. Submit Qualifications of firm and project staff to Owner upon request.

1.7 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures. See also Related Work in this section.
- B. Submit testing, adjusting and balancing reports bearing the seal and signature of the NEBB or AABC Certified Test and Balance Supervisor. The reports certify that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.
- C. Submission:
 1. Distribute electronic copies of the Report to the Contractor, the Lead Contractor, the Owner, and the Prime Engineer.
- D. Enter a RFI, with a copy of the Testing and Balancing Report Summary as an upload, indicating that the Testing and Balancing Report is posted on the Overview page and requesting review of the report.

1. Format: Cover page identifying project name, project number and descriptive title of contents. Divide the contents of the report into the below listed divisions:
 - a. General Information.
 - b. Summary.
 - c. Air Systems.
2. Contents: Provide the following minimum information, forms and data:
 - a. Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.
 - b. Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.
 - c. The remainder of the report to contain the appropriate standard NEBB or AABC forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate same.

PART 2 PRODUCTS

2.1 INSTRUMENTATION

- A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB or AABC Standards and instrument manufacturer's specifications.
- B. All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by Owner upon request. Calibration and maintenance of all instruments to be in accordance with the requirements of NEBB or AABC Standards

PART 3 EXECUTION

3.1 DAILY REPORTS

- A. Submit to Owner's Project Representative daily work activity reports for each day on which testing and balancing work is performed. Reports shall include description of day's activities and description of any system deficiencies.

3.2 PRELIMINARY PROCEDURES

- A. Review preconstruction meeting report, applicable construction bulletins, applicable change orders and approved shop drawings of equipment, outlets/inlets and temperature controls.
- B. Check filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and hydronic systems for proper charge and purging of air.
- C. Notify Owner's Project Representative on a daily basis during balancing. Identify deficiencies preventing completion of testing, adjusting and balancing procedures. Do not proceed until systems are fully operational with all components necessary for

complete testing, adjusting and balancing. Installing Contractors are required to provide personnel to check and verify system completion, readiness for balancing and assist Balancing Agency in providing specified system performance.

3.3 PERFORMING TESTING, ADJUSTING AND BALANCING

- A. Perform testing, adjusting and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards except as may be modified below.
- B. Unless specifically instructed in writing, all work in this specification section is to be performed during the normal workday.
- C. In areas containing ceilings, remove ceiling tile to accomplish balancing work; replace tile when work is complete and provide new tile for any tile that are damaged by this procedure. If the ceiling construction is such that access panels are required for the work of this section and the panels have not been provided, inform the Owner's Project Representative.
- D. Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.
- E. In air systems employing filters, blank off sufficient filter area to simulate a pressure drop that is midway between that of a clean filter and that of a dirty filter.
- F. Measure and record system measurements at the fan and/or pump to determine total flow. Adjust equipment as required to yield specified total flow at terminals. Proceed with taking measurements in mains and branches as required for final terminal balancing. Perform terminal balancing to specified flows balancing branch dampers and valves prior to adjustment of terminals.
- G. Measure and record static air pressure conditions across fans, coils and filters. Indicate in report if cooling coil measurements were made on a wet or dry coil and if filter measurements were made on a clean or dirty filter. Spot check static air pressure conditions directly ahead of terminal units.
- H. Adjust outside air and return air dampers for design conditions at both the minimum and maximum settings and record both sets of data. Balance modulating dampers at extreme conditions and record both sets of data.
- I. Adjust register, grille and diffuser vanes and accessories to achieve proper air distribution patterns and uniform space temperatures free from objectionable noise and drafts within the capabilities of the installed system.
- J. Provide fan and motor drive sheave adjustments necessary to obtain design performance. Provide drive changes specifically noted on drawings, if any. If work of this section indicates that any drive or motor is inadequate for the application, advise the Owner's project representative by giving the representative properly sized motor/drive information (in accordance with manufacturers original service factor and installed motor horsepower requirements); Confirm any change will keep the duct/piping system within its design limitations with respect to speed of the device and pressure classification of the distribution system. Required motor/drive changes not specifically noted on drawings or in specifications will be considered an extra cost and

will require an itemized cost breakdown submitted to Owner's project representative. Prior authorization is needed before this work is started.

- K. Final air system measurements to be within the following range of specified cfm:
 - 1. Fans 0% to +10%.
 - 2. Supply grilles, registers, diffusers 0% to +10%.
 - 3. Return/exhaust grilles, registers 0% to -10%.
- L. Contact the temperature control Contractor for assistance in operation and adjustment of controls during testing, adjusting and balancing procedures. Cycle controls and verify proper operation and setpoints. Include in report description of temperature control operation and any deficiencies found.
- M. Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.
- N. Leave systems in proper working order, replacing belt guards, closing access doors and electrical boxes, and restoring temperature controls to normal operating settings.
- O. Verify and record, in the T&B Report, "K" factors for all VAV air terminal devices and air flow stations.
- P. Coordinate air handling unit minimum outside air set points with the Temperature Control Contractor.

3.4 DEFICIENCIES

- A. Division 23 Contractor to correct any installation deficiencies found by the test and balance agency that were specified and/or shown on the Contract Documents to be performed as part of that division of work. Test and balance agency will notify the Owner's Project Representative of these items and instructions will be issued to the Division 23 Contractor for correction of the deficient work. All corrective work to be done at no cost to the Owner. Retest mechanical systems, equipment, and devices once corrective work is complete as specified.

END OF SECTION 23 05 93

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SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for all duct systems used on this project. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Design Criteria.
 - h. Delivery, Storage and Handling.
 2. PART 2 – PRODUCTS.
 - a. General.
 - b. Ductwork Pressure Class.
 - c. Materials.
 - d. Low Pressure Ductwork (Maximum 2 inch pressure class).
 - e. Duct Sealant.
 - f. Gaskets.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Ductwork Support.
 - c. Low Pressure Duct (Maximum 2 inch pressure class).
 - d. Leakage Test.
 - e. Construction Verification Items.
 4. APPENDIX.
 - a. Duct Leakage Test Report.

1.2 RELATED WORK

- A. Section 23 33 00 - Air Duct Accessories.
- B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this Section.

1.4 REFERENCE STANDARDS

- A. ASTM A90 Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- B. ASTM A167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- C. ASTM A623 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

- D. ASTM A527 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
- E. ASTM 924 Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-dip Method.
- F. ASTM C 1071 Specification for Fibrous Glass Duct Lining Insulation.
- G. ASTM E 84 Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM C 1338 Test Method for Determining Fungal Resistance of Insulation Materials and Facings.
- I. ASTM G 21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- J. ASTM C 916 Standard Specification for Adhesives for Duct Thermal Insulation NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems.
- K. UL 181 Standard for Safety for Factory Made Air Ducts and Air Connectors.
- L. NAIMA Fibrous Glass Duct Liner Standard.

1.5 QUALITY ASSURANCE

- A. Refer to Division 1.

1.6 SHOP DRAWINGS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Include manufacturer's data and/or Contractor data for the following:
 1. Fabrication and installation drawings.
 2. Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, all with details as appropriate.
 3. Duct sealant and gasket material.
 4. Duct liner including data on thermal conductivity, air friction correction factor, and limitation on temperature and velocity.

1.7 DESIGN CRITERIA

- A. Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.
- B. Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:
 1. HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.
 2. HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012.
 3. HVAC Systems - Duct Design, 4th Edition, 2006.
 4. Rectangular Industrial Duct Construction Standard, 2nd Edition, 2004.
 5. Round Industrial Duct Construction Standards, 2nd Edition, 1999.

- C. Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Promptly inspect shipments to ensure that Ductwork is undamaged and complies with the specification.
- B. Protect Ductwork against damage.
- C. Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end caps/packageing are provided, take precautions so caps/packageing remain in place and free from damage.
- D. Offsite storage agreements do not relieve the Contractor from using proper storage techniques.
- E. Storage and protection methods must allow inspection to verify products.

PART 2 PRODUCTS

2.1 GENERAL

- A. All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork and spiral duct take-offs 12" and below may be 26 gauge where allowed in SMACNA HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.
- B. Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.

2.2 DUCTWORK PRESSURE CLASS

- A. Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G. positive or negative, depending on the application.

2.3 MATERIALS

- A. Galvanized Steel Sheet:
 - 1. Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90. Provide "Paint Grip" finish for ductwork that will be painted.

2.4 LOW PRESSURE DUCTWORK (MAXIMUM 2 INCH PRESSURE CLASS)

- A. Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA recommendations.
- B. Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork.
- C. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.

- D. Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA publications, Type RE 3.
- E. Where space will not allow and the C value of the radius elbow, as given in SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00.
- F. Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.
- G. Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.
- H. Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.
- I. Button punch snaplock construction will not be accepted on aluminum ductwork.
- J. Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission of the Engineer.
- K. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

2.5 DUCT SEALANT

- A. Manufacturer:
 - 1. 3M 800: www.3m.com.
 - 2. 3M 900: www.3m.com.
 - 3. H.B. Fuller/Foster: www.hbfuller.com.
 - 4. Hardcast: www.hardcast.com.
 - 5. Hardcast Peal & Seal: www.hardcast.com.
 - 6. Lockformer cold sealant: www.lockformer.com.
 - 7. Mon-Eco Industries: www.mon-ecoindustries.com.
 - 8. United Sheet Metal: www.unitedsheetmetal.com.
 - 9. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Silicone sealants are not allowed in any type of ductwork installation.
- C. Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

2.6 GASKETS

- A. 2 inch pressure class and lower:
 - 1. Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Architect in the event of any interference.
- B. Make allowances for beams, pipes or other obstructions in building construction and for work of other Contractors. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 4-8, Fig. E. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.
- C. Test openings for test and balance work will be provided under Section 23 05 93.
- D. Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.
- E. Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.
- F. Where two different metal ducts meet, the joint shall be installed in such a manner that metal ducts do not contact each other by using proper seal or compound.
- G. Install all motor operated dampers and connect to or install all equipment furnished by others. Blank off all unused portions of louvers, as indicated on the drawings, with 1-1/2 inch board insulation with galvanized sheet metal backing on both sides.
- H. Do not install ductwork through dedicated electrical rooms or spaces unless the ductwork is serving this room or space.
- I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- J. Provide adequate access to ductwork for cleaning purposes.
- K. Provide temporary capping of ductwork openings to prevent entry of dirt, dust and foreign material.
- L. Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the Ductwork.
- M. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 DUCTWORK SUPPORT

- A. Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5-5, except supporting ductwork with secure wire method is not allowed.

- B. Support with 3/32 inch, 7 x 7, stainless steel air-craft cable, with matching fastener rated for 50% of actual load, will be allowed on round ductwork under 12 inches if installed as detailed, with cable double looped on duct and at point of support.

3.3 LOW PRESSURE DUCT (MAXIMUM 2 INCH PRESSURE CLASS)

- A. Seal all duct, with the exception of transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.
- B. Install a manual balancing damper in each branch duct and for each diffuser or grille. The use of splitter dampers, extractors, or grille face dampers will not be accepted for balancing dampers.
- C. Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheet metal screws or pop rivets. Trapeze hangers may be used at Contractor's option.
- D. Remove all dirt and foreign matter from the entire duct system and clean diffusers, registers, grilles and the inside of air-handling units before operating fans.
- E. Clean duct systems with high power vacuum machines where systems have been used for temporary heat, air-conditioning, or ventilation purposes during construction. Protect equipment that may be harmed by excessive dirt with filters, or bypass during cleaning.

3.4 LEAKAGE TEST

- A. Test all ductwork in accordance with test methods described in Section 5 of SMACNA HVAC Air Duct Leakage Test Manual. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.
- B. If excessive air leakage is found locate leaks, repair the duct in the area of the leak, seal the duct, and retest.
- C. Leakage rate shall not exceed more than 5% of the system air quantity for low pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.
- D. Leakage rate shall not exceed more that 1% of the system air quantity for high pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.
- E. Leakage test for ductwork downstream of air terminal devices may be omitted but will not relieve the Contractor from duct sealing requirements.
- F. Submit a signed report to the Owner's Construction Representative, indicating test apparatus used, results of the leakage test, and any remedial work required to bring duct systems into compliance with specified leakage rates.

3.5 CONSTRUCTION VERIFICATION ITEMS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under Division 1 in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 31 00

DUCT LEAKAGE TEST REPORT

Project Number: _____
Date Submitted: _____

Project	Name: _____		
	Location: _____		
	Contractor: _____		
System	Fan No: _____	Leakage Class (C _L): _____	
Data	Fan Design CFM: _____	Duct Pressure Class (P _C): _____	
		Test Pressure (P _T): _____	
Test Equipment	Manufacturer: _____	Model No: _____	Serial No: _____

For large systems, use the reverse side for a simple sketch of the entire duct system. Then use letter designations to indicate the various duct sections being tested at one time. Also use the reverse side for test comments.

Note that due to normal construction sequencing it is usually necessary to test risers separately prior to enclosing chases.

Design Data					Field Test Data							
Duct Section	Duct Shape	Duct Surface (Ft ²)	Allowable Leakage		Diameter		Pressure (in. wc.)		Date	Performed By	Observed By	Actual CFM
			Leakage Factor (P ^{.65} C _L)	CFM for Section	Tube (D ₁)	Orifice (D ₂)	In Duct (P)	Across Orifice (P _{drop})				
TOTAL												

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SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SCOPE

- A. This section includes accessories used in the installation of duct systems. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Related Work.
 - b. Reference.
 - c. Reference Standards.
 - d. Quality Assurance.
 - e. Shop Drawings.
 - f. Operation and Maintenance Data.
 2. PART 2 – PRODUCTS.
 - a. Manual Volume Dampers.
 - b. Turning Vanes.
 - c. Fire Dampers.
 - d. Control Dampers.
 - e. Access Doors.
 - f. Flexible Duct.
 - g. Duct Lining.
 - h. Duct Flexible Connections.
 - i. Louvers.
 3. PART 3 – EXECUTION.
 - a. Manual Volume Dampers.
 - b. Turning Vanes.
 - c. Fire Dampers.
 - d. Control Dampers.
 - e. Access Doors.
 - f. Flexible Duct.
 - g. Duct Lining.
 - h. Duct Flexible Connections.

1.2 RELATED WORK

- A. Section 23 05 29 - Hanger and Supports for HVAC Piping and Equipment.
B. Section 23 31 00 - HVAC Ducts and Casings.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this Section.

1.4 REFERENCE STANDARDS

- A. NFPA 90A Standard for Installation of Air Conditioning and Ventilating Systems.
- B. SMACNA HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, 2005.

- C. UL 214 Standard for Factory-Made Air Ducts and Air Connectors.
- D. UL 555 (6th edition) Standard for Fire Dampers and Ceiling Dampers.
- E. UL 555S (4th edition) Leakage Rated Dampers for Use in Smoke Control Systems.
- F. ACMA 610-10 Certified Ratings Program – Product Rating Manual for Airflow Measurement Stations.

1.5 QUALITY ASSURANCE

- A. Refer to Division 1.

1.6 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Submit for all accessories and include dimensions, capacities, ratings, installation instructions, and appropriate identification.
- C. Include certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance of sound attenuators.
- D. Submit manufacturer's color charts where finish color is specified to be selected by the Engineer.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 Closeout Submittals.

PART 2 PRODUCTS

2.1 MANUAL VOLUME DAMPERS

- A. Manufacturers:
 1. Ruskin: www.ruskin.com.
 2. Vent Products: www.ventproducts.com.
 3. Air Balance: www.airbalance.com.
 4. Pottorff: www.pottorff.com.
 5. United Enertech: www.unitedenertech.com.
 6. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Dampers must be constructed in accordance with SMACNA Fig. 2-12, Fig. 2-13, and notes relating to these figures, except as modified below.
- C. Reinforce all blades to prevent vibration, flutter, or other noise. Construct dampers in multiple sections with mullions where width is over 48 inches. Use rivets or tack welds to secure individual components; sheet metal screws will not be accepted. Provide operators with locking devices and damper position indicators for each damper; use an elevated platform on insulated ducts. Provide end bearings or bushings for all volume damper rods penetrating ductwork constructed to a 3" w.c. pressure class or above.

2.2 TURNING VANES

- A. Manufacturers:
 1. Aero Dyne: www.aero-dyne.net.
 2. Anemostat: www.anemostat.com.
 3. Barber-Colman: www.barber-colman.com.

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4. Hart & Cooley: www.hartandcooley.com.
 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Construct turning vanes and runners for square elbows in accordance with SMACNA Fig. 4-2 and Fig. 4-3 except use only airfoil type vanes. Construct turning vanes for short radius elbows and elbows where one dimension changes in the turn in accordance with SMACNA Fig. 4-4 and Fig. 4-9.

2.3 FIRE DAMPERS

- A. Manufacturers:
1. Air Balance: www.airbalance.com.
 2. Advanced Air: www.advancedair.net.
 3. American Warming and Ventilating: www.awv.com.
 4. Greenheck: www.greenheck.com.
 5. Phillips-Aire: www.drillspot.com.
 6. Prefco: www.prefco-hvac.com.
 7. Ruskin: www.ruskin.com.
 8. Safe-Air: www.safe-air-corp.com.
 9. Pottorff: www.pottorff.com.
 10. United Enertech: www.unitedenertech.com.
 11. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Static Fire Dampers:
1. Static fire damper assemblies must be UL 555 (6th edition) listed and labeled for static applications (where air systems do not operate during a fire) and meet requirements of NFPA 90A. Damper must be type B curtain type with blades out of the air stream; dampers with blades in the air stream will not be accepted. Damper fire rating to be compatible with the rating of the building assembly in which the damper is used.
- C. Use airfoil shaped damper blades on the following system:

2.4 CONTROL DAMPERS

- A. Control dampers are specified in Section 23 09 13.

2.5 ACCESS DOORS

- A. Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches.
- B. For both hinged and non-hinged doors provide sufficient number of camp sash latches to provide airtight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork.

- C. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.
- D. Use insulated, 1-1/2 hour UL 1978 listed and labeled access doors in kitchen exhaust ducts.

2.6 FLEXIBLE DUCT

- A. Manufacturers:
 - 1. Anco Products: www.ancoproductsinc.com.
 - 2. Clevaflex: www.clevaflex.com.
 - 3. Thermafex: www.thermafex.net.
 - 4. Flexmaster: www.flexmasterusa.com.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Factory fabricated, UL 181 listed as a class 1 duct, and having a flame spread of 25 or less and smoke developed rating of 50 or under in accordance with NFPA 90A.
- C. Suitable for pressures and temperatures involved but not less than a 180°F service temperature and ±2 inch pressure class, depending on the application.
- D. Duct to be composed of polyester film, aluminum laminate or woven and coated fiberglass fabric bonded permanently to corrosion resistant coated steel wire helix. Two-ply, laminated, and corrugated aluminum construction may also be used.
- E. Where duct is specified to be insulated, provide a minimum 1 inch fiberglass insulation blanket with maximum thermal conductance of 0.23 K (75 degrees F.) and vapor barrier jacket of polyethylene or metalized reinforced film laminate. Maximum perm rating of vapor barrier jacket to be 0.1 perm.

2.7 DUCT LINING

- A. Manufacturer:
 - 1. Manville: www.jm.com.
 - 2. Owens-Corning: www.owenscorning.com.
 - 3. Knauf: www.knaufusa.com.
 - 4. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. 1 inch thick, flexible, mat faced insulation made from inorganic glass fibers bonded with a thermosetting resin with thermal conductivity of .25 Btu inch / hour sq.ft. deg F.
- C. Meet erosion testing per UL 181 or ASTM C 1071 for 5000 fpm maximum air velocity. ASTM C 411 maximum operating temperature rating of 250 deg F. ASTM E84 flame spread less than 25 and smoke developed less than 50.
- D. Meet requirements of ASTM C 1338 and ASTM G21 for fungi resistance.
- E. Install liner using adhesive conforming to ASTM C 916.

2.8 DUCT FLEXIBLE CONNECTIONS

- A. Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.

- B. Connections to be a minimum of 3 inches wide, crimped into metal edging strip, and airtight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.
- C. Use coated glass fiber fabric for all applications. Material for inside applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with neoprene, air and watertight, suitable for temperatures between -10°F and 200°F and have a nominal weight of 30 ounces per square yard. Material used for outdoor applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with Hypalon, air and water tight, suitable for temperatures between -10°F and 250°F, and have a nominal weight of 26 ounces per square yard.

2.9 LOUVERS

- A. Manufacturers:
 - 1. Airolite; K6776: www.airolite.com.
 - 2. Industrial Louvers; 658: www.industriallouvers.com.
 - 3. American Warming and Ventilating; LE-31: www.awv.com.
 - 4. Construction Specialties; 6177: www.c-sgroup.com.
 - 5. Pottorff: www.pottorff.com.
 - 6. United Enertech: www.unitedenertech.com.
 - 7. Substitutions: Refer to Section 01 60 00 – Product Requirements.
- B. Similar to Airolite Type K6776, extruded aluminum alloy not less than 12 gauge (.081" thick), 6063 series frame and blades, all-welded assembly, 35 degree or 45 degree blades with water baffle, 6 inches thick. Provide with bird screen of 1/2" x 1/2" mesh aluminum in 12 gauge aluminum frame and an aluminum sill. Locate the bird screen inside of the louver unless noted otherwise.
- C. Louver to bear the AMCA certified ratings seal for both air performance and water penetration, having a free area not less than 50% based on a 48" x 48" section, a water penetration less than 0.1 oz/square foot under AMCA test at 1000 feet per minute, and an intake pressure drop less than 0.20 inches of water at 1000 feet per minute.
- D. Finish to be anodized or Kynar 500 in a custom color to be selected by the Architect. Furnish sufficient paint in the same color as the louver to paint the outer surface of panels over unused portions of louvers and to paint the interior portion of ductwork visible through the louvers.

PART 3 EXECUTION

3.1 MANUAL VOLUME DAMPERS

- A. Install manual volume dampers in each branch duct and for each grille, register, or diffuser as far away from the outlet as possible while still maintaining accessibility to the damper. Install so there is no flutter or vibration of the damper blade(s).

3.2 TURNING VANES

- A. Install turning vanes in all rectangular, mitered elbows in accordance with SMACNA standards and/or manufacturer's recommendations.

- B. Install double wall, airfoil, 2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity less than 2000 fpm. Install double wall, airfoil, 4-1/2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity 2000 fpm or greater.
- C. If duct size changes in a mitered elbow, use single wall type vanes with a trailing edge extension. If duct size changes in a radius elbow or if short radius elbows must be used, install sheetmetal turning vanes in accordance with SMACNA Figure 2-5 and Figure 2-6.

3.3 FIRE DAMPERS

- A. Install dampers in strict accordance with manufacturer's installation instructions. Install damper sleeves with retaining angles on both sides of rated partition. Connections of ductwork to fire damper assemblies to be as specified on the installation instructions. Where it is necessary to set dampers out from the rated wall, install a sleeve extension encased in two hour rated fire proofing insulation. Install an access door at each fire damper, located to permit resetting the damper replacing the fusible link.
- B. Manually test each fire damper for proper operation by removing the fusible link. Repair or replace any fire damper that does not close completely. Re-install fusible link after test.

3.4 CONTROL DAMPERS

- A. Install dampers in locations indicated on the drawings, as detailed, and according to the manufacturer's instructions. Install blank-off plates or transitions where required for proper mixing of airstreams in mixing plenums. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

3.5 ACCESS DOORS

- A. Install access doors where specified, indicated on the drawings, and in locations where maintenance, service, cleaning or inspection is required. Examples include, but are not limited to motorized dampers, fire and smoke dampers, smoke detectors, fan bearings, heating and cooling coils, filters, valves, and control devices needing periodic maintenance.
- B. Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils.

3.6 FLEXIBLE DUCT

- A. Flexible duct may only be used for final connections of air inlets and outlets at diffuser, register, and grille locations. Where flexible duct is used, it shall be the minimum length required to make the final connections, but no greater than 5 feet in length, and have no more than one (1) 90 degree bend.
- B. Secure inner jacket of flexible duct in place with stainless steel metal band clamp. Secure insulation vapor barrier jacket in place with steel or nylon draw band. Sheetmetal screws and/or duct tape will not be accepted.

- C. Flexible duct used to compensate for misalignment of main duct or branch duct will not be accepted.
- D. Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.
- E. Flexible ductwork used as transfer duct shall be sized for a maximum velocity of 300 fpm.
- F. Penetration of any partition, wall, or floor with flexible duct will not be accepted.

3.7 DUCT LINING

- A. Apply lining to the following ductwork:
- B. Do not apply lining to the following ductwork:
 1. Outside air ductwork.
 2. Kitchen exhaust ductwork.
 3. Dishwashing exhaust ductwork.
 4. Shower exhaust ductwork.
 5. Supply, return and exhaust ductwork associated with shop ventilation systems where air handling units are located in the shops.
- C. Install liner in compliance with the latest edition of NAIMA's Fibrous Glass Duct Liner Standard. Locate longitudinal joints at the corners of duct only. Cut and fit to assure lapped, compressed joints. Coat all transverse and longitudinal joints and edges with adhesive. Provide metal nosing on leading edge where lined duct is preceded by unlined duct. Adhere liner to duct with full coverage area of adhesive. Additionally, secure liner to duct using mechanical fasteners spaced as recommended by the liner manufacturer without compressing liner more than 1/8" with the fasteners.

3.8 DUCT FLEXIBLE CONNECTIONS

- A. Install at all duct connections to rotating or vibrating equipment, including air handling units (unless unit is internally isolated), fans, or other motorized equipment in accordance with SMACNA Figure 2-19. Install thrust restraints to prevent excess strain on duct flexible connections at fan inlets and outlets; see Related Work.
- B. Furnish louvers to the General Contractor for mounting in exterior walls. Connect outside air intake duct to the louver, sealing all connections air and watertight.
- C. Provide bird screen on inside of active louver area where none is provided with louvers. Where louvers are equipped with inside bird screen, remove screen at all locations where duct connections are not made.
- D. Install insulated metal panel on unused portion of louver. Panels must be sealed weathertight to louver assembly with flashing as required for proper drainage to outside of building. Paint outside surface of panel to match louver prior to installation. Where ductwork is visible through louver when viewed from outside the building, paint inside of duct to match louver color.

END OF SECTION 23 33 00

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SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for fans that are not an integral part of a manufactured device. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Shop Drawings.
 - g. Operation and Maintenance Data.
 - h. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Ceiling Exhaust Fans.
 - 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Construction verification Items.
 - c. Owner Training.

1.2 RELATED WORK

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this Section.

1.4 REFERENCE STANDARDS

- A. AMCA 203 - AMCA Fan Application Manual – Troubleshooting.
- B. AMCA 210 - Laboratory Method of Testing Fans for Rating.
- C. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- D. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.5 QUALITY ASSURANCE

- A. Refer to Division 1.

1.6 SHOP DRAWINGS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Include dimensions, capacities, fan curves, materials of construction, ratings, weights, motors and drives, sound power levels, appropriate identification and vibration isolation for all equipment. Sound power levels to be based on tests performed in accordance with AMCA Standard 300.

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- C. Fan curves shall indicate the relationship of CFM to static or total pressure for various fan speeds. Brake horsepower, recommended selection range, and limits of operation are to also be indicated on the curves. Indicate operating point on the fan curves at design air quantity and indicate the manufacturer's recommended drive loss factor for the specific application. Tabular fan performance data is not acceptable.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.

1.8 DESIGN CRITERIA

- A. Tested and certify all fans in accordance with the applicable AMCA test code.
- B. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.
- C. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.
- D. Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, provide any motor, drive and/or wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.
- E. All internal insulation and other components exposed to the airstream are to meet the flame spread and smoke ratings contained in NFPA 90A.

PART 2 PRODUCTS

2.1 CEILING EXHAUST FANS

- A. Manufacturers:
 - 1. Carnes: www.carnes.com.
 - 2. Greenheck: www.greenheck.com.
 - 3. Penn: www.pennstateind.com.
 - 4. Jenn-Air: www.jennair.com.
 - 5. Cook: www.lorencook.com.
 - 6. ACME: www.acmefan.com.
 - 7. Aerovent: www.aerovent.com.
 - 8. Twin City Fan: www.tcf.com.
 - 9. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Centrifugal blower wheel, steel housing with acoustical lining, integral exhaust grille, adjustable mounting brackets to allow for any ceiling thickness, permanently lubricated motor, integral junction box with permanently lubricated and thermally protected motor factory wired, 24 volt electrically operated control damper with blade edge and jamb seals, and damper operator.
- C. Provide wall, eave, or roof discharge assembly, as indicated on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install as shown on the drawings, as detailed, and according to manufacturer's installation instructions. On units provided with a drain connection, reduce drain connection down to 1/2 inch fitting and leave open.

3.2 CONSTRUCTION VERIFICATION ITEMS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under Division 1 in accordance with the procedures defined for construction verification checklists.

3.3 OWNER TRAINING

- A. All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under Division 1.

END OF SECTION 23 34 00

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SECTION 23 37 13

DIFFUSERS, REGISTERS AND GRILLES

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for air terminal equipment. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Submittals.
 - g. Design Criteria.
 - 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Side-Wall Registers and Grilles.
 - c. Filter Frame Return Grilles.
 - d. Fan Powered HEPA Diffuser
 - 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Construction Verification Items.

1.2 RELATED WORK

- A. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- B. Section 23 31 00 - HVAC Ducts and Casings.
- C. Section 23 33 00 - Air Duct Accessories.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 - Factory-Made Air Ducts and Connectors.
- C. ARI-ADC Standard 880.

1.5 QUALITY ASSURANCE

- A. Refer to Section 01 40 00 - Quality Requirements.

1.6 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Furnish submittal information including, but not limited to, the following:
 - 1. Manufacturer's name and model number.
 - 2. Identification as referenced in the documents.

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3. Capacities/ratings.
4. Materials of construction.
5. Sound ratings.
6. Dimensions.
7. Finish.
8. Color selection charts where applicable.
9. Manufacturer's installation instructions.
10. All other appropriate data.

1.7 DESIGN CRITERIA

- A. All performance data shall be based on tests conducted in accordance with Air Diffusion Council (ADC) Test Code 1062 GRD 84.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carnes: www.carnes.com.
- B. Krueger: www.krueger-hvac.com.
- C. Titus: www.titus-hvac.com.
- D. Metal-Aire: www.metalaire.com.
- E. E.H. Price: www.price-hvac.com.
- F. United Sheet Metal: www.unitedsheetmetalinc.com.
- G. Tuttle & Bailey: www.tuttleandbailey.com.
- H. Raymon Donco: www.raymon-hvac.com.
- I. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- J. Acceptable manufacturers for specific products are listed under each item.

2.2 SIDE-WALL REGISTERS AND GRILLES

- A. Aluminum (Steel) unless otherwise indicated, with frame type appropriate to installation.
- B. Double deflection type blade supply registers and supply grilles allow deflection adjustment in all direction.
- C. Opposed blade volume control damper supply registers, operable from face.
- D. Fixed blade (0 degree, 45 degree) core return and exhaust registers and grilles.
- E. Opposed blade volume control damper return registers, operable from face.
- F. Register and grille sizes as shown on drawings and/or as scheduled.
- G. White, baked enamel finish or powder coat finish, unless otherwise indicated.
- H. Screw holes on surface counter sunk to accept recessed type screws.
- I. Manufacturers:
 1. Titus; Series 300 (supply) and series 350 (return/exhaust): www.titus-hvac.com.
 2. Carnes; Model R series: www.carnes.com.
 3. Price; Model 520 (Supply) Or 530 (return/exhaust): www.price-hvac.com.

4. Metal Aire; Series V4000 or H4000: www.metalaire.com.
5. Krueger; Series 880: www.krueger-hvac.com.
6. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.3 FILTER FRAME RETURN GRILLES

- A. Aluminum construction, with frame type appropriate to installation.
- B. Unit shall include a hinged face and integral frame designed to accept a 1" thick filter. Filter face shall be secured in place with 1/4" turn fasteners.
- C. The units shall be the size and quantity as outlined in the plans.
- D. Border shall be 1-1/4" wide with shaped fixed deflector blades on .666" centers set at 45°.
- E. Units shall be designed for surface mounting applications and provided with counter sunk screw holes on the face of the device.
- F. Manufacturers:
 1. Metal Aire: Series RHF.
 2. Titus: Series 350FLF.

2.4 FAN POWERED HEPA DIFFUSER

- A. Basis of Design: Price Industries, Inc.:
 1. Fan Filter Unit: Model FFU.
- B. General:
 1. The fan filter unit shall be supplied to provide unidirectional supply air at controlled discharge velocities. The units shall include a high efficiency HEPA or ULPA filter.
 2. Modules sizes, electrical characteristics, efficiencies, capacities, and options shall be as scheduled on the drawings.
- C. Fan Filter Unit:
 1. Performance:
 - a. The unit shall provide filtered air tested at an average velocity of 90 fpm (+/-15 fpm) measured 12 inches from the face of the unit in accordance with IEST-RP-CC0022.2.
 - b. The room sound level shall be less than 55 dBA when measured at 30 inches from the filter face at 90 fpm average face velocity in accordance with IEST-RP-CC0022.2.
 - c. The unit is to be factory sealed and tested to assure leakage is consistent with the filter.
 2. Construction:
 - a. Plenum material shall be:
 - 1) Aluminum.
 - b. Face material shall be:
 - 1) Aluminum.
 - c. Plenum shall be walkable up to 250 lbs.
 - d. The diffuser plenum shall feature four (4) eyebolts at each plenum corner for securing the unit to structural supports above the ceiling.
 - e. The 51% free-area perforated distribution plate shall be secured to the face using quarter-turn fasteners with anti-slip, snap-in retainers and stainless steel retainer cables for ease of installation and removal.

- f. Inlet: standard round or optional rectangular collar ducted applications.
 - g. Eye bolts for hanging shall be mounted on the top four (4) corners of the plenum and capable of each supporting 75 lbs.
 - h. Provide a gasketed plaster frame for hard lid ceiling installation.
3. Filters:
- a. The filter shall be framed in extruded aluminum with an integral cavity filled with a urethane gel to provide a leak-tight seal between the filter frame and the border.
 - b. Filter type shall be:
 - 1) High Efficiency Particulate Air (HEPA) filter shall provide 99.997% efficiency on .30 μm particulate, with an initial pressure drop of 0.45" wg at 100 fpm.
 - c. Filter shall be UL 900 classified.
 - d. Filter pack depth shall be 2.5".
 - e. Filter media shall be borosilicate micro-fiberglass.
 - f. Filter shall be:
 - 1) Room side removable and replaceable, mounted in an extruded aluminum frame and provided with a gel seal knife edge.
4. Plenum Finish shall be:
- a. Washed Mill Aluminum.
5. Face and frame finish shall be:
- a. All aluminum components shall have White B12 Standard baked-on powder coat finish.
 - 1) The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 - 2) The paint film thickness shall be a minimum of 2.0 mils.
 - 3) The finish shall have a hardness of 2H.
6. Fan:
- a. The centrifugal type fan shall be supplied with rubber mounts to isolate the motor/blower assembly from the diffuser plenum.
 - b. Fans are to be of metal construction with a direct drive:
 - 1) Backward curved impeller.
7. Electrical Systems:
- a. Single point power connection.
 - b. Transformers shall be included where required for motor and unit operation.
8. Fan Motor:
- a. Coordinate interlock with the electrical contractor so that the fan is energized whenever the room lights are on in the Surgery Room. The unit serving the Prep Area shall be interlocked with the Furnace fan by the Mechanical Contractor. Operation is required to maintain acceptable cooling levels in each space containing a unit.
 - b. The fan motor shall be:
 - 1) Electrically Commutated Motor (ECM):
 - a) Constant Torque Program.
 - c. Fan motor shaft directly connected to fan and isolated from casing to prevent transmission of vibration.
 - d. Fan motor shall have internal thermal and overload protection.
 - e. Fan motor shaft shall be directly connected to the fan impeller, and isolated from casing to prevent transmission of vibration.

- f. Fan motor shall be supplied with a motor speed controller:
 - 1) ECM standard speed controller.
 - a) The ECM speed controller shall operate on 24 VAC supply voltage.
 - b) The ECM speed controller shall have dual outputs to control up to two motors simultaneously.
 - c) The ECM speed controller shall be supplied with a BAS interface to accept 2-10 VDC signal for variable speed remote control, as well as be able to remotely shut off via BAS signal.
9. Options:
- a. Filter replacement style:
 - 1) Room Side replaceable filter.
 - b. Pre-filter:
 - 1) Ducted units:
 - a) Not required. Filter return grilles will be field furnished and installed.
 - c. Disconnect Switch: A factory supplied disconnect switch shall be provided for disconnection of power to the terminal block.
 - d. Motor/blower access:
 - 1) Room side access.
 - e. Filter status indicator shall be communicated by:
 - 1) LED Indicator light:
 - a) The LED indicator light shall be visible from the occupied area to determine the filter loading status without opening the diffuser.
 - b) The LED light shall turn from green to yellow when the pressure drop across the filter exceeds the specified limit.
 - c) The LED kit shall be provided with a switch, factory pre-calibrated for 150% of initial clean filter pressure drop.
 - d) The LED kit shall operate on a 24 VAC power supply, provided by others.
 - f. Motor status shall be communicated by:
 - 1) Motor status LED:
 - a) The LED indicator light shall be visible from the occupied area to determine the motor operating status without opening the diffuser.
 - b) The motor LED shall be green to indicate normal motor operation, and that the unit static pressure is above 0.2" wg.
 - c) The motor LED shall turn from green to red when the motor is not in operation, and when the unit static pressure is below 0.2" wg.
 - 2) Motor status BAS signal:
 - a) The factory- calibrated motor BAS signal shall close a dry contact to generate a BAS signal when the motor is not operating.
 - b) Unit shall be field wired to the terminal block according to manufacturer's instructions.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.
- B. Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 duct diameter straight duct into diffuser. Equalizing grids shall consist of individually

adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

- C. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar size.
- D. Seal connections between ductwork drops and diffusers/grilles airtight.
- E. Blank off unused portion of linear slot diffusers and linear bar diffusers and grilles.
- F. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.
- G. In clean rooms and animal holding rooms, caulk space between diffuser or grille and ceiling or wall to be air and watertight. Use clear, non-hardening silicone sealant compatible with ceiling or wall surfaces. Sealant shall be resistant to microbiological growth.

3.2 CONSTRUCTION VERIFICATION ITEMS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under Division 01 in accordance with the procedures defined for construction verification checklists.

END OF SECTION 23 37 13

SECTION 23 54 00
GAS FIRED FURNACES

PART 1 GENERAL

1.1 SCOPE

- A. This section includes specifications for gas fired furnaces. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Energy Efficiency.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Furnaces.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Furnaces.
 - c. Owner Training.

1.2 RELATED WORK

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

1.3 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.4 REFERENCE STANDARDS

- A. AGA American Gas Association.
B. ANSI Z21.64 Direct Vent Central Furnaces.
C. GAMA Gas Appliance Manufacturers Association.
D. NEC National Electrical Code.

1.5 ENERGY EFFICIENCY

- A. Provide gas furnaces that bear the ENERGY STAR label and meet the ENERGY STAR specifications for energy efficiency.

1.6 SUBMITTALS

- A. Include specific manufacturer and model numbers, equipment identification corresponding to project drawings and schedules, dimensions, capacities, materials of construction, ratings, weights, power requirements and wiring diagrams, filter information and information for all accessories.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified.

1.8 WARRANTY

- A. Furnace primary and secondary heat exchangers warranted for 20 years under normal use and maintenance. Remainder of furnace components warranted for 1 year from date of startup.

PART 2 PRODUCTS

2.1 FURNACES

- A. Manufacturers:
 - 1. Carrier: www.carrier.com.
 - 2. Lennox: www.lennox.com.
 - 3. York: www.york.com.
- B. Substitutions: Refer to applicable sections in Bidding Requirements and Division 1 - General Requirements. Direct vent, sealed combustion, condensing type AGA certified for use with natural gas. Minimum annual fuel utilization efficiency (A.F.U.E.) of 91. All ratings are to be certified by GAMA. All wiring shall comply with the National Electrical Code.
- C. 22 gauge steel casing with baked enamel finish or pre-painted galvanized steel. Insulate casing back and side panels with foil faced fiberglass insulation.
- D. Construct primary heat exchanger of aluminized steel. Construct secondary heat exchanger of stainless steel with aluminum fins or of polypropylene laminated steel. Aluminized steel multi-port in-shot burner with hot surface or electronic spark ignition, approved for vertical or sidewall venting.
- E. Provide two stage heating.
- F. AGA listed gas controls including manual main shut-off valve, double automatic gas valves for redundancy and gas pressure regulator.
- G. Centrifugal type blower fan statically and dynamically balanced with multiple speed, direct drive or belt drive fan motor. Provide low energy induced draft blower for heat exchanger prepurge and combustion gas venting.
- H. Provide unit with 2" thick MERV 8 minimum disposable type panel air filter and filter holding rack.
- I. Provide solid state integral control unit with all necessary controls and relays including but not limited to:
 - 1. Pressure switch for airflow of flue products through furnace and out vent system.
 - 2. Rollout switch with manual reset to prevent over temperature in burner area.
 - 3. Electronic flame sensor.
 - 4. Blower access safety interlock.
 - 5. Timed blower start after main burners ignite.
 - 6. Factory installed 24 v transformer for controls and thermostat.
 - 7. LED's to indicate status and to aid in troubleshooting.

- J. Provide unit with matching cased "A" configuration cooling coil for upflow units, and vertical flat face configuration cooling coil for horizontal units.
- K. Minimum 1/2" OD seamless copper tubing mechanically bonded to heavy ripple edged aluminum fins with thermal expansion valve, holding charge and copper tube stubs for field piping.
- L. Non-corrosive stainless steel or polymer drain pan with 3/4" NPT drain connection.
- M. 20 gauge steel Coil casing with baked enamel finish and fiberglass insulation.
- N. This Contractor shall provide all temperature control and interlocking necessary to perform the specified control sequence. All wiring is to be in conduit in accordance with Division 26 - Electrical. All relays, transformers and controls are to be in enclosures.
- O. Provide a Honeywell RedLINK Wireless VisionPRO 8000 – TH8110R1008 thermostat with 2 occupied periods per day, automatic changeover, separate heating and cooling set points for both occupied and unoccupied modes. Provide auxiliary controls on sub-base to open minimum outside air damper during occupied mode. Substitutions will not be accepted.
- P. Provide lockable thermostat guards in public spaces.
- Q. During occupied mode run the supply fan continuously, cycle the cooling or heating as required to maintain occupied space temperature cooling or heating set point. During unoccupied mode cycle the supply fan and cooling or heating as required to maintain unoccupied cooling or heating temperature set point.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install units as shown on plans and according to the manufacturer's installation instructions.
- B. Install remote thermostats where indicated on the drawings. Provide all wiring between remote thermostats and the gas fired item.

3.2 FURNACES

- A. Install on concrete housekeeping pad, steel stand or suspend unit from structure as indicated on the drawings. Pipe condensate to floor drain.
- B. Provide schedule 40 PVC, ASTM D1785 combustion air and vent piping and fittings with solvent welded joints as indicated on the drawings. Terminate as recommended by the furnace manufacturer.

3.3 OWNER TRAINING

- A. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 8 hours.

END OF SECTION 23 54 00

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SECTION 23 62 13

PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSING UNITS

1.1 SCOPE

- A. This section includes specifications for air cooled condensing units for use with split system type air conditioning. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference.
 - d. Reference Standards.
 - e. Quality Assurance.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - h. Delivery, Storage and Handling.
 - i. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Units up to 5 Tons.
 - b. Refrigerant Piping Sizing.
 - c. Refrigerant Piping Accessories.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Startup.

1.2 RELATED WORK

- A. Section 23 05 00 - Common Work Results for HVAC.

1.3 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this section.

1.4 REFERENCE STANDARDS

- | | |
|----------------|---|
| A. ARI 210/240 | Unitary Air Conditioning and Heat Pump Equipment. |
| B. ARI 365 | Commercial and Industrial Unitary Air Conditioning Condensing Units. |
| C. ASHRAE 15 | Safety Standard for Refrigeration Systems. |
| D. ASHRAE 90.1 | (2004 edition) Energy Standard for Buildings Except Low Rise Residential Buildings. |
| E. NEC | National Electrical Code. |
| F. ASTM B117 | Standard Practice for Operating Salt Spray (fog) Apparatus. |
| G. UL | Underwriters Laboratory. |

1.5 QUALITY ASSURANCE

- A. Unit Energy Efficiency Ratio (EER), Coefficient of Performance (COP) and Integrated Part Load Value (IPLV) shall meet the minimum applicable requirements of ASHRAE 90.1(2004 edition). Units that are labeled ENERGY STAR® will be acceptable.

- B. Rate unit performance in accordance with the latest edition of ARI Standard 365 or ARI Standard 210/240, whichever is applicable for the equipment.
- C. Construct units in accordance with ASHRAE 15, UL standards and the NEC. Units shall carry the UL label.
- D. Factory run test units to see that each control device operates properly. Pressure test, evacuate, charge with holding charge of refrigerant and full oil charge prior to shipping from the factory.

1.6 SUBMITTALS

- A. Submit shop drawings including the following information: specific manufacturer and model numbers, dimensional and weight data, required clearances, materials of construction, capacities and ratings, refrigerant type and charge, component information, size and location of piping connections, electrical connections, wiring diagrams and information for all specialties and accessories.
- B. Submit manufacturer's installation and start-up instructions, maintenance data, troubleshooting guide, parts lists, controls and accessories.
- C. At substantial completion, submit warranty certificate and copy of start-up report.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer's instructions for storing, rigging, unloading, and transporting units. Protect units from physical damage. Leave factory-shipping covers in place until installation.
- B. Ship units to jobsite fully assembled.

1.9 WARRANTY

- A. Provide a one-year parts and labor warranty on the entire unit beginning upon substantial completion of project.
- B. Provide a five-year parts warranty on the compressor(s) beginning upon substantial completion of project.

PART 2 PRODUCTS

2.1 UNITS UP TO 5 TONS

- A. Manufacturers:
 - 1. Lennox: www.lennox.com.
 - 2. Carrier: www.carrier.com.
 - 3. York: www.york.com.
- B. Provide factory assembled, outdoor mounted, air -cooled condensing unit suitable for on grade or rooftop installation. Include compressor, air cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls, motor starting components and additional features as specified herein or required for safe, automatic operation. Capacity and steps of unloading as indicated in the equipment schedule. Refrigerant is to be R-410A.

C. CABINET:

1. Construct cabinet of heavy gauge, galvanized steel coated with weather resistant paint. Provide removable access panels to facilitate full access to the compressor, fan and control components.

D. COMPRESSOR:

1. Provide hermetic reciprocating or scroll type compressor with built in motor winding temperature and current protection, liquid and suction service valves, gage ports, sight glass and liquid line filter dryer. Provide crankcase heater with reciprocating type compressors. Mount compressors on vibration isolators. Cooling shall be a minimum of two-stages.

E. CONDENSER:

1. Provide condenser coils with aluminum alloy plate fins mechanically fastened to seamless copper tubing with integral subcooler. Construct coils with design working pressure suitable for the refrigerant. Louvered condenser guard shall be provided.

- F. Provide direct-drive statically and dynamically balanced propeller type fans with vertical or horizontal discharge as indicated on the drawings and guards constructed of heavy gage PVC coated wire or galvanized steel.

G. POWER WIRING:

1. Provide factory installed 24-volt control circuit with fusing; control power transformer and all associated internal wiring. Provide a single point power connection to the unit(s). Provide factory installed magnetic contactors for compressor and condenser motors.
2. Electrical characteristics shall be as indicated in the equipment schedule.

H. CONTROLS:

1. Provide high/low refrigerant pressure cutouts with manual reset and anti-short cycle compressor timer.
2. Provide "low ambient" controls and accessories needed so that unit is capable of operating down to ambient temperature of 25°F.

2.2 REFRIGERANT PIPING SIZING

- A. The unit manufacturer shall verify the final refrigeration pipe sizing process to ensure conformance to specific unit requirements such as max lengths, refrigerant velocities, unloading considerations and proper oil return. Provide factory pre-charged line sets unless the distance between the unit and the evaporator coil is too great. In this case, provide sizing criteria and materials to the Mechanical Contractor for this purpose.

2.3 REFRIGERANT PIPING ACCESSORIES

- A. For systems using R-410A, provide all refrigerant piping specialties with a maximum working pressure of full vacuum to 850 psig and a maximum working temperature of 225 degree F.
- B. Filter Dryers: For circuits below 15 tons provide straight pattern filter dryers without replaceable core.
- C. Sight glasses: Two piece brass construction with solder end connections. Include color indicator for sensing moisture.

- D. Solenoid Valves: Two way normally closed with two piece brass body, full port, stainless steel plug, stainless steel spring, teflon diaphragm and solder end connections. Provide replaceable coil assembly.
- E. Thermostatic Expansion Valves: Brass body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.
- F. Charging Valves: Provide 1/4" SAE brass male flare access ports with finger tight, quick seal caps. Provide 2-inch long copper extension sections.
- G. Check valves: Spring loaded type with bronze body, bronze disc, neoprene seat, bronze bonnet, stainless steel spring and solder end connections.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install units, piping and accessories in accordance with the manufacturer's written instructions and recommendations. Mount unit(s) on a poured concrete pad on grade or on roof mounted rails as indicated on the drawings. Units shall be level on pitched roofs.
- B. Maintain adequate service access and airflow clearances for all components as recommended by the manufacturer and as indicated on the drawings.
- C. Charge unit(s) with full oil charge and refrigerant charge based on the entire refrigeration system pipe size and length.
- D. Provide all control wiring in conduit in compliance Division 26 - Electrical.
- E. Coordinate power wiring requirements with the electrical trade.

3.2 STARTUP

- A. Adjust units for maximum operating efficiency, adjust all controls to required final settings and demonstrate that all components are functioning properly. Submit four copies of a written startup report following the initial startup. Include in the report: work done to the system, all readings taken, a statement certifying that the refrigeration system(s) are leak free and a statement certifying that the unit(s) have been placed in proper running condition as recommended by the manufacturer and as intended in the drawings and specifications.

END OF SECTION 23 62 13

SECTION 23 81 27

SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Indoor ductless fan & coil units.

1.2 RELATED REQUIREMENTS

- A. Section 23 05 00 - Common Work Results for HVAC.
- B. Section 26 27 02 - Equipment Wiring: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
- D. AHRI 610 - Performance Rating of Central System Humidifiers for Residential Applications; Air Conditioning, Heating, and Refrigeration Institute; 2004.
- E. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE Std 15).
- F. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.
- G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- I. UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- D. Design Data: Indicate refrigerant pipe sizing.

- E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- F. Project Record Documents: Record actual locations of components and connections.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Refer to Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Filters: Two for each unit; of each type and size.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience and approved by manufacturer.

1.6 WARRANTY

- A. Refer to Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer's warranty for heat exchangers; condensing units; compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. York International Corporation / Johnson Controls.
- B. Lennox Industries.
- C. Carrier Corporation.
- D. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.2 INDOOR UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
 - 1. Location: High-wall.
 - 2. Sound Rating:
 - 3. Cabinet: Galvanized steel.
 - a. Finish: White.
 - 4. Fan: Line-flow fan direct driven by a single motor.
 - 5. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
 - 6. Wall-Mounted Units.

- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL listed.
 - 2. Manufacturer: System manufacturer.

2.3 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Comply with AHRI 210.
 - 2. Refrigerant: R-410A.
 - 3. Cabinet: Galvanized steel; Steel with baked enamel or powder coat paint finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 - 4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23
- B. Compressor: Inverter type capable of modulating load.
- C. Air Cooled Condenser: Aluminum fin and copper tube coil, with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
 - 1. Condenser Fans: Direct-drive propeller type.
- D. Coil: Air-cooled, aluminum fins bonded to copper tubes.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A.
- C. Install refrigeration systems in accordance with ASHRAE Std 15.
- D. Pipe drain from cooling coils; to nearest floor drain.

END OF SECTION 23 81 27

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The electrical work included in all other Divisions is the responsibility of the Contractor performing the Division 26 work unless noted otherwise.

1.2 PROJECT OVERVIEW

- A. Addition of a Veterinarian Tech area to the existing WTIC New Richmond building.

1.3 SCOPE

- A. The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Project Overview.
 - b. Scope.
 - c. Related Work.
 - d. Reference Standards.
 - e. Regulatory Requirements.
 - f. Quality Assurance.
 - g. Continuity of Existing Services and Systems.
 - h. Protection of Finished Surfaces.
 - i. Approved Electrical Testing Laboratories.
 - j. Sleeves and Openings.
 - k. Sealing and Firestopping.
 - l. Intent.
 - m. Omissions.
 - n. Submittals.
 - o. Project/Site Conditions.
 - p. Work Sequence and Scheduling.
 - q. Work by Other Trades.
 - r. Offsite Storage.
 - s. Request and Certificate for Payment.
 - t. Salvage Materials.
 - u. Certificates and Inspections.
 - v. Operating and Maintenance Data.
 - w. Record Drawings.
2. PART 2 – PRODUCTS.
 - a. Access Panels and Doors.
 - b. Identification.
 - c. Sealing and Firestopping.
3. PART 3 – EXECUTION.
 - a. Excavation and Backfill.
 - b. Concrete Work.
 - c. Cutting and Patching.
 - d. Building Access.
 - e. Equipment Access.

- f. Coordination.
- g. Sleeves.
- h. Sealing and Firestopping.
- i. Housekeeping and Clean Up.
- j. Owner Training.

1.4 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.5 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:
 - 1. ANSI American National Standards Institute.
 - 2. ASTM American Society for Testing and Materials.
 - 3. EPA Environmental Protection Agency.
 - 4. ETL Electrical Testing Laboratories, Inc.
 - 5. IEEE Institute of Electrical and Electronics Engineers.
 - 6. IES Illuminating Engineering Society.
 - 7. ISA Instrument Society of America.
 - 8. NBS National Bureau of Standards.
 - 9. NEC National Electric Code.
 - 10. NEMA National Electrical Manufacturers Association.
 - 11. NESC National Electrical Safety Code.
 - 12. NFPA National Fire Protection Association.
 - 13. UL Underwriters Laboratories Inc.

1.6 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of the State of Wisconsin Electrical Code the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).
- B. All Division 26 work shall be done under the direction of a currently certified State of Wisconsin Certified Master Electrician.

1.7 QUALITY ASSURANCE

- A. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- B. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply. Where two or more manufacturers are specified and no reference is made to "or equal" other manufacturers, other manufacturers will be considered for prior approval with ten day prior approval submittals.

- C. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by Owner, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, shall be so labeled.

1.8 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the Owner Project Representative. The Owner may require written approval. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.
- B. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible. Note that Owner operations are on a seven-day week schedule, unless otherwise specified.

1.9 PROTECTION OF FINISHED SURFACES

- A. Furnish one can of touch-up paint for each different color factory finish furnished by the Contractor. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

1.10 APPROVED ELECTRICAL TESTING LABORATORIES

- A. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
 - 1. Underwriters Laboratories Inc.
 - 2. Electrical Testing Laboratories, Inc.

1.11 SLEEVES AND OPENINGS

- A. Below Grade Wall Penetrations.
- B. Conduit Penetrations.

1.12 SEALING AND FIRESTOPPING

- A. Sealing and firestopping of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, etc. and the structural or partition opening shall be the responsibility of the Contractor whose work penetrates the opening. The Contractor responsible shall hire individuals skilled in such work to do the sealing and firestopping. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

1.13 INTENT

- A. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- B. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the Owner's intent (as determined by the Owner / Project Manager). Refer to the General Conditions of the Contract for further clarification.

- C. It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- D. All sizes as given are minimum except as noted.
- E. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Owner's and/or Architect/Engineer's inspections, tests and approval from the commencement until the acceptance of the completed work.
- F. Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

1.14 OMISSIONS

- A. No later than ten (10) days before bid opening, the Contractor shall call the attention of the Owner to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

1.15 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
- C. On request from the Owner or Architect/Engineer, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.
- D. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.
- E. The submittals must be approved before fabrication is authorized.

1.16 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 Owner before proceeding.
- C. Tools, materials and equipment shall be confined to areas designated by the Owner.

1.17 WORK SEQUENCE AND SCHEDULING

- A. Install work in phases to accommodate Owner's occupancy requirements. During the construction period coordinate electrical schedule and operations with Owner's Construction Representatives.

1.18 WORK BY OTHER TRADES

- A. Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this Trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.
- B. Electrical details on drawings for equipment to be provided by others are based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others.

1.19 OFFSITE STORAGE

- A. If payment will be requested for approved offsite stored material, then the Contractor shall complete an "Off-site Storage Agreement" which the Owner will consider on a case by case basis. Prior approval by Owner personnel for offsite storage will be needed. No material will be accepted for offsite storage unless submittals for the material have been approved.

1.20 REQUEST AND CERTIFICATE FOR PAYMENT

- A. Refer to the General Conditions for all payment request requirements.

1.21 SALVAGE MATERIALS

- A. No materials removed from this project shall be reused except as specifically noted on the plans. All materials removed shall become the property of and shall be disposed of by the Contractor.

1.22 CERTIFICATES AND INSPECTIONS

- A. Refer to the General Conditions for Certificates and Inspections.
- B. This Contractor is responsible for coordination of Owner electrical inspection. Inspection requirements will be issued at a pre-installation meeting, arranged by this Contractor and the Electrical Inspector having jurisdiction.

1.23 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under Section 01 78 00 - Closeout Submittals.
- B. In addition to the general content specified under Section 01 78 00 - Closeout Submittals supply the following additional documentation:
 - 1. Manufacturer's wiring diagrams for electrically powered equipment.

1.24 RECORD DRAWINGS

- A. The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.
- B. The Owner or Engineer will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. Dimensions and elevations on the record drawings shall locate all buried or concealed piping, conduit, or similar items.
- C. The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.
- D. At completion of the project, the Contractor shall submit the marked-up record drawings to the Owner prior to final payment.

PART 2 PRODUCTS

2.1 ACCESS PANELS AND DOORS

- A. Lay-in Ceilings:
 - 1. Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration provided under other divisions are sufficient; no additional access provisions are required unless specifically indicated.
- B. Plaster Walls and Ceilings:
 - 1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers and similar wet areas, concealed hinges, screwdriver operated cam latch for general application, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

2.2 IDENTIFICATION

- A. See Electrical Section 26 05 53 – Identification for Electrical Systems.

2.3 SEALING AND FIRESTOPPING

- A. Fire and/or Smoke Rated Penetrations:
 - 1. Whenever possible, avoid penetrations of fire and smoke rated partitions. When they cannot be avoided, verify that sufficient space is available for the penetration to be effectively fire and smoke stopped.
- B. Manufacturers:
 - 1. 3M: www.3m.com.
 - 2. STI/SpecSeal: www.stifirestop.com.
 - 3. Tremco: www.tremcosealants.com.
 - 4. Hilti: www.hilti.com.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- C. All firestopping systems shall be by the same manufacturer.
- D. Submittals:
 - 1. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
 - 2. Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.
- E. Product:
 - 1. Firestop systems shall be UL listed or tested by an independent testing laboratory approved by the Department of Commerce.
- F. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

- G. Contractor shall use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.
- H. Non-Rated Penetrations:
 - 1. Conduit Penetrations Through Below Grade Walls:
 - a. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or a water-stop type wall sleeve.
 - 2. Conduit and Cable Tray Penetrations:
 - a. At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work to accomplish indicated electrical systems installation in accordance with section 31 23 16.13 - Trenching. Blasting will not be allowed without written permission of the Owner.

3.2 CONCRETE WORK

- A. The Division 3 Contractor will perform all cast-in-place concrete unless noted otherwise elsewhere. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.

3.3 CUTTING AND PATCHING

- A. Refer to Division 1, General Requirements for Cutting and Patching.

3.4 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.5 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access doors.

3.6 COORDINATION

- A. The Contractor shall cooperate with other trades and Owner's personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
- C. Coordinate all work with other Contractors prior to installation. Any installed work that is not coordinated and that interferes with other Contractor's work shall be removed or relocated at the installing Contractor's expense.
- D. Cooperate with the testing consultant in ensuring specification Section 26 05 04 compliance. Verify system completion to the testing consultant. Demonstrate the starting, interlocking and control features of each system so the testing Contractor can perform its work.

3.7 SLEEVES

- A. Pipe sleeves for conduits 6" in diameter and smaller, in new poured concrete construction, shall be schedule 40 steel pipe, plastic removable sleeve or sheet metal sleeve, all cast in place.
- B. In wet area floor penetrations, top of sleeve to be 2 inches above the adjacent floor. In existing wet area floor penetrations, core drill sleeve openings large enough to insert schedule 40 sleeve and grout the area around the sleeve. If a pipe clamp resting on the sleeve supports the pipe penetrating the sleeve, weld a collar or struts to the sleeve that will transfer weight to the existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling unit coils, converters, pumps, chillers, boilers, and similar waterside equipment.
- C. Pipe penetrations in existing concrete floors that are not in wet areas may omit the use of schedule 40 sleeve and use the core drilled opening as the sleeve.

3.8 SEALING AND FIRESTOPPING

- A. Fire and/or Smoke Penetrations:
 - 1. Install approved product in accordance with the manufacturer's instructions where a pipe (i.e. cable tray, bus, cable bus, conduit, wireway, trough, etc.) penetrates a fire rated surface.
- B. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support any substantial weight.
- C. Non-Rated Surfaces:
 - 1. When the opening is through a non-fire rated wall, floor, ceiling or roof the opening must be sealed using an approved type of material.
 - 2. Install escutcheons or floor/ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces for this paragraph include only those rooms with finished ceilings and the penetration occurs below the ceiling.
 - 3. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions. Install so that the bolts used to tighten the seal are accessible from the interior of the building or vault.
 - 4. At interior partitions, conduit penetrations are required to be sealed for all clean rooms, laboratories, and most hospital spaces, computer rooms, dormitory rooms, tele/data/com rooms and similar spaces where the room pressure or odor transmission must be controlled. Apply sealant to both sides of the penetration in such a manner that the annular space between the conduit sleeve and the conduit is completely filled.

3.9 HOUSEKEEPING AND CLEAN UP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

3.10 OWNER TRAINING

- A. All training provided for the Owner shall comply with the format, general content requirements and submission guidelines specified under General Conditions.
- B. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 8 hours.

END OF SECTION 26 05 00

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SECTION 26 05 02

ELECTRICAL DEMOLITION FOR REMODELING

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes the demolition of a vestibule to make a connection the new building addition. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - 2. PART 2 – PRODUCTS.
 - a. Material and Equipment.
 - 3. PART 3 – EXECUTION.
 - a. Examination.
 - b. Preparation.
 - c. Demolition and Extension of the Existing Electrical Work.
 - d. PCB Ballast Handling and Disposal.
 - e. Lamp Handling and Disposal.
 - f. Cleaning and Repair.
 - g. Installation.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work as specified in the individual Sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Verify whether or not PCB ballasts exist in light fixtures which will be disposed of. If PCB light fixture ballasts exist, then follow requirements in **PCB BALLAST HANDLING AND DISPOSAL** below.
- D. Demolition Drawings are based on casual field observation and/or existing record documents. Report discrepancies to the Engineer before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with the Owner, Architect, and Engineer. Also, if applicable, coordinate utility service outages with the local Utility Company.

- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. In particular, all security and safety systems must be maintained in operation at all times as required by the Owner. This includes security and safety lighting.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work to meet all requirements of these specifications.
- B. If certain raceways and boxes are abandoned but not scheduled for removal, those items must be shown on the "As Built Drawings".
- C. Remove, relocate, and extend existing installations to accommodate new construction.
- D. Remove abandoned wiring to source of supply.
- E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- G. Disconnect and remove abandoned panelboards and distribution equipment.
- H. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- I. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.
- K. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- L. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. This includes the extension of the circuit from the last active device to the next device in the system to be activated.

3.4 PCB BALLAST HANDLING AND DISPOSAL

- A. Generally, all high power factor fluorescent light ballasts manufactured before 1978 and some HID ballasts contain PCB compounds in their capacitors. The Contractor shall inspect all ballasts in all light fixtures (which will become the property of the Contractor and will be removed from the project site as part of this project) and take the actions described below.
 - 1. All ballasts labeled as "NON-PCBs" or "NO PCBs" shall become the property of the Contractor. If the PCB content is not stated on the ballast label, the ballast shall be handled as a PCB ballast.

2. All PCB ballasts shall be removed from the light fixtures and shall have the wires clipped off. However, before removal, all PCB ballasts shall be carefully inspected for leaks. If a ballast appears to be leaking (evidenced by potting compound leaking out or by an oily film on the ballast surface) the ballast must be handled per EPA and DNR PCB regulations. Basically, this means the ballast is to be carefully removed from the fixture and placed in an approved drum. See paragraph below for the drum specifications. The person removing the ballast from the fixture shall wear protective gloves, eye protection, and protective clothing as necessary.
 3. If the fixture has also been contaminated, it must be cleaned to less than 10 micrograms/100 square centimeters contamination before disposal. This cleaning must be done by an approved PCB contractor and is not considered a part of this contract. Contact Owner for contractor approval before commencing with the cleanup.
 4. The ballasts shall then be placed in US DOT approved type 17C or type 17H drums (barrels) furnished by the Contractor. 55 gallon and 30 gallon drums are available from most drum suppliers. The quantity and size of the drums will be determined by the Contractor at the time of construction.
 5. These barrels shall be placed in storage with the cover that came with the barrels, in a location within a building, as designated by the Owner or project representative. The barrels are not to be placed outside where they are exposed to weather.
 6. THESE BALLASTS ARE NOT TO BE REMOVED FROM THE WORK SITE BY THE CONTRACTOR. To do so, would be a violation of DNR and DOT hazardous waste regulations and may result in a fine to the Contractor.
 7. The Contractor shall label and mark the PCB storage drums with EPA approved PCB labels and the storage area with signs, marks and lines to meet the regulations of Wisconsin Code NR 157.
 8. The Contractor shall also provide approved PCB absorbent materials to be stored immediately adjacent to the drum storage area. Do not place loose absorbent material in the drums.
 9. The Contractor shall provide to the Owner, in written form, a total count of these ballasts (or their total weight by barrel) and where they are stored.
- B. When the ballast demolition is completed and all PCB ballasts are placed in drums ready to be picked up for disposal, the Electrical Contractor shall contract with a licensed PCB disposal contractor to pick up and dispose of the PCB ballasts.

3.5 LAMP HANDLING AND DISPOSAL

- A. All lamps (fluorescent, incandescent, and HID) contain mercury and/or lead (in the base) as well as other heavy metals and compounds which are regulated by the EPA and DNR during the disposal process. As a result, regulations have been issued covering the handling and disposal of all lamps. Therefore, lamps which have been removed from service for disposal shall be handled as follows by the Contractor.
1. The Contractor shall very carefully remove all lamps (fluorescent, incandescent, and HID) from light fixtures before removal of the fixture from its mounted position. This is to reduce the likelihood that the lamp(s) will be broken.
 2. The Contractor shall obtain approved containers from a licensed lamp recycling vendor. Removed lamps shall be placed in containers and marked with the number and type of lamps. Containers shall be placed in storage in a location on the Owner's property (this may be in another building) arranged by the Owner. The Contractor shall label the area as "Hazardous Material Storage - Mercury".

3. Contractor shall make arrangements for lamps to be picked up by a licensed lamp recycling vendor.

3.6 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts (if required) and broken electrical parts.

3.7 INSTALLATION

- A. Install relocated materials and equipment under the provisions of other sections.

END OF SECTION 26 05 02

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes furnishing and installing required wiring and cabling systems including pulling, terminating and splicing. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. References.
 - d. Submittals.
 - e. Project Conditions.
 - 2. PART 2 – PRODUCTS.
 - a. General.
 - b. Building Wire.
 - c. Variable Frequency Drive (VFD) Wire.
 - d. Underground Wire for Exterior Work.
 - e. Wiring Connectors.
 - 3. PART 3 – EXECUTION.
 - a. General Wiring Methods.
 - b. Wiring Installation In Raceways.
 - c. Wiring Connections and Terminations.
 - d. Field Quality Control.
 - e. Wire Color.
 - f. Branch Circuits.
 - g. Emergency Circuits.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- C. Section 26 05 53 – Identification for Electrical Systems.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Submit product data: Provide for each cable assembly type.
- C. Submit factory test reports: Indicate procedures and values obtained.
- D. Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.
- E. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.5 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper.
- C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.
- D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 PRODUCTS

2.1 GENERAL

- A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.
- B. All conductors shall be copper.
- C. Insulation shall have a 600 volt rating.
- D. All conductors shall be stranded.
 - 1. Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

2.2 BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Insulation: Type THHN/THWN, XHHW-2 insulation for feeders and branch circuits.

2.3 VARIABLE FREQUENCY DRIVE (VFD) WIRE

- A. All power wiring from the VFD output to the motor shall be type XHHW-2 insulation, single conductor wire.

2.4 UNDERGROUND WIRE FOR EXTERIOR WORK

- A. Description: Stranded single or multiple conductor insulated wire.
- B. Insulation: Type XHHW-2 or USE.
- C. This wiring shall be used in all underground applications, except when run in a concrete-encased ductbank.

2.5 WIRING CONNECTORS

- A. Split Bolt Connectors: Not acceptable.
- B. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.
- C. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- D. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.
- E. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

- F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps. Connector shall be irreversible type meeting IEEE Standard 837-2002, UL Listed.

PART 3 EXECUTION

3.1 GENERAL WIRING METHODS

- A. All wire and cable shall be installed in conduit.
- B. Do not use wire smaller than 12 AWG for power and lighting circuits.
- C. All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).
- D. Make conductor lengths for parallel conductors equal.
- E. Splice only in junction or outlet boxes.
- F. No conductor less than 10 AWG shall be installed in exterior underground conduit.
- G. Identify ALL low voltage, 600v and lower, wire per section 26 05 53.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

3.2 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Completely and thoroughly swab raceway system before installing conductors.
- D. Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.
- E. VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.

3.3 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice only in accessible junction boxes.
- B. Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.
- C. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.
- D. Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.
- E. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.

- G. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.4 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 04.
 - 1. Additional testing as follows shall be performed if aluminum conductors are used:
 - a. Equipment terminated with aluminum conductors shall be tested with a thermal imager and recorded.
 - b. Conductors shall be closely checked for loose or poor connections, and for signs of overheating or corrosion.
 - c. Test procedures shall meet NETA guidelines.
 - d. Test results and report shall be provided to the engineer.
 - e. Contractor shall correct all deficiencies reported in the test report.

3.5 WIRE COLOR

- A. General:
 - 1. For wire sizes 10 AWG and smaller - Wire shall be colored as indicated below.
 - 2. For wire sizes 8 AWG and larger – Use colored wire, or identify wire with colored tape at all terminals, splices and boxes. Colors to be as indicated below.
 - 3. In existing facilities, use existing color scheme.
 - 4. use Phase A black, Phase B red and Phase C blue for circuits at 120/208 volts single or three phase, and use Phase A brown, Phase B orange and Phase C yellow for circuits at 277/480 volts single or three phase. Note: This includes fixture whips except for Listed whips mounted by the fixture manufacturer on the fixture and Listed as a System.
 - 5. All switch legs shall be the same color as their associated circuit. Traveler conductors run between 3 and 4 way switches shall be colored pink or purple.
- B. Neutral Conductors: White for 120/208V systems, Gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with a different stripe.
- C. Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color coded.
- D. Feeder Circuit Conductors: Each phase shall be uniquely color coded.
- E. Ground Conductors: Green for 6 AWG and smaller. For 4 AWG and larger, identify with green colored wire, or with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, Contractor shall provide green with yellow tracer.

3.6 BRANCH CIRCUITS

- A. The use of single-phase, multi-wire branch circuits with a common neutral is not permitted. All branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductors.

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes grounding electrodes and conductors, equipment grounding conductors, and bonding. Included are the following topics:
 - 1. PART 1 - GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. References.
 - d. Regulatory Requirements.
 - 2. PART 2 - PRODUCTS.
 - a. Wire.
 - b. Bus.
 - 3. PART 3 - EXECUTION.
 - a. General.
 - b. Less Than 600 Volt System Grounding.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 WIRE

- A. Material: Stranded copper (aluminum not permitted).
- B. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

2.2 BUS

- A. Material: Copper (aluminum not permitted).
- B. Size: 1/4" X 2" minimum.

PART 3 EXECUTION

3.1 GENERAL

- A. Install Products in accordance with manufacturer's instructions.

- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
- C. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.

3.2 LESS THAN 600 VOLT SYSTEM GROUNDING

- A. Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.
- B. Provide communications system grounding conductor at point of service entrance and connect to building common grounding electrode system.
- C. Telecommunications and Audio Visual systems shall be installed with an isolated grounding system which has only one ground point. That ground point is to be the common grounding electrode system at the electrical service entrance for the building. Contractor is to provide an isolated grounding conductor from the electrical service entrance of the building to each Telecommunications Grounding Bus Bar (TGBB) in each Telecommunication Room. Use a minimum No. 2/0 AWG copper conductor, or as indicated on the plans, for the telecommunications service grounding conductor. Leave 10 feet slack grounding conductor at each Telecommunications Room. The grounding conductor **MUST NOT** be attached to building steel (except as allowed at the main electrical service entrance).
- D. Telecommunications Equipment Rack Grounding: Use a #6 or larger AWG copper conductor from all telecommunications cabinets and racks to the Telecommunications Grounding Bus Bar (TGBB) in each Telecommunication Room.

3.3 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 - d. Quality Assurance.
 - 2. PART 2 – PRODUCTS.
 - a. Material.
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for support channel.

1.4 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 PRODUCTS

2.1 MATERIAL

- A. Support Channel: Steel, Galvanized, Enameled or other corrosion resistant.
- B. Hardware: Corrosion resistant.
- C. Minimum sized threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and 1/4" for single conduits 1" and smaller.
- D. Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using pre-cast insert system, preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only).
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable type anchors.
- C. Powder-actuated fasteners and plastic wall anchors are not permitted.
- D. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.
- E. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not fasten to suspended ceiling grid system.
- F. Do not drill structural steel members unless approved by Owner.
- G. Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- H. In wet locations, mechanical rooms and electrical rooms install free-standing electrical equipment on 3.5 inch concrete pads.
- I. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch off wall (7/8" Uni-strut or 3/4" painted, fire-retardant plywood is acceptable).
- J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- K. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes conduits, surface raceways, multi-outlet assemblies, auxiliary gutters, wall duct, and boxes for electrical systems including wall and ceiling outlet boxes, floor boxes, and junction boxes. Included are the following topics:
1. PART 1 - GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 2. PART 2 - PRODUCTS.
 - a. Rigid Metal Conduit and Fittings.
 - b. Intermediate Metal Conduit (IMC) and Fittings.
 - c. Electrical Metallic Tubing (EMT) and Fittings.
 - d. Flexible Metal Conduit and Fittings.
 - e. Liquidtight Flexible Metal Conduit and Fittings.
 - f. Rigid Nonmetallic Conduit and Fittings.
 - g. Conduit Supports.
 - h. Surface Metal Raceway.
 - i. Surface Nonmetal Raceway.
 - j. Auxiliary Gutters (Wireways).
 - k. Wall Duct.
 - l. Outlet Boxes.
 - m. Floor Boxes.
 - n. Pull and Junction Boxes.
 - o. General.
 3. PART 3 - EXECUTION.
 - a. Conduit Sizing, Arrangement and Support.
 - b. Conduit Installation.
 - c. Conduit Installation Schedule.
 - d. Surface Metal Raceway and Multi-Outlet Assembly Installation.
 - e. Nonmetallic Surface Raceway Installation.
 - f. Auxiliary Gutters (Wireways) Installation.
 - g. Coordination of Box Locations.
 - h. Outlet Box Installation.
 - i. Floor Box Installation.
 - j. Pull and Junction Box Installation.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 27 26 - Wiring Devices.
- D. Section 26 27 02 - Equipment Wiring Systems.
- E. Section 28 31 00 - Fire Detection and Alarm.
- F. Section 27 00 00 - Communications Cable and Equipment.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Surface Raceway System - submit product data and catalog sheets for all components.
- C. Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 PRODUCTS

2.1 RIGID METAL CONDUIT AND FITTINGS

- A. Conduit: Heavy wall, galvanized steel, schedule 40, threaded.
- B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.2 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

- A. Conduit: Galvanized steel, threaded.
- B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Conduit: Steel, galvanized tubing.
- B. Fittings: All steel, set screw, concrete tight. No push-on or indenter types permitted.
- C. Conduit Bodies: All steel threaded conduit bodies.

2.4 FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Conduit: Steel, galvanized, spiral strip.
- B. Fittings and Conduit Bodies: All steel, galvanized, or malleable iron (except as allowed in specification 26 51 13).

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Conduit: Flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.6 RIGID NONMETALLIC CONDUIT AND FITTINGS

- A. Conduit: Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90 °C conductors.
- B. Fittings and Conduit Bodies: NEMA TC 2, Listed.

2.7 CONDUIT SUPPORTS

- A. See section 26 05 29.

2.8 SURFACE METAL RACEWAY

- A. Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- B. Size: As shown on Drawing.
- C. Finish: Ivory enamel.
- D. Fittings: Couplings, elbows, and connectors designed for use with raceway system.

E. Boxes and Extension Rings: Designed for use with raceway systems.

2.9 AUXILIARY GUTTERS (WIREWAYS)

A. Description: General purpose type wireway without knockouts.

B. Size: As indicated on Drawings; length as indicated on Drawings.

C. Cover: Hinged cover with full gasketing.

D. Connector: Slip-in construction

E. Fittings: Lay-in type with removable top, bottom, and side; captive screws.

F. Finish: Rust inhibiting primer coat with gray enamel finish.

2.10 OUTLET BOXES

A. Sheet Metal Outlet Boxes: Galvanized steel, with stamped knockouts.

B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.

C. Concrete Ceiling Boxes: Concrete type.

D. Cast Boxes: Cast ferroalloy, or aluminum type deep type, gasketed cover, threaded hubs.

2.11 FLOOR BOXES

A. Floor Boxes for Installation in Cast-In-Place Concrete Floors: Full adjustable, cast iron

2.12 PULL AND JUNCTION BOXES

A. Pull boxes and junction boxes shall be minimum 4 inch square by 2-1/8 inches deep for use with 1 inch conduit and smaller. On conduit systems using 1-1/4 inch conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4-11/16 inch square.

B. For telecommunication, fiber optic, security, and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on telecommunication, security, other low voltage and fiber optic systems with conduits of 1-1/4 inch and larger, shall be sized per the NEC conduit requirements. For determining box size, the conduit is the determining factor not the wire size.

C. Sheet Metal Boxes: Code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

D. Sheet Metal Boxes Larger than 12 inches in any dimension shall have a hinged cover or a chain installed between box and cover.

E. Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron or aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

F. Fiberglass or Concrete Handholes with weatherproof cover of non-skid finish shall be used for underground installations.

G. Box extensions and adjacent boxes within 48 inches of each other are not allowed for the purpose of creating more wire capacity.

H. Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.

I. Wireways shall not be used in lieu of junction boxes.

2.13 GENERAL

- A. All steel fittings and conduit bodies shall be galvanized.
- B. No cast metal or split-gland type fittings permitted.
- C. Mogul-type condulets larger than 2 inch not permitted except as approved or detailed.
- D. All conduit covers must be fastened to the conduit body with screws and be of the same manufacturer.
- E. Wireways, gutters and c-condulets shall not be used in lieu of pull boxes and condulets.
- F. All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

PART 3 EXECUTION

3.1 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. EMT is permitted to be used in sizes 4 inch and smaller for power and telecommunication systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.
- B. Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch minimum except **all homerun conduits shall be 3/4 inch**, or as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**
- C. Size conduit for all other wiring, including but not limited to data, control, security, fire alarm, telecommunications, signal, video, etc. shall be sized per number of conductors pulled and their cross-section. 40% fill shall be maximum for all new conduit fills.
- D. Arrange conduit to maintain headroom and present a neat appearance.
- E. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- F. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- G. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.
- H. Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- I. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.
- J. Support and fasten metal conduit at a maximum of 8 feet on center.
- K. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.

- L. In general, all conduit shall be concealed except where noted on the drawings or approved by the Engineer. Contractor shall verify with Engineer all surface conduit installations except in mechanical rooms.
- M. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.
- N. For indoor conduits, no continuous conduit run shall exceed 100 feet without a junction box.
- O. All conduits installed in exposed areas shall be installed with a box offset before entering box.

3.2 CONDUIT INSTALLATION

- A. Cut conduit square; de-burr cut ends.
- B. Conduit shall not be fastened to the corrugated metal roof deck.
- C. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- D. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.
- E. All conduit terminations (except for terminations into conduit bodies) shall use conduit hubs, or connectors with one locknut, or shall use double locknuts (one each side of box wall) and insulated bushing. Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 26 05 26 – Grounding and Bonding for Electrical Systems for grounding bushing requirements.
- F. Install no more than the equivalent of three 90 degree bends between boxes.
- G. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.
- H. Conduit shall be bent according to manufacturer's recommendations. Torches or open flame shall not be used to aid in bend of PVC conduit.
- I. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.
- J. Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.
- K. Install expansion-deflection joints where conduit crosses building expansion joints. Note: expansion-deflection joints are not required where conduit crosses building control joints if the control joint does not act as an expansion joint. Install expansion fitting in PVC conduit runs as recommended by the manufacturer.
- L. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.
- M. Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide Listed conduit seals to prevent the passage of moisture and water vapor through the conduit.
- N. Route conduit through roof openings for piping and ductwork where possible.
- O. Conduit is not permitted in any slab topping of two inches or less.
- P. Ground and bond conduit under provisions of Section 26 05 26.
- Q. PVC conduit shall transition to galvanized rigid metal conduit before it enters a concrete pole base, foundation, wall (where exposed) or up through a concrete floor.

- R. Identify conduit under provisions of Section 26 05 53.
- S. All conduit installed underground (exterior to building) shall be buried a minimum of 24 inches below finished grade, whether or not the conduit is concrete encased.
- T. PVC conduit shall be cleaned with solvent, and dried before application of glue. The temperature rating of glue/cement shall match weather condition. Apply full even coat of cement/glue to entire area that will be inserted into fitting. The entire installation shall meet manufacturer recommendations.

3.3 CONDUIT INSTALLATION SCHEDULE

- A. Conduit other than that specified below for specific applications shall not be used.
- B. Underground Installations within Five Feet of Foundation Wall: Rigid steel conduit.
- C. Underground Installations More than Five Feet from Foundation Wall: Rigid steel conduit. Plastic-coated rigid steel conduit. Schedule 40 PVC conduit.
- D. Under Slab on Grade Installations: Schedule 40 PVC conduit.
- E. Exposed Outdoor Locations: Rigid steel conduit.
- F. Concealed in Concrete and Block Walls: Rigid steel conduit. Electrical metallic tubing. Schedule 40 PVC conduit.
- G. Wet Interior Locations: Rigid steel conduit.
- H. Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.
- I. Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.
- J. Motor and equipment connections: Flexible PVC coated metal conduit (all locations). Minimum length shall be one foot, maximum length shall be three feet. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
- K. Light fixtures: Direct box or conduit connection for surface mounted and recessed fixtures. Flexible metal conduit from a J-box for recessed lay-in light fixtures. Conduit size shall be 3/8 inch minimum diameter and six foot maximum length. Conduit length shall allow movement of fixture for maintenance purposes.

3.4 SURFACE METAL RACEWAY INSTALLATION

- A. Use flat-head screws to fasten channel to surfaces every twenty-four (24) inches. Mount plumb and level.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 26 05 26.
- D. Fastener Option: Use clips and straps suitable for the purpose.

3.5 AUXILIARY GUTTERS (WIREWAYS) INSTALLATION

- A. Bolt auxiliary gutter to wall using two-piece hangers or steel channels fastened to the wall or in self-supporting structure.
- B. Gasket each joint in oil-tight gutter.
- C. Mount rain-tight gutter in horizontal position only.

- D. Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 26 05 26.

3.6 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.
- D. Boxes shall not be fastened to the metal roof deck.
- E. It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.
- F. In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Engineer and install outlet as instructed by the Engineer.
- G. The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.
- H. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch by 24 inch access doors.
- I. Locate and install to maintain headroom and to present a neat appearance.
- J. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

3.7 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls. Provide minimum 6 inch separation, except provide minimum 24 inch separation in acoustic-rated walls.
- B. Power:
 - 1. Recessed (1/4" maximum) outlet boxes in masonry, concrete or tile construction shall be minimum 4 inch square, with device rings. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.
- C. Low Voltage:
 - 1. Recessed (1/4" maximum) outlet boxes in masonry, concrete or tile construction shall be minimum 4-11/16 inch square, 2-1/8 inch deep. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.
- D. Provide knockout closures for unused openings.
- E. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.

- F. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide non-metallic barriers to separate wiring of different voltage systems.
- G. Install boxes in walls without damaging wall insulation.
- H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- I. Ceiling outlets shall be 4 inch square, minimum 2-1/8 inch deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.
- J. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- K. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- L. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- M. Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.
- N. Surface wall outlets shall be 4 inch square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.

3.8 FLOOR BOX INSTALLATION

- A. Set boxes level and flush with finish flooring material.

3.9 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install Owner approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.
- B. Support pull and junction boxes independent of conduit.

END OF SECTION 26 05 33

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes the products and execution requirements relating to labeling of power, lighting, general wiring, signal, fire alarm, and telecommunications wire and cabling. Further, this section includes labeling of all terminations and related sub-systems, including but not limited to nameplates, stenciling, wire and cable marker labeling of all backbone fiber optic (inter-building, tie & riser) cables, terminating equipment and labeling of inner duct (fiber optic). Included are the following topics:
 - 1. PART 1 - GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 - 2. PART 2 - PRODUCTS.
 - a. Materials.
 - 3. PART 3 - EXECUTION.
 - a. General.
 - b. Junction and Pullbox Identification.
 - c. Communication System Identification and Labeling.
 - d. Communication Backbone, Riser and Tie Cable Labeling.
 - e. Innerduct Labeling.
 - f. Communication Conduit Labeling.
 - g. Power and Control Wire Identification.
 - h. Nameplate Engraving.
 - i. Panelboard Directories.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- C. Section 27 00 00 - Communications Cable and Equipment.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Include schedule for nameplates and stenciling.
- C. Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8-1/2" x 11" sheets annotated, explaining their purposed use.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED. Exception: Back side of device plates and junction boxes may use handwritten, legible labeling on box covers, unless specifically prohibited by other specification sections.

- B. Cable label size shall be appropriate for the conductor or cable size(s), outlet faceplate layout and patch panel design. All labels shall be self-laminating, white/transparent vinyl and be wrapped around the cable or sheath. Labels for power conductors (600V and lower) shall be cloth-type. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.
- C. Nameplates: Engraved three layer laminated plastic, black letters on a white background. Emergency system (level 1 and level 2) shall use white letters on red background.
- D. Tape (phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.
- E. Adhesive type labels not permitted except for phase and wire identification. Machine generated adhesive labels shall be permitted for device plates, 4-11/16 inch and smaller junction boxes, fire alarm and control devices.

PART 3 EXECUTION

3.1 GENERAL

- A. Where mixed voltages are used in one building (e.g. 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system must be labeled for voltage in addition to other requirements listed herein.
- B. All branch circuit and power panels must be identified with the same symbol used in circuit directory in main distribution center.
- C. Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent.
- D. Install all labels firmly as recommended by the label manufacturer.
- E. Labels shall be installed plumb and neatly on all equipment.
- F. Install nameplates parallel to equipment lines.
- G. Secure nameplates to equipment fronts using screws, rivets or manufacturer approved adhesive or cement.
- H. Embossed tape will not be permitted for any application.

3.2 JUNCTION AND PULLBOX IDENTIFICATION

- A. The following junction and pullboxes shall be identified utilizing spray painted covers:

System	Color(s)
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White
Emergency Power – 480Y/277V	Brown/Red
Emergency Power – 208Y/120V	White/Red
Fire Alarm	Red
Temperature Control	Green
Door Control and Door Monitoring System	Orange
Sound and Intercom Systems	Blue
Video Surveillance System/MATV	Yellow

- B. Provide circuit numbers, and source panel designations for power wiring. Other system shall be identified as shown on details or approved shop drawings. Temperature control shall identify the source.

3.3 BACKBOARD AND EQUIPMENT RACKS

- A. Backboards and equipment racks shall be labeled by the Contractor identifying the room number. Additionally, equipment racks shall have an alpha character after the room number unique to that particular communications room. For example, Rack 205A would be the first rack in room 205. Character height shall be 1 inch (minimum).

3.4 STATION CABLE AND TERMINATION COMPONENTS

- A. Individual labels shall be placed on all Telecommunications Outlets, Data Patch Panels, Voice Termination Blocks, and cables. This is inclusive of each voice, data, video, or fiber optic outlet, or any configuration thereof, as identified on the drawings.
- B. Each component shall be clearly labeled using a code identifying each information outlet location throughout the facility. The project documents identify the numbering at each outlet location. Each media type shall be numbered separately. The format of the identifier shall be as follows:

TR-####X

Where: TR = Telecommunication Room identifier serving that location
= a sequential number assigned to that port starting at 001
X = an alpha character identifying cable type. V=Voice, D=Data

For example: "1A-001D" represents the first data jack served from the Telecommunications Room on the first floor identified as room 1A for that building. A voice outlet at the same location would be labeled as "1A-001V".

- C. Telecommunication Rooms identifiers shall be unique in each building.
- D. Telecommunications Outlets are to be labeled 1) on the cover of the assembly and 2) on each cable terminated at that location.
- E. All new outlet faceplates shall incorporate recessed label holders and shall be fitted with clear plastic covers. Where no such label holders are present on existing to remain outlets, the faceplate labels shall be protected with a clear over-laminate.
- F. Labels shall be White background with Black lettering. Lettering size shall be as large as practicable (up to 16-point) to fit properly on the outlet label. No lettering shall be smaller than 12-point.
- G. Copper Data and Fiber Optic Patch Panels shall be labeled identifying Outlet ID. Modular Jacks and/or Fiber Couplers shall be positioned in sequence of Outlet ID. Fiber Panels shall also be labeled with the fiber number. Fibers shall be sequenced in order per the manufacturer's color code.
- H. Each Station Cable shall be labeled within 4-inches of the cable end at the Data Patch Panel, 110 blocks, and Information Outlet.

3.5 COMMUNICATION BACKBONE, RISER AND TIE CABLE LABELING

- A. All fiber optic backbone and copper (inter-building, riser and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same cable terminates (e.g. Equipment Room or Telecommunications Closet I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.
- B. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.6 INNERDUCT LABELING

- A. All innerduct containing fiber optic cable installed under this project shall be labeled where exposed. This includes areas where the innerduct is (1) installed alone in risers, tunnels or trays, (2) where they transit manholes and/or pull boxes and (3) in equipment rooms.
- B. The innerduct shall be labeled with a durable Yellow Polyethylene tag which reads "CAUTION FIBER OPTIC CABLE" and includes blank spaces for adding fiber count and destination information. The destination of the cable(s) contained in the innerduct and the fiber count shall be marked on the tag. Hand lettering is acceptable on this tag, using an indelible type ink.
- C. The tag shall be secured to the innerduct(s) using self-locking ties.
- D. Innerduct shall be labeled on each floor in a riser installation, in each manhole and/or handhole or at 25 foot intervals in a tunnel or tray installation.

3.7 COMMUNICATION CONDUIT LABELING

- A. All conduits installed between Telecommunication Rooms shall be clearly labeled in accordance with ANSI/TIA/EIA-606. Both ends of the conduits shall be labeled. All labels shall be mechanical, no hand written labels. The label shall indicate the location of the far end of the conduit run and a unique conduit number. (i.e. TR-1A-01 or Room #216 – 01).

3.8 POWER AND CONTROL WIRE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
- B. All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated including wiring used for temporary purposes.

3.9 WIRING DEVICE IDENTIFICATION

- A. Wall switches, receptacles, occupancy sensors, wall dimmers, device plates and box covers, poke-through fittings, access floor boxes, photocells and time clocks shall be identified with circuit numbers and source. In exposed areas, identifications should be made inside of device covers, unless directed otherwise. Use machine-generated labels, or neatly hand-written permanent marker.

3.10 NAMEPLATE ENGRAVING

- A. Provide nameplates of minimum letter height as scheduled below.
- B. Panelboards, Switchboards and Motor Control Centers: 1 inch; identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source.
- C. Equipment Enclosures: 1 inch; identify equipment designation.
- D. Circuit Breakers, Switches, and Motor Starters in Panelboards or Switchboards or Motor Control Centers: 1/2 inch; identify circuit and load served, including location.
- E. Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: 1/2 inch; identify source and load served.

- F. Transformers: 1 inch; identify equipment designation. 1/2 inch; identify primary and secondary voltages, primary source, and secondary load and location.
- G. Junction boxes: 1 inch; identify system source(s) and load(s) served. Junction boxes may be neatly identified using a permanent marker.

3.11 PANELBOARD DIRECTORIES

- A. Typed directories for panels must be covered with clear plastic, have a metal frame. Room number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

END OF SECTION 26 05 53

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SECTION 26 05 73

SHORT CIRCUIT/COORDINATION STUDY AND ARC FLASH HAZARD STUDY

PART 1 GENERAL

1.1 SCOPE

- A. The Electrical Contractor shall retain the services of an independent third party firm to perform a short circuit/coordination study and arc flash hazard study as described herein.
- B. The studies shall be submitted to the Design Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.
- C. The studies shall include all portions of the electrical distribution system from the normal power source or sources, and emergency / standby sources, down to and including the smallest circuit breaker in the distribution system (for short circuit calculations). Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- D. The firm should be currently involved in high and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Wisconsin. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Design Engineer for approval prior to start of the work. A minimum of five 5 years of experience in power system analysis is required for the individual in charge of the project.
- E. The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
- F. The study and assessment shall be performed based on SKM's Dapper, Captor and PowerTool software.
- G. Included are the following topics:
 1. PART 1 - GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Quality Assurance.
 - d. Data Collection for the Study.
 - e. Submittals.
 2. PART 2 - PRODUCTS.
 - a. Not Used.
 3. PART 3 - EXECUTION.
 - a. Short Circuit and Coordination Study.
 - b. Field Settings.
 - c. Arc Flash Hazard Study.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.

B. Section 26 24 16 - Panelboards.

1.3 QUALITY ASSURANCE

A. Reference standards listed in the *IEEE Recommended Practices for Protection and Coordination of Industrial and Commercial Power Systems* ("Buff Book"), latest edition.

1.4 DATA COLLECTION FOR THE STUDY

A. The Contractor shall provide the required data for preparation of the studies. The engineer performing the system studies shall furnish the Contractor with a listing of the required data immediately after award of the contract.

B. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

1.5 SUBMITTALS

A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Third Party Qualifications:

1. Submit qualifications of individual(s) who will perform the work to Design Engineer for approval prior to commencement of the studies.

C. Draft Report:

1. Submit a draft of the study to Design Engineer for review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer.

D. Final Study Report:

1. Provide studies in conjunction with equipment submittals to verify equipment ratings required.

2. The results of the power system study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted. Provide two (2) copies in PDF format of the study, so that it can be more easily stored and shared. Also, provide 2 copies (on CD) of the report in MS word, and 2 copies (on CD) of the one-line diagram in CAD format.

3. The report shall include the following sections:

a. Overview.

b. Short Circuit Study:

SC-1 Purpose.

SC-2 Explanation of Data.

SC-3 Assumptions.

SC-4 Analysis of Results.

SC-5 Recommendations.

SC-6 DAPPER Fault Analysis Input Report.

c. Protective Device Coordination Study:

PDC-1 Purpose.

PDC-2 Explanation of Data.

PDC-3 Assumptions.

PDC-4 Analysis of Results.

PDC-5 Recommendations (Including NEC 700-27 Requirement).

PDC-6 CAPTOR Results.

PDC-7 Example Drawings.

d. Arc Flash Study:

ARC-1 Purpose.

ARC-2 Explanation of Data.

ARC-3 Assumptions.

- ARC-4 Analysis of Results.
 - ARC-5 Recommendations.
 - ARC-6 SKM Arc Flash Evaluation Report.
 - e. Prioritized Recommendations and Conclusions.
 - f. Appendices:
 - APP-1 DAPPER One-line Diagrams.
 - APP-2 AutoCAD One-line Diagrams.
 - APP-3 SKM Protective Device Summaries.
 - APP-4 Reference Data.
 - APP-5 Sample Work Permit Form.
 - APP-6 Copy of Warning Labels, including study date.
- E. The above sections shall include the following items in detail:
1. Obtain available fault current from the local utility company.
 2. Short circuit studies shall evaluate the available fault current at each bus (each change of impedance), including all three-phase motors.
 3. Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
 4. Recommendations for improving the coordination and/or load distribution, as well as ground fault requirements.
 5. Arc flash values for two normal cases to define the highest values (low short circuit and high short circuit).
 6. Arc flash values for two maintenance cases, which define the arc flash values available at the equipment that would be available if the instantaneous trip of the upstream circuit breaker is set at a minimum value. This is recommended if someone has to work on live equipment.
 7. IEEE standard one-line diagram with equipment evaluation and circuit breaker setting forms that clearly define the system data and are easy to interpret.
 8. Recommendations to reduce the arc flash incident energy in all areas that require class 2 and higher PPE.
 9. Prioritized report summarizing all recommendations from this study. This shall include observed NEC code violations and their corrective action.
 10. The Contractor shall provide a one-line diagram that meets IEEE/ANSI standard 141, mounted on 24" x 36" (minimum) Styrofoam backboard. This one-line diagram shall be mounted in each electrical room.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 SHORT CIRCUIT AND COORDINATION STUDY

- A. The short circuit, coordination, and arc flash hazard studies shall be performed using SKM Dapper, Captor and PowerTool for Windows software packages. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.

- B. In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
- C. Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
- D. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
- E. Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- F. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.
- G. Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.
- H. Include fault contribution of all motors in the study. Notify the Engineer in writing of circuit protective devices not properly rated for fault conditions.
- I. Provide settings for the chiller motor starters or obtain from the mechanical contractor, include in the study package, and comment.
- J. When an emergency generator is provided, include phase and ground coordination of the generator protective devices, to meet NEC 700.27 requirements. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.

- K. Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- L. For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current to ensure protective devices will not trip major or group operation.

3.2 FIELD SETTINGS

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device coordination study and arc flash hazard study.
- B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.

3.3 ARC FLASH HAZARD STUDY

- A. As part of the short circuit and coordination study, arc flash hazard study shall be included. The study shall include the following:
 - 1. Determine and document all possible utility and generator/emergency sources that are capable of being connected to each piece of electrical gear. Calculations shall be based on highest possible source connection.
 - 2. Calculations to conform to National Fire Protection Association (NFPA) 70E – 2003 calculation standards. All incident energy units shall be calculated in calories per square centimeter.
 - 3. Provide recommended boundary zones and personal protective equipment (PPE) based on the calculated incident energy and requirements of NFPA 70E-2003 for each piece of electrical gear.
- B. Electrical Contractor shall provide labeling as required by OSHA based upon the results of the arc flash hazard study. At a minimum, the labeling shall contain the following information: PPE level, Flash Hazard Boundaries, Flash Protection Boundary, and Shock Hazard Boundaries such as Limited Approach Boundary, Restricted Approach Boundary, Prohibited Approach Boundary, and study date.

END OF SECTION 26 05 73

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SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes main, distribution and branch circuit panelboards. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 - d. Operation and Maintenance Data.
 - e. Spare Parts.
 - 2. PART 2 – PRODUCTS.
 - a. Main and Distribution Panelboards.
 - b. Branch Circuit Panelboards.
 - 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Field Quality Control.
 - c. Owner Training.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, and circuit breaker arrangement and sizes.

1.4 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 Closeout Submittals.

1.5 SPARE PARTS

- A. Keys: Furnish 2 keys for each panelboard to Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Square D: www.squared.com.
- B. Siemens: www.siemens.com.
- C. General Electric: www.geindustrial.com.
- D. Cutler Hammer: www.cutlerhammer.com.
- E. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.2 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.

- B. Enclosure: Type 1. Minimum cabinet size: 5-3/4 inches deep; 20 inches (508 mm) wide with 5 inch minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.
- C. Provide flush cabinet front with concealed trim clamps, concealed hinge and flush cylinder lock all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.
- D. Provide metal directory holders with clear plastic covers.
- E. Provide panelboards with copper bus (phase buses, bus fingers, etc., ratings as scheduled on Drawings. Provide ground bars in all panelboards. Neutral and ground bars can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.
- F. Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings.
- G. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
- H. Do not use tandem circuit breakers.
- I. Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any sort will be approved.
- J. All of the panelboards provided under this section shall be by the same manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

- A. See section 26 05 29 for support requirements.
- B. Install panelboards plumb with wall finishes.
- C. Height: 6 feet to top.
- D. Install a crimp type stud termination to stranded conductor when terminating on circuit breakers without a captive assembly rated for terminating stranded conductors.
- E. Provide filler plates for unused spaces in panelboards.
- F. See section 26 05 53 for identification requirements. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Stub three (3) empty 3/4 inch conduits to accessible location above ceiling or below floor out of each recessed panelboard. Cap these conduits to prevent material from entering them.

3.2 FIELD QUALITY CONTROL

- A. If aluminum conductors size #1/0 and larger (per Section 26 05 19) are to be used as panelboard feeders, it is the responsibility of the Contractor to provide panelboards with adequate wire bending space to accommodate the aluminum conductors and terminators to meet allowable code requirements. The Contractor shall circuit the panelboards as shown on the drawings. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance the phase loads within 10 percent.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

3.3 OWNER TRAINING

- A. All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified.

END OF SECTION 26 24 16

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SECTION 26 27 02

EQUIPMENT WIRING SYSTEMS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes electrical connections to equipment specified under other Divisions and/or Sections, or furnished by Owner, including, but not limited to:
 - 1. HVAC motors, VFDs, and panels.
- B. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 - d. Coordination.
 - 2. PART 2 – PRODUCTS.
 - a. Cords and Caps.
 - b. Other Products.
 - 3. PART 3 – EXECUTION.
 - a. Inspection.
 - b. Preparation.
 - c. Installation.
 - d. HVAC and Plumbing Connections.
 - e. Equipment Connection Schedule.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
 - 1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for cord and wiring devices.

1.4 COORDINATION

- A. Coordinate all equipment requirements with the various Contractors and the Owner. Review the complete set of drawings and specifications to determine the extent of wiring, starters, devices, etc., required.

PART 2 PRODUCTS

2.1 CORDS AND CAPS

- A. Straight-blade Attachment Plug: NEMA WD 1.
- B. Locking-blade Attachment Plug: NEMA WD 5.
- C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.
- D. Cord Construction: Oil-resistant thermoset insulated multiconductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

- E. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

2.2 OTHER PRODUCTS

- A. Refer to related sections for other product requirements.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 INSTALLATION

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
- B. Make conduit connections to equipment using flexible PVC-coated metal conduit.
- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
- F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.
- G. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

3.4 HVAC CONNECTIONS

- A. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (VFDs), and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
- B. VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.
- C. Provide 120 volts to each temperature control panel. Coordinate requirements with HVAC/DDC Contractors.
- D. Unless otherwise specified, all electrical motors and control devices such as aquastats, float and pressure switches, fan powered VAV boxes, switches, electro-pneumatic switches, solenoid valves and damper motors requiring mechanical connections shall be furnished and installed and wired by the Contractor supplying the devices.

- E. Each motor terminal box shall be connected with a minimum 12 inch, maximum 36 inch piece of flexible PVC-coated metal conduit to a fixed junction box. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
- F. Check for proper rotation of each motor.

3.5 EQUIPMENT CONNECTION SCHEDULE

- A. As indicated on the drawings.

END OF SECTION 26 27 02

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SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes wall switches, receptacles, occupancy sensors, wall dimmers, device plates and box covers, poke-through service fittings, access floor boxes, photo cells and time clocks. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Wall Switches.
 - c. Receptacles.
 - d. Occupancy Sensors.
 - e. Wall Dimmers.
 - f. Device Plates and Box Covers.
 - g. Photo Cells.
 - h. Time Clocks.
 - i. Time Switch.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Field Quality Control.
 - c. Occupancy Sensors.
 - d. Adjusting.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Provide product data showing model numbers, configurations, finishes, dimensions, and manufacturer's instructions.
- C. For occupancy sensor shop drawings, the manufacturer's actual layout of occupancy sensors and the wiring diagrams shall be provided.

1.4 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 Closeout Submittals.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cooper: www.cooperwiringdevices.com.
- B. Hubbell: www.hubbell-wiring.com.
- C. Pass and Seymour: www.passandseymour.com.

- D. Leviton: www.leviton.com.
- E. SensorSwitch: sensorswitch.com.
 - 1. Note: SensorSwitch makes occupancy sensors and photocells, not outlets and toggle switches.
- F. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.2 WALL SWITCHES

- A. Wall Switches for Lighting Circuits and Motor Loads Under 1/2 HP: Heavy duty use toggle switch, rated 20 amperes and 120/277 volts AC. Switches shall be UL20 Listed and meet Federal Specification WS-896. All switches shall be heavy duty Specification Grade with separate green ground screw.
- B. All switches shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG. Switches shall be Leviton model 1221-S, Hubbell model CS1221, Pass & Seymour model CSB20, Cooper model CSB120, or approved equal.
 - 1. Handle: Ivory, made of nylon or high impact resistant material.

2.3 RECEPTACLES

- A. Convenience and Straight-blade Receptacles: NEMA Type 5-20R, Ivory nylon or high impact resistant face. Receptacles shall be UL498 Listed and meet Federal Specification WC-596. All duplex receptacles shall be heavy duty Specification Grade, 20 amp rated. All receptacles shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with a separate green ground screw. Receptacles shall be Leviton model 5362, Hubbell model HBL5362, Pass & Seymour model 5362A, or Cooper model AH5362.
- B. Generally, all receptacles shall be duplex convenience type unless otherwise noted.
- C. All receptacles installed in outdoor locations, in garages, within 6 feet of the outside edge of sinks, and in other damp or wet locations shall be GFCI type.
- D. GFCI Receptacles: Duplex convenience receptacle, Specification Grade, with integral ground fault current interrupter meeting the requirements of UL standard 943 Class A and UL standard 498. GFCI receptacles shall be Leviton model 7899, Hubbell model GF20, Pass & Seymour model 2095, Cooper model VGF20 or approved equal.
- E. All receptacles on emergency circuits shall have a red face.
- F. All receptacles designated as isolated ground shall have an isolated ground triangle imprint on the face of the receptacle.
- G. Locking-Blade Receptacles: As indicated on drawings.
- H. Specific-use Receptacle Configuration: As indicated on drawings.

2.4 OCCUPANCY SENSORS

- A. All occupancy sensors shall be hardwired type; battery type shall not be permitted.
- B. Wall Mounted (Wall Switch Type):
 - 1. The sensor shall use either passive infrared or, if dual technology, passive infrared and passive acoustic sensing, or passive infrared and ultrasonic, for detecting room occupancy. The unit shall fit in/on a standard single gang switch box.
 - 2. Rated capacity: 600 watts minimum at 120 volts, 60 Hz; 1000 watts minimum at 277 volts, 60 Hz.
 - 3. Sensitivity shall be user adjustable or self adjusting type.

4. The delay timer shall be adjusted within a range of 6 to 30 minutes by the Contractor in the field. The sensor shall have a test mode for performance testing.
5. The off switch shall have manual override for positive off and automatic on.
6. The test LED shall indicate motion.
7. The area of coverage shall be approximately 180 degrees by 35-40 feet.
8. The unit shall have a five year warranty.

C. Ceiling Mounted:

1. The sensor shall use either passive infrared or, if dual technology, passive infrared and passive acoustic sensing, or passive infrared and ultrasonic, for detecting room occupancy. The unit shall fit in/on a standard octagon box. All ceiling mounted sensors shall be installed to a box with ring and box support.
2. Rated capacity shall be 20 amps at 120 or 277 volts, for fluorescent lamps. Provide power pack as required for low voltage sensors.
3. Sensitivity shall be user adjustable or self adjusting type.
4. The delay timer shall be adjusted within a range of 6 to 30 minutes by the Contractor in the field. The sensor shall have a test mode for performance testing.
5. The coverage area shall be 360 degrees by approximately 15 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas.
6. Test LED to indicate motion.
7. The unit shall have a five year warranty.
8. See drawings for actual type of sensor.

2.5 WALL DIMMERS

- A. Wall Dimmers: Linear slide semiconductor type.
- B. Rating: 600 Watts minimum, larger size to accommodate load shown on Contract Drawings.

2.6 DEVICE PLATES AND BOX COVERS

- A. Decorative Cover Plate: Ivory smooth thermoplastic nylon. 302/304 smooth stainless steel. Note requirement for red plates on emergency outlets.
- B. Weatherproof Cover Plate: Gasketed metal with hinged device covers.
- C. Surface Cover Plate: Raised galvanized steel.

2.7 POKE-THROUGH FITTINGS

- A. Description: Assembly comprising service fitting, poke- through component, firestops and smoke barriers, and junction box for conduit termination.
- B. Fire Rating: 3 hours.
- C. Service Fitting:
 1. Type: Pedestal Flush.
 2. Housing: Satin aluminum.
 3. Device Plate: Stainless steel.
 4. Configuration: One duplex.

2.8 PHOTO CELLS

- A. The controller shall be rated 2000 watts tungsten at 120, 240 or 277 volts. The cell shall be cadmium sulfide, 1 inch diameter.
- B. The enclosure shall be die cast zinc, gasketed for maximum weather proofing.
- C. The enclosure shall include the positioning lug on the top of the enclosure.

- D. The unit shall have a delay of up to two minutes to prevent false switching. ON/Off adjustment shall be done by moving a light selector with a range from 2 to 50 foot-candles.
- E. Mounting shall be for a ½ inch conduit nipple.
- F. The unit shall have a 5 year warranty.
- G. The contacts shall be SPST normally closed.
- H. The operational temperature range shall be -40 to 140 degrees F.

2.9 TIME CLOCKS

- A. Unit shall be a multi-purpose, 7 day, 365 day advance single and skip a day, combination 2 channel electronic time clock with a SPDT switching configuration and astronomic dial.
- B. The contacts shall be rated 10 amp resistive at 120/250 VAC, 7.5 amps inductive at 120/250 VAC, 5 amps inductive at 30 VDC and up to 1/2 hp at 250 VAC. The unit shall be rate for 30 VDC, 120 VAC, 250 VAC and 277 VAC.
- C. The controller shall be capable of programming in the AM/PM or 24 hour format by jumper selection, in one minute resolution, using 2 buttons only for all basic settings.
- D. Display shall be LED type.
- E. The unit shall have 365 day and or holiday selection capabilities, with 16 single date and 5 holiday selection options and user selectable daylight savings/standard time functions.
- F. The unit shall have 72 hour memory backup with rechargeable battery and charger.
- G. The unit shall be capable of manual override, On and OFF to the next scheduled event, using 1 button for each channel.
- H. The enclosure shall be rated for indoor or outdoor installation.

2.10 TIME SWITCH

- A. The switch shall be programmed to automatically turn lights off after a preset time. The delay timer shall be adjustable with a range of 5 minutes to 12 hours.
- B. Switch shall be rated for 120/277V, 1200W load.
- C. The switch shall beep warning every 5 seconds during the last minute of countdown. Also, the switch shall flash lights (for warning) at one minute before timer expires.
- D. Time scrolling shall be provided to override preset time by pressing the ON/OFF switch for four seconds.
- E. LCD provided to show count down time.
- F. The switch shall have zero crossing circuitry.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install wall switches 46 inches above floor to the center of device, OFF position down.
- B. Install wall dimmers 46 inches above floor to the center of device; de-rate ganged dimmers as instructed by manufacturer; do not use common neutral.
- C. Install convenience receptacles 24 inches above floor, grounding pole on bottom.

- D. Install box for information outlet 18 inches above finished floor. Install box for telephone jack for wall telephone 48 inches above finished floor.
- E. Install specific-use receptacles at heights shown on Contract Drawings.
- F. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions.
- G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- H. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- I. Install devices and wall plates flush and level.
- J. Receptacles shall have a bonding conductor from grounding terminal to the metal conduit system. Self-grounding receptacles using mounting screws as bonding means are not approved.

3.2 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch and sensor with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.
- F. Owner personnel reserve the right to be present at all tests.

3.3 OCCUPANCY SENSORS

- A. Power packs used in return air plenum ceiling areas shall be installed in an approved enclosure or UL listed for return air plenum.
- B. Provide a minimum of 4 feet of coiled cable for ceiling-mounted sensors.
- C. Sensitivity Test: After the sensor has been energized for at least 15 minutes, walk to the middle of the room (if conference room) or sit at the normal desk position (if and office). Make no motion for 20 seconds. Move one arm up and down slowly. The test LED should blink.
- D. Time Delay Test: Set the time delay for 10 minutes. Walk into the room to activate the sensor then leave room. Sensor must turn lights off at approximately 10 minutes. Walk into the room again to reactivate the lights. Lights should activate within 1 second.
- E. For lights on emergency power without a remote transfer device, route the emergency circuit through a separate relay controlled by the occupancy sensor(s) in the respective area. For lights on emergency power with a remote transfer device, the emergency power does not get routed through the occupancy sensor relay, but the normal power does get routed through the occupancy sensor relay.

3.4 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Mark all conductors with the panel and circuit number serving the device with a machine generated label, at the device, and on the back of the device cover.

END OF SECTION 26 27 26

SECTION 26 27 28

DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes disconnect switches, fuses and enclosures. Included are the following topics:
 - 1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 - d. Operation and Maintenance Data.
 - 2. PART 2 – PRODUCTS.
 - a. Manufacturers.
 - b. Disconnect Switches.
 - 3. PART 3 – EXECUTION.
 - a. Installation.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Include outline drawings with dimensions, and equipment ratings for voltage, ampacity, horsepower, and short circuit.

1.4 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 Closeout Submittals.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Square D: www.squared.com.
- B. Siemens: www.siemens.com.
- C. General Electric: www.geindustrial.com.
- D. Cutler Hammer: www.cutlerhammer.com.
- E. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.2 DISCONNECT SWITCHES

- A. Nonfusible Switch Assemblies: NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- B. Enclosure: NEMA Type as indicated on Drawings.
- C. Provide manufacturer's equipment ground kit in all disconnect switches.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated on Drawings.
- B. Provide identification as specified in Section 26 05 53.

END OF SECTION 26 27 28

SECTION 26 43 13

SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes Surge Protective Devices (SPD) as indicated on the project drawings and electrical diagrams. Included are the following topics:
 - 1. PART 1 - GENERAL
 - a. Scope.
 - b. Related Work.
 - c. Reference Standards.
 - d. Quality Assurance.
 - e. Warranty.
 - f. Submittals.
 - g. Operation and Maintenance Data.
 - 2. PART 2 - PRODUCTS
 - a. Surge Protective Devices.
 - 3. PART 3 - EXECUTION
 - a. Installation.
 - b. Owner Training.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.3 REFERENCE STANDARDS

- A. UL 1449, Fourth Edition – Standard For Safety For Surge Protective Devices.
- B. ANSI/IEEE C62.41.1 Guide on the Surge Environment in Low-Voltage AC Power Circuits.
- C. ANSI/IEEE C62.41.2 Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- D. ANSI/IEEE C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.
- E. IEEE C62.62 Standard Test Specification for Surge Protective Devices For Low-Voltage AC Power Circuits.
- F. Military Standard 220B.
- G. NFPA 70, NEC Article 285.

1.4 QUALITY ASSURANCE

- A. The manufacturer shall have been in the Surge Protective Device industry for a minimum of 5 years.

1.5 WARRANTY

- A. The manufacturer shall provide a 5 year warranty from the date of shipment of the SPD.

1.6 SUBMITTALS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.

- B. Include all SPD data necessary to show device is in compliance with all product specifications. Include product data sheets which show the device dimensions, weight, connections, and mounting requirements, along with installation instructions.

1.7 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.1 SURGE PROTECTIVE DEVICES

- A. The SPD shall be listed in accordance with UL 1449, Third Edition. The product and ratings shall be included in the database of the UL.com web site.
- B. The surge protective device (SPD) shall be designated a location Type 1 or Type 2 device intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch panel.
- C. The SPD shall be connected in parallel with the facility's electrical system.
- D. The SPD shall be made up of metal oxide varistors (MOV's), or a combination of MOV's with selenium cells or silicon avalanche diodes, ensuring that all of the performance requirements are met. Gas tubes shall not be used.
- E. The entire SPD shall be enclosed in a metal or ABS enclosure, NEMA rated for the location. SPDs at main service equipment shall be mounted outside the switchboard or panelboard (not integral to, or installed within the switchboard or panelboard). SPDs for branch panelboard (2nd tier) locations may be mounted outside of, or integral to, the branch panelboard.
- F. The SPD shall have a maximum continuous operating voltage (MCOV) rating not less than 115% of nominal voltage of the system it is protecting.
- G. Protection Modes:
 - 1. The SPD shall have line to neutral (L-N), line to ground (L-G), line to line (L-L) and neutral to ground (N-G) protection modes for grounded wye configured systems. For a delta configured system, the device shall have line to line (L-L) and line to ground (L-G) protection modes.
- H. Voltage Protection Rating (VPR):
 - 1. The UL 1449 Voltage Protection Rating (VPR) for the device shall not exceed the following:
 - a. 208Y/120 volt applications: 900V L-N,L-G, N-G; 1200V L-L.
 - b. 480Y/277 volt applications: 1200V L-N,L-G, N-G; 2000V L-L.
 - c. 480 volt delta applications: 1800V L-G, 2000V L-L.
- I. Nominal Discharge Current (In):
 - 1. The SPD shall have a UL 1449 Nominal Discharge Current Rating (In) of not less than 20kA.
- J. Short Circuit Current Rating (SCCR):
 - 1. The SPD shall have a UL 1449 Short Circuit Current Rating (SCCR) of not less than 200kA.
- K. Single Impulse Surge Current Rating:
 - 1. The single-pulse (8 X 20 microsecond waveform as specified in ANSI/IEEE Standard C62.41) surge current capacity shall not be less than the following:

- a. 150 kA per mode for service entrance, switchboard, and main distribution panel locations.
 - b. 65 kA per mode for branch panelboard (2nd tier) locations.
- L. Electrical Noise Filtering:
- 1. The SPD shall contain an EMI/RFI noise filter with minimum attenuation of -50dB at 100 kHz, tested per MIL-STD-220B.
- M. Each SPD shall include externally-mounted LED visual status indicators that indicate the on-line status of the unit, for each phase.
- N. Each SPD shall be provided with audible diagnostic monitoring by way of audible alarm with on/off silence function.
- O. Each SPD shall be provided with one set of NO/NC dry contacts for alarm conditions.
- P. Approved Manufacturers:
- 1. Advanced Protection Technologies: www.aptsurge.com.
 - 2. Mersen: www.mersen.com.
 - 3. Current Technologies: www.tnbpowersolutions.com/current_technology.
 - 4. Siemens: www.siemens.com.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install SPD units in accordance with manufacturer's written instructions, applicable requirements of NEC and NEMA standards, and recognized industry practices.
- B. The SPD units shall be installed at the locations shown on the drawings, or as indicated in the one-line diagram. They shall be parallel-connected to, and located adjacent to the switchboard or panelboard being protected. Locate as close as practical to the bus, keeping lead length as short as possible (less than 5 feet preferred). SPDs shall be connected through a multi-pole circuit breaker or fused disconnect switch, not into main lugs. Circuit breaker or fused disconnect switch shall be 60A minimum for main service device, 30A minimum for branch panelboard device or as recommended by the manufacturer (whichever is larger). Use schedule 40 PVC conduit or metallic conduit between the SPD and the switchboard or panelboard as recommended by the manufacturer. Avoid sharp bends, excess length, and splices in the wires. Where possible, use a close-nippled connection with wires going directly to a circuit breaker within the switchboard or panelboard.
- C. Setup and test per the manufacturer's recommendations.

3.2 OWNER TRAINING

- A. All training provided for owner shall comply with the format, general content requirements and submission guidelines specified.

END OF SECTION 26 43 13

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SECTION 26 51 13

INTERIOR LIGHTING FIXTURES, LAMPS, AND BALLASTS

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes interior luminaires and accessories, exit signs, lamps, and ballasts. Included are the following topics:
 - 1. PART 1 - GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Reference Standards.
 - d. Definitions.
 - e. Submittals.
 - f. Operation and Maintenance Data.
 - g. Extra Material.
 - 2. PART 2 - PRODUCTS.
 - a. Interior Luminaires and Accessories.
 - b. Lamps.
 - c. LED Luminaires.
 - 3. PART 3 - EXECUTION.
 - a. Installation.
 - b. Adjusting and Cleaning.
 - c. Interface with Other Products.
 - d. Field Quality Control.
 - e. Luminaire Connections.
 - f. Owner Training.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 27 26 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. RoHS - Restriction of Hazardous Substances. Council of the European Union (EC) Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
- B. LM-79-08 (or latest) - IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
- C. LM-80-08 (or latest) - IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- D. TM-21-11 (or latest) - IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.
- E. NEMA SSL 1-2010 (or latest) - Electronic Drivers for LED Devices, Arrays, or Systems.

1.4 DEFINITIONS

- A. Driver - the power supply used to power LED luminaires, modules, or arrays.

- B. L70, L₇₀, or L_{70%} - The reported life of an LED component or system to reach 70% lumen maintenance, or 70% of the LED's original light output. This test is being developed by the IES and is currently described by TM-21-11.
- C. LED's - Broadly defined as complete luminaire with light emitting diode (LED) packages, modules, light bars or arrays, complete with driver.
- D. LED luminaire failure - Negligible light output from more than 10 percent of the LED's constitutes luminaire failure.

1.5 SUBMITTALS

- A. Refer to Division 1, for submittal procedures.
- B. Include outline drawings, lamp and ballast data, support points, weights, accessory information and performance data for each luminaire type.
- C. For each luminaire type, submit luminaire information including catalog cuts with highlighted catalog numbers and required accessories:
 - 1. Luminaire:
 - a. Manufacturer and catalog number.
 - b. Type (identification) as indicated on the plans and schedule.
 - 2. Ballast:
 - a. Manufacturer and catalog number.
 - b. Type (Programmed Start, etc.), Ballast Factor, THD, etc.
 - c. Quantity per luminaire.
 - 3. Lamps:
 - a. Manufacturer, catalog number, and wattage.
 - b. Quantity per luminaire.

1.6 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.7 EXTRA MATERIAL

- A. Provide three (3) percent of each lamp type, but not less than one (1) of each type.
- B. Provide one (1) of each type of LED module, light bar, or array (if applicable). If the LED's are integrated into the luminaire and are not separate components, then extra LED's are not required.
- C. Provide one (1) ballast of each type. This includes LED drivers.

PART 2 PRODUCTS

2.1 INTERIOR LUMINAIRES AND ACCESSORIES

- A. See the Luminaire Schedule on the drawings for type of luminaires and catalog numbers. Catalog numbers are shown on the drawings for quality and performance requirements only. Luminaires manufactured by others are equally acceptable provided they meet or exceed the performance of the indicated luminaires, and meet the intent of the design.
- B. Luminaire shall be certified by a Nationally Recognized Testing Laboratory (UL, ETL, or IEC).
- C. Provide luminaires with quick-connect disconnecting means, similar to Thomas & Betts Sta-Kon.

2.2 LED LUMINAIRES

- A. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
1. Minimum Light Output.
 2. Zonal Lumen Requirements.
 3. Minimum Luminaire Efficacy.
 4. Minimum CRI.
 5. L70 Lumen Maintenance.
 6. Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.
 7. Additional requirements:
 - a. Color Temperature of 3000K-4100K for interior luminaires as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
 - b. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.
 - c. Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.
 - d. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
 - e. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
 - f. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
 - g. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
 - h. Driver shall have a rated life of 50,000 hours, minimum.
 - i. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
 - j. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
 - k. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
 - l. LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
 - m. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
 - n. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
 - o. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
 - p. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.

- q. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
 - r. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
 - s. All luminaires shall be provided with knockouts for conduit connections.
 - t. The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
 - u. Provide all of the following data on submittals:
 - 1) Delivered lumens.
 - 2) Input watts.
 - 3) Efficacy.
 - 4) Color rendering index.
8. LED Luminaires used for Emergency Egress Lighting:
 - a. The failure of one LED shall not affect the operation of the remaining LEDs.
 9. Emergency LED Luminaire Compatibility with Inverters:
 - a. Emergency Inverters shall be sine-wave type, or have written confirmation from the luminaire manufacturer that the luminaire will function with a square-wave inverter.
 10. Dimming:
 - a. LED driver shall be compatible with dimming controls where dimming is indicated on the plans. Dimmable drivers shall use Dimming Constant Current (DCC) or Pulse Width Modulation (PWM) operation.
 - b. LED luminaires shall dim to (20%, 15%, 10%, 5%, or 0.1%) as specified in the Luminaire Schedule on the plans without visible flicker or "popcorn effect". "Popcorn effect" is defined as the luminaire being on a pre-set dimmed level (less than 100%), and going to 100% prior to returning to the pre-set level when power is returned to the luminaire.

PART 3

PART 3 EXECUTION

3.1 INSTALLATION

- A. Verify ceiling types with Architectural plans or with existing ceilings. Verify specified luminaires are compatible with specified ceiling type(s) prior to ordering luminaires.
- B. Install in accordance with manufacturer's instructions.
- C. Install suspended luminaires using aircraft cable, or pendants supported from swivel hangers. Heavy duty chain supports may be used where indicated on the luminaire schedule. Provide aircraft cable, pendants, or chain lengths required to suspend luminaire at indicated height. All aircraft cables or pendant supported luminaires shall have an independent support to structure at all cable or pendant support locations. When chain is used, tie-wrap the luminaire whip to the chain.
- D. Support luminaires larger than 2 x 4 foot (600 x 1200 mm) size independent of ceiling framing.
- E. Provide independent support for all luminaires over 50 lbs.
- F. Locate ceiling luminaires as indicated on reflected ceiling plan.
- G. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

- H. The Contractor shall install luminaire supports as required. Luminaire installations with luminaires supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to support all luminaires adequately, providing extra steel work for the support of luminaires if required. Any components necessary for mounting luminaires shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.
- I. Install recessed luminaires to permit removal from below.
- J. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- K. Install code required hardware to secure recessed grid-supported luminaires in place.
- L. Install wall mounted luminaires and exit signs at height as scheduled. Use pendants supported from swivel hangers in exposed ceiling/structure locations where necessary to mount exit signs at the specified height.
- M. Install accessories furnished with each luminaire.
- N. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- O. Bond luminaires and metal accessories to branch circuit equipment grounding conductor.
- P. Dimmed luminaire circuits shall have separate neutrals.
- Q. Dimmed LED luminaires shall have a positive OFF, which requires turning off the circuit to the luminaire so that the luminaires don't "glow" at the lowest dimmed setting. This shall be accomplished using a switch, relay, or some other means acceptable to Owner.
- R. All lamps shall be delivered to the job in sealed cartons and protected from dirt and dust during storage on the project. Lamps shall be taken directly from the cartons and installed in the luminaire with special care so that they do not become dusty and are not soiled in the operation.
- S. Lamps installed in luminaires using dimming ballasts shall be burned in at 100% rated output by the contractor for a minimum of 100 hours as recommended by the ballast manufacturer.
- T. All new lamps shall be operational at the Substantial Completion of the project.

3.2 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of Work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Aim and adjust luminaires as indicated on Drawings or as directed by the Engineer.
- C. Touch up luminaire finish at completion of work.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Interface with air handling accessories furnished and installed under Division 23.
- B. Provide controls as indicated on the plans. Refer to section 26 27 26 - Wiring Devices. Controls shall be compatible with the luminaires/ballasts/drivers being installed.

3.4 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.5 LUMINAIRE CONNECTIONS

- A. Provide direct box or conduit connections for surface mounted and recessed luminaires. Use a luminaire fixture whip from a J-box for recessed lay-in luminaires. Luminaire fixture whips shall be aluminum or steel AC Cable (Armored Cable) or Flexible Metal Conduit (FMC). Cable/Conduit whips shall be 3/8" (10 mm) minimum diameter and six foot (1.8 m) maximum length. Flexible whips between master and satellite luminaires may be supported off of the ceiling grid wires. Cable/conduit whip length shall allow movement of the luminaire for maintenance purposes. Flexible metal conduit shall not be used for connections to luminaires where the conduit is exposed in finished spaces.
- B. The flexible connectors shall be steel, galvanized, clamp type with locknut, snap-in type with locknut, or snap-in connector type, including those used on the master-satellite unit.

3.6 OWNER TRAINING

- A. All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified under Division 1.

END OF SECTION 26 51 13

SECTION 26 51 15

LOW VOLTAGE LIGHTING CONTROL

PART 1 GENERAL

1.1 SCOPE

- A. The work under this section includes power supplies, control equipment, enclosures and switches associated with low voltage lighting control. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Submittals.
 - d. Record Documents.
 - e. Operation and Maintenance Data.
 2. PART 2 – PRODUCTS.
 - a. Manufacturers
 - b. Components.
 3. PART 3 – EXECUTION.
 - a. Examination.
 - b. Installation.
 - c. Construction Verification Items.
 - d. Functional Performance Testing.
 - e. Owner Training.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.3 SUBMITTALS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Submit product data indicating system and component construction, ratings, and operating parameters.
- C. Submit manufacturer's installation instructions.

1.4 RECORD DOCUMENTS

- A. Accurately record location of switches, power supplies, and control enclosures. Include description of switching and circuiting arrangements.

1.5 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 00 Closeout Submittals.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Lithonia: www.lithonia.com.

2.2 COMPONENTS

- A. Power Supply: ANSI/NFPA 70; Class 2 energy limited. 120 /24 volt transformer, rated 75 VA momentary, 40 VA continuous, with silicon rectifier rated 20 amperes intermittent, 7.5 amperes continuous, 30 VAC.

- B. Switches: Momentary contact, three position switches, toggle type, Ivory color, rated 20 amperes at 120 VAC.
- C. Key Switches: Match non-key switch.
- D. Switch Plates: Per section 26 27 26.
- E. Master Selector Switch: Capabilities with control of up to thirty-two relay outputs. Switch control shall be microprocessor based with two independent inputs and provide master group control, master switch leg extension and maintained to momentary input conversion.
- F. Remote Control Interface: System shall be able to operate with remote input on an individual local switching basis.
- G. Cabinets and Enclosures: Shop fabricated and wired. Include appropriate barrier strips for mounting relays and separating energy- limited wiring from line voltage wiring. Include knockouts for relay mounting. Include space for percent minimum additional relays and one additional power supply in each cabinet and enclosure.
- H. The entire system shall interface with existing/new building automation system.
 - 1. Existing building lighting control system is the nLight system by Lithonia.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions are as shown on Drawings.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Use 20 AWG copper conductor building wire 'free-air' for low voltage wiring (see section 26 05 23 for requirements). Install relays to be accessible. Allow space for adequate ventilation and circulation of air.

3.3 CONSTRUCTION VERIFICATION ITEMS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under specification in accordance with the procedures defined for construction verification checklists.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. Contractor is responsible for utilizing the functional performance test procedures supplied under specification in accordance with the procedures defined for functional performance test procedures.

3.5 OWNER TRAINING

- A. All training provided for Owner shall comply with the format, general content requirements and submission guidelines specified.

END OF SECTION 26 51 15

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SECTION 27 00 05

COMMUNICATIONS CABLE AND EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

A. This section describes the products and execution requirements relating to furnishing and installation of Telecommunications Cabling and Termination Components and related sub-systems as part of a Structured Cabling System at the remodeled WITC Ashland facility. Inter-building, Vertical (Backbone), and Horizontal (Station) cabling comprised of Copper, Fiber Optic, and Coaxial Cabling are covered under this document. Included are the following topics:

1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Work.
 - c. Regulatory References.
 - d. Design Intent.
 - e. Work Sequence.
 - f. Submittals.
 - g. Quality Assurance.
 - h. Delivery, Storage and Handling.
 - i. Drawings.
2. PART 2 – PRODUCTS.
 - a. Backbone Fiber Optic Cable.
 - b. Indoor Type Fiber Optic Cable.
 - c. Horizontal Media (Station Cables).
 - 1) Horizontal Data and WAP Station Cable (Copper).
 - d. Coaxial Cable (Video-RF).
 - e. Video Distribution Line Amplifier.
 - f. Coaxial Cable Splitters.
 - g. Information Outlet.
 - 1) Data and Voice Jacks.
 - 2) Wall-Mount Voice-Only Outlets.
 - 3) F-Connector (RG-6 Coax).
 - h. Data Patch Panel.
 - i. Fiber Optic Patch Panels.
 - j. Equipment Rack.
 - 1) Jumper Management.
 - k. Equipment Cabinets (Wall Mount).
 - l. Miscellaneous Materials.
 - 1) Fiber Optic Patch Cables.
 - 2) Power Strip/Surge Suppressor.
 - m. Surface Raceway.
 - n. Telecommunications Ground.
3. PART 3 – EXECUTION.
 - a. General.
 - 1) System Topology and Cable Size Requirements.
 - a) Fiber Optic Backbone.
 - b) Fiber Optic Cable Installation.
 - c) Station Cabling.

- d) Station Cabling on Modular Furniture.
- e) Information Outlet.
- f) Wireless Access Point (WAP) Locations
- 2) Innerduct.
- 3) Cable Termination.
 - a) General.
 - b) Cable Termination - Data UTP.
 - c) Cable Termination - Fiber Optic.
 - d) Cable Termination RG-6 Coax.
 - e) Equipment Rack (Free Standing).
 - f) Identification and Labeling.
 - g) Work by Owner.
 - h) Cooperation.
- 4) Testing and Acceptance.
 - a) General.
 - b) Data Station Cabling (Category 6).
 - c) Category 6 Performance Testing.
 - d) Fiber Optic Cable.
 - e) RG-6 – Testing.
- 5) Documentation.
 - a) General.
 - b) Test Data - Copper Media.
 - c) Test Data - Fiber Optic Media.
 - d) Cross Connect Data.
- 6) Warranty.
- 7) Construction Verification Items.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
 - 1. Section 26 05 00 - Common Work Results For Electrical.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 3. Section 26 27 26 - Wiring Devices.
 - 4. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 5. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 6. Section 26 05 53 - Identification for Electrical Systems.

1.3 REGULATORY REFERENCES

- A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, State of Wisconsin Electrical Code and present manufacturing standards.
 - 1. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.
- B. Other applicable standards are as follows:
 - 1. ANSI/IEEE C2 - National Electrical Safety Code.
 - 2. NFPA 70- 2002 - National Electrical Code.
 - 3. DILHR Chapter 16 – Wisconsin Electrical Code.
 - 4. TIA/EIA Standards 526-14A (OFSPT-14A), 526-7 (OFSPT-7), 568B.1 (Category 5e), 568B.2 (Category 6), 568B.3, 569A, 606A, and 607 (with exception).

5. IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 6. ICEA publication S-80-576-2002.
- C. The Horizontal (Station) Cabling System is based on the installation of 4-Pair Unshielded Twisted Pair (UTP) DATA Category 6 and 4-Pair UTP DATA (for Wireless Access Points) Category 6A Copper Cables. The cables shall be installed from the Standard Information Outlet (SIO) in the work area to the Telecommunications Room (TR) or Equipment Room (ER) serving that area and terminated as specified in this document. Station cables shall be installed in conduit, in cable tray and in modular furniture. Outlets shall be mounted flush on a wall-mounted box, on Surface Raceway and in Modular Furniture. Information Outlet locations are to be identified on Project Drawings.
- D. Backbone Copper and Fiber Optic Cables (linking Equipment Rooms and/or Telecommunications Rooms) shall be installed in conduit in building riser pathways, in cable tray and/or free-air in as identified on the Drawings. Backbone Intra-building Fiber Optic Cabling shall be installed via Conduit and/or Cable Tray.
- E. At the Equipment Room Data, Fiber Optic and Coaxial cable terminations shall be mounted on freestanding equipment racks. At each TR termination hardware for all cable types shall be rack mounted.
- F. All cables and related termination, support and grounding hardware, bonding, shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following section[s].
- G. The Contractor shall provide all labor and materials necessary to construct the system as described herein. This includes - but is not limited to - furnishing and installing cable, cable supports, innerduct, racking and termination components, termination, testing, labeling and documentation.

1.4 WORK SEQUENCE

- A. During the construction period, coordinate telecommunications schedule and operations with the Owner.

1.5 SUBMITTALS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Under the provisions of Section 26 05 00 and Division 1, prior to the start of work the Contractor shall submit:
1. Six (6) sets of Manufacturer's Data covering all products proposed indicating construction, materials, ratings and all other parameters identified in Part 2 (Products) below.
 2. Manufacturer's installation instructions and one (1) two-foot section of each cable type to be utilized for final approval by the Engineer. This two-foot section shall have the manufacturer's cable markings visible. Upon request, samples from every reel sent to the site shall be provided.
 3. Submittals should be grouped to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, dimensions should be marked in units to match those specified.
 4. Submittals shall be original catalog sheets, photocopies, or electronic format (ADOBE Portable Document format ".pdf") thereof. Facsimile (fax) sheets shall not be accepted.
 5. Two sets of submittals. The Engineer shall review the Submittals and annotate them indicating approvals and shall return to the Contractor.

6. Work shall not proceed without the Engineer's approval of the submitted items.
 7. If materials are furnished as specified no further qualifications is necessary, except for items requiring shop drawings. However, if the Contractor wishes to substitute another manufacturer and/or catalog number, the following information in triplicate shall be submitted to the Engineer.
 8. A complete description of the material which the Contractor proposes to substitute (shop drawings, illustrations, catalog data, performance characteristics, etc.) and the reason for the substitution identifying any benefit to the Owner.
- C. The Contractor shall receive approval from the Engineer on all substitutions of material. No substituted materials shall be installed except by written approval from the Engineer.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit and record documents under provisions of 26 05 00.
- B. Accurately record exact sizes, locations and quantities of cables.

1.7 QUALITY ASSURANCE

- A. The manufacturer shall be a company specializing in communication cable and/or accessories with a minimum of five years documented experience in producing cable and/or accessories similar to those specified below.
- B. The Contractor shall have been in this line of business for a minimum of five (5) years and completed four (4) jobs of the magnitude specified in the following sections.
- C. The installing Contractor shall have at a minimum one (1) Certified Installer trained to the latest industry standards to ensure the most reliable installation available. The Certified Installer shall have been trained by a company(s) that offer a minimum fifteen (15) year system warranty.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Cable shall be stored according to manufacturer's recommendations as minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 4 degrees C., the cable shall be moved to a heated (10 degrees C. minimum) location.
- B. If the Contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner. If necessary, cable shall be stored off site at the Contractor's expense.

1.9 DRAWINGS

- A. It shall be understood that the electrical and telecommunication details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the Contractor in bidding the job. The Contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.
- B. The Contractor shall verify all dimensions at the site and be responsible for their accuracy. Prior to submitting the bid, the Contractor shall call the attention of the Engineer to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted, within ten (10) days prior to the Bid Due Date.

PART 2 PRODUCTS

18043-6

**WITC New Richmond
Vet Tech**

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2.1 BACKBONE FIBER OPTIC CABLE

A. General:

1. Cables shall incorporate Optical fibers meeting the specifications detailed in the sub-section(s) below. Backbone Fiber Optic Cable sizing (fiber count) shall be per Project Drawings. Fiber cables installed in a Plenum area shall be installed in the appropriate sized conduit.

2.2 INDOOR TYPE FIBER OPTIC CABLE

A. This cable shall be suitable for installation in building riser systems, in conduit, in cable tray or in innerduct.

B. Cable materials shall be all dielectric (no conductive material).

C. Cable shall carry an OFNR rating (Optical Fiber Non-Conductive Riser).

1. Outer Sheath:

a. PVC:

- 1) The outer sheath shall be marked with the manufacture's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.

2. Temperature Range:

- a. Storage: -40° to +70°C (no irreversible change in attenuation).
- b. Operating: -40° to +70°C .

3. Humidity Range: 0 to 100%.

4. Max. Tensile Load (Riser and Tie):

- a. During Installation: 1332 Newton (300 lb. force) (no irreversible change in attenuation).
- b. Long Term: 600 N (135-lb. force).

5. Bending Radius:

- a. During Installation: 20 times cable diameter.
- b. No Load: 10 times cable diameter.

D. Multi-mode Optical Fibers (62.5/125):

1. Multi-mode Optical Fibers in each cable shall meet the following specifications:

- a. Fiber Type Multi-mode; doped silica core surrounded by a concentric glass cladding.
- b. Index Profile Graded Index.
- c. Transmission Windows 850-nm and 1300-nm.
- d. Core Diameter (nom) 62.5- μm (microns) \pm 3.
- e. Cladding Diameter 125- μm \pm 2.
- f. Core-clad Concentricity \leq 3- μm .
- g. Cladding Non-circularity \leq 2.0%.
- h. Fiber Coating Diameter 250- μm \pm 15 (primary coating).
 - 1) All coatings shall be mechanically strippable without damaging the optical fiber.
- i. Attenuation (max. @ 23 \pm 5 °C; Backbone) :
 - a) @ 850-nm 3.5-dB/km.
 - b) @ 1300-nm 1.0 “.

2. Changes to multi-mode fiber performance at extreme operational temperatures (-40 to +70 C) shall not exceed 0.2 dB/km at 1300 nm (per FOTP-3 procedures).

a. Bandwidth (min.):

- 1) @ 850-nm 200-MHz*km.
- 2) @ 1300-nm 500 “.

3. No multi-mode optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that fiber by the Owner.

2.3 HORIZONTAL MEDIA (STATION CABLES)

A. General:

1. The Horizontal (Station) Cable System is based on the installation of Un-shielded Twisted Pair (UTP) DATA Category 6 and DATA (for Wireless Access Points) Category 6A copper cables to install from the work area to the wiring hub locations(s). Refer to the Floor plan Drawings(s) which identify the location of the wiring hubs, Standard Information Outlets (SIO) and Wireless Access Point locations.
2. Data Station Cables shall be constructed of individually twisted pairs with 23-AWG insulated solid copper conductors.
3. All Cables and Termination hardware shall be technically compliant with and installed in accordance with the referenced TIA/EIA documents.
4. All cables shall be suitable for installation in the environment defined and shall meet a CM rating (or approved substitutes as defined by the 2002 NEC).
5. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code and shall meet the specifications of NEMA (low loss), UL 444, and ICEA.
6. Pairs of all 4-pair cables shall be unshielded and shall be identified by a banded color code in which conductor insulation is marked with a dominant color and banded with a contrasting color. By pair number, the pair colors or dominant band are:
 - a. Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White).
 - b. Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White).
 - c. Pair 3: Tip - White/Green; Ring - Green (or Green/White).
 - d. Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White).

B. Horizontal Data and Voice Station Cable (Copper):

1. All horizontal Data Station Cables shall terminate on modular Patch Panels in their respective Telecommunications Rooms (TR) or Equipment Room (ER) as specified on the drawings.
2. All cables, termination components and support hardware shall be furnished, tested, installed and wired by the Contractor.
3. Transmission characteristics of the Data and Voice Station Cables shall meet full Category 6 performance criteria as defined by the referenced TIA/EIA documents. Refer to the Execution Section which details the required performance criteria of the completed Link of which the Cable is a part.
4. Transmission characteristics of the Wireless Access Point Station Cables shall meet full Category 6A performance criteria as defined by the referenced TIA/EIA documents.
5. **IMPORTANT:** Cable and Termination Components (Jack, Patch Panel, Wiring Blocks) are specified to function as a System. The compatibility of the Cable to be installed with the proposed termination components shall be recognized and documented by the Termination Component Manufacturer.
6. The jacket color for Data cables shall be Green.
7. The jacket color for Voice cables shall be Owner can select the color.
8. Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

C. Multi-mode Optical Fibers:

1. Multi-mode Optical Fibers in each cable shall meet the following specifications:
 - a. Fiber Type: Multi-mode; doped silica core surrounded by a concentric glass cladding.
 - b. Index Profile: Graded Index.
 - c. Transmission Windows: 850-nm and 1300-nm.
 - d. Core Diameter (nom) : 62.5- μm (microns) \pm 3.
 - e. Cladding Diameter: 125- μm \pm 2.
 - f. Core-clad Concentricity: \leq 3- μm .
 - g. Cladding Non-circularity: \leq 2.0%.
 - h. Fiber Coating Diameter: 250- μm \pm 15 Primary coating.
900- μm (nominal) Secondary coating (tight buffer).
2. All coatings shall be mechanically strippable without damaging the optical fiber.
 - a. Attenuation (max. @ 23 \pm 5 °C; Station):
 - 1) @ 850-nm 3.5-dB/km.
 - 2) @ 1300-nm 1.5 dB/km.
 - b. Changes to multi-mode fiber performance at extreme operational temperatures (-40° to +70°C) shall not exceed 0.2 dB/km at 1300-nm (in accordance with FOTP-3 procedures).
 - c. Bandwidth (min.):
 - 1) @ 850-nm 200-MHz*km.
 - 2) @ 1300-nm 500-Mhz*km.
 - d. No multi-mode optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that fiber by the Owner.

2.4 COAXIAL CABLE (VIDEO-RF)

- A. This Contractor shall install the coaxial cables including connectors, splitters, and line amplifiers as contracted, and as shown on the Drawings. Refer to Execution Section of this document.
- B. Inside Cable:
 1. The horizontal cable runs shall be RG-6.

2.5 VIDEO DISTRIBUTION LINE AMPLIFIER

- A. This Contractor shall provide all Video Line Amplifiers. All video distribution line amplifiers shall support a video bandwidth of 750 MHz or higher. Line Amplifiers shall be equipped to include "plug-in" equalization variable slope and gain controls, and built-in diplex filters for standard sub-channel two-way operation with active return, which will support two-way interactive services. Maximum full gain shall be 45-50 dB. The Video Line Amplifier shall be a trunk/bridge type with appropriate gain. The amplifier shall be compatible with existing equipment.

2.6 COAXIAL CABLE SPLITTERS

- A. This Contractor shall provide all hard-line coaxial splitters to provide adequate distribution of all horizontal coaxial cable in each IDF and MDF. All splitters shall support a video bandwidth of 1 GHz.
- B. "TV" Coax (RG-6) Cable shall be listed as being suitable for use in environment defined and shall meet a CM rating (or better as defined by the 2002 NEC).
- C. Basic Construction:

1. Center conductor - 18 AWG Copper Covered Steel; 0.040" O.D. (nominal); foamed polyethylene dielectric.
2. Inner shield - aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
3. Second shield - 60% 34 AWG bare aluminum braid wire.
4. Third shield - non-bonded aluminum foil tape.
5. Outer shield -42% 34 AWG bare aluminum braid wire.
6. Outer Jacket - Flame retardant PVC.
7. Impedance 75-Ohms.
8. Capacitance 16.0 pF/ft (nominal).
9. Velocity of propagation 84.0%.

2.7 INFORMATION OUTLET

- A. Station cables shall each be terminated at their designated workstation location in the connector types described in the sub-sections below. Included are modular jacks (Voice & Data) and Coaxial Connector assemblies. These connector assemblies shall snap into a mounting frame and exit flush. The combined assembly is referred to as the Standard Information Outlet (SIO).
- B. SIO mounting configurations shall be as follows: Flush where existing boxes are in place.
 1. Surface mounted on Systems Furniture (base panel) - Systems Furniture Type shall be defined prior to construction. All data/voice jacks shall be flush.
 2. The Telecommunications Outlet Frame shall accommodate:
 - a. A minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a wall-mounted assembly.
 - b. A minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a Floor-mounted assembly.
 - c. A minimum of two (2) Modular Jacks and/or Coaxial Connectors when installed on modular furniture.
 - d. The outlet frame shall incorporate a mechanism for adjusting the surface plate to a plumb position.
 3. Multiple Jacks - identified in close proximity on the drawings (and not separated by a physical barrier) - may be combined in a single assembly. The Contractor shall be responsible for determining the optimum compliant configuration based on the products proposed and documenting these in the as-built records.
 4. The same orientation and positioning of Jacks and Connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Engineer.
 5. Wall Mount Outlet Faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
 6. Where stand-alone "Data" or "Voice" only Jacks are identified, the SIO Frame shall be configured as to allow for the addition of one (1) additional jack (Voice or Data) to be installed to supplement each such jack as defined by this project. The installation of these supplemental Jacks IS NOT part of this project. Any unused jack positions shall be fitted with a removable blank inserted into the opening.
 7. The faceplate of the SIO shall be constructed of High Impact Plastic. Faceplate color shall (1) match the faceplate color used for other utilities in the building or (2) when installed in Surface Raceway (if applicable), match the color of the Raceway.

8. Different frame designs for locations which include fiber optic cabling verses those which terminate only Copper Cabling (UTP and/or Coax) are acceptable. Outlets which incorporate optical fiber shall be compliant with the above requirements plus:
 - a. Be a low-profile assembly.
 - b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
 - c. Position the fiber optic couplings to face downward or at a downward angle to prevent contamination.
 - d. Incorporate a shroud that protects the optical couplings from impact damage.
9. Wall-mounted "Voice Only" outlets shall be installed where identified on the Floor plan Drawings to accommodate wall-mounted telephone sets. The Wall Plate shall be of Stainless Steel construction, accommodate one (1) voice jack as defined below, mount on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.
10. All Standard Information Outlets and the associated Jacks shall be of the same manufacturer throughout the project. An allowable exception, however, is the Wall-mounted "Voice Only" Outlet described above.

C. Data and Voice Jacks:

1. Data and Voice jacks shall be an 8-pin Modular Jack.
2. The interface between the jack and the station cable shall be a 110-Style block or insulation displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
3. Data Jacks shall be pinned to match existing with the pairs as follows:

1) TIA-568A:	Pair 1 - Pins 5 & 4	TIA-568B:	Pair 1 - Pins 5 & 4
TIA-568A:	Pair 2 - Pins 3 & 6	TIA-568B:	Pair 2 - Pins 1 & 2
TIA-568A:	Pair 3 - Pins 1 & 2	TIA-568B:	Pair 3 - Pins 3 & 6
TIA-568A:	Pair 4 - Pins 7 & 8	TIA-568B:	Pair 4 - Pins 7 & 8
4. Transmission characteristics of the Data and Voice Jack shall be as required to meet the TIA/EIA Category 6 performance criteria. Refer to the Execution Section which details the required performance criteria of the completed Link of which the Jacks are a part.
5. The Jack shall be UL verified and listed.
6. Jack contacts shall have a minimum of 50 micro-inches of gold plating.
7. The color of the Data Jack shall be verified with Owner. Where used for another application a color unique from the data and voice jack shall be used. Alternately, a color-coded Bezel or Icon may be used to identify the Data and Voice Jack.

D. Voice Jack:

1. Voice jacks shall be non-keyed 8-pin Modular Jack (8P8C).
2. The interface between the jack and the station cable shall be a 110-Style block or insulation displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
3. Voice Jacks shall be pinned per the USOC standard with the pairs as follows:
 - a. Pair 1 - Pins 5 & 4.
 - b. Pair 2 - Pins 3 & 6.
 - c. Pair 3 - Pins 2 & 7.
 - d. Pair 4 - Pins 1 & 8.

4. Voice Termination hardware shall meet Category 3 performance specifications as defined by the referenced EIA/TIA documents.
 5. The color of the Voice Jack shall be Owner can select the color. Alternately, a color-coded Bezel or Icon may be used to identify the Voice Jack.
- E. Wall-mount Voice-Only Outlets:
1. Wall mounted "voice Only" outlets shall be installed where identified ("W") on the Project Drawing(s) to accommodate wall-mounted telephone sets. The Wall Plate shall be of Stainless Steel construction, accommodate one (1) voice jack as previously defined, mounted on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.
- F. Fiber Optic Connector:
1. The Optical Connector shall be ST-type (bayonet mount).
 2. The connector ferrule shall be ceramic or glass-in-ceramic, metallic, or equivalent. The optical fiber within the connector ferrule shall be secured with an adhesive or mechanical process to prevent positioning and other movement of the fiber strand.
 3. The Connector Body shall be of Metal or a Composite material.
 4. The attenuation per mated pair shall not exceed the following values:
 - a. Multi-mode 0.5-dB (individual); 0.3-dB (average).
 - b. Single Mode (if applicable) 0.5-dB (individual); 0.3-dB (average).
 - c. These values shall hold throughout the Cable System. Connectors shall sustain a minimum of 200 mating cycles per EIA/TIA-455-21 without violating specifications.
 5. The connector shall meet the following performance criteria:

Test Procedure	Max. Attenuation Change
Cable Retention (FOTP-6)	0.2-dB
Mating Durability (FOTP-21)	0.2-dB
Impact (FOTP-2)	0.2-dB
Thermal Shock (FOTP-3)	0.2-dB
Humidity (FOTP-5)	0.2-dB
- G. F-Connector (RG-6 Coax):
1. RG-6 Coax cable shall be terminated at the Workstation and at the Telecommunications Rooms in a Male "F" type connector.
 2. The Male F-Connector shall:
 3. Be matched to the RG-6 cable type proposed by the Contractor.
 4. Be a single piece connector.
 5. Incorporate a ½" crimp ring which uses hex or compression crimp.
 6. When preparing the RG-6 cable for termination, manufacturer installation procedures shall be adhered to. Special care shall be taken to ensure the proper center conductor length as specified by the manufacturer.
 7. The Male F Connectors shall be mated to Female/Female Feed-thru Couplings at both the Outlet and Patch Panel locations. These couplings shall be matched to the Male F connector type. Couplings shall be of sufficient length as to allow for the Male F-Connector to fully seat (both sides).
 8. IMPORTANT: It is the responsibility of the Contractor to ensure that their proposed design considers the available mounting depth in both the existing wall boxes and possible Surface Raceway. This may include the provision of Right Angle Cable Plugs, Feed through Couplings or other means.

2.8 DATA PATCH PANEL

- A. Data cabling shall be terminated at the Main Equipment Room and Telecommunications Rooms on panels incorporating Modular Jacks meeting the specifications for the Telecommunications Outlet detailed in the Section above.
- B. At each Telecommunications Room, the panels shall be rack mounted.
- C. The Data Patch Panel shall consist of a Modular to 110-type connector system. Modular jacks shall meet the specifications detailed above (NON-KEYED 8-pin). On the Wall-mounted panels, this interface shall be on the front of the panel (same size as modular jacks) and be protected by a cover plate when in use.
- D. The largest single patch panel configuration shall not exceed 48 ports. Panels which are modular shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12-jacks. High density patch panel configurations must incorporate horizontal cable management systems sized to accommodate the quantity of patch panel jacks being installed.
- E. The Patch Panel blocks shall have the ability to seat and cut 8 conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Data blocks shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
- F. The Data Patch Panel as a system (including jack, cable interface and intermediate components) must maintain Category 6 performance per the referenced TIA/EIA documents. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.
- G. Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.
- H. The Patch Panel shall have color coded designation strips to identify cable count.
- I. Transmission performance shall be maintained by the Data Patch Panel as a system (including jack, cable interface and intermediate components).

2.9 FIBER OPTIC PATCH PANELS

- A. General:
 - 1. All terminated fibers shall be mated to simplex ST. Couplers shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types.
 - 2. Each fiber cabling segment shall be installed such that odd numbered fibers are Position A at one end and Position B at the other end while the even numbered fibers are Position B at one end and Position A at the other end. See TIA/EIA-568-B.1, section 10.3.2 for further details and diagrams.
 - 3. At each Telecommunications Room, the panels shall be rack or wall.
 - 4. The patch panel enclosure shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings - including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor, and/or those included in "Bid Alternates" (if applicable).
 - 5. Patch panels shall be enclosed assemblies affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable metallic front cover designed to protect the connector couplings and fiber optic jumpers.

6. The patch panels enclosure shall provide for strain relief of incoming cables and shall incorporate radius control mechanisms to limit bending of the fiber to the manufacturer's recommended minimums or 1.2", whichever is larger.
7. Access to the inside of the patch panel enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the cabinet to gain entry will not be accepted.
8. All Patch Panels shall provide protection to both the "facilities" and "user" side of the coupling. The patch panel enclosure shall be configured to require front access only when patching. The incoming cables (e.g. Backbone, Riser, etc.) shall not be accessible from the patching area of the panel. The enclosure shall provide a physical barrier to access of such cables.
9. Where "Loose Buffered" cables are installed, the 250 µm coated fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering -an Aramid reinforced tube for example - with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and sub-assemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µm coated fibers shall not be permitted.
10. Where splicing of the cabling at system end points is a requirement of the installation, the Termination Enclosure shall incorporate a mechanism for securing the Splice Tray(s) and fiber slack. The Splice Tray and fiber slack shall not be accessible from the "user" side of the enclosure.

2.10 COAX PATCH PANEL

- A. All terminated coaxial cables shall be mated to Female/Female "F" Series Couplings mounted on a panel.
- B. The panels shall incorporate a dielectric (e.g. polycarbonate) insert on which the couplings are mounted to provide electrical isolation of connection points.
- C. The panels shall incorporate cable management brackets at the rear of the panel on which to secure the RG-6 cables.

2.11 EQUIPMENT RACK

- A. Free Standing Equipment Rack:
 1. At the Telecommunications Room, Equipment Racks shall be furnished and installed by the Contractor to house Cable Termination components (e.g. Copper Data and Fiber Optic) and Network Electronics (by others). Refer to Part 3 ("Execution") of this Section for quantities required at each location. Where additional Equipment Racks are required or where existing racks are in place and none are required, it shall be so noted on the Floor plan Drawings.
 2. The rack shall conform to the following requirements:
 - a. The rack shall comply with State Building Codes for the seismic area in which it is to be installed.
 - b. Rack shall be 84" in height and shall be self-supporting.
 - c. Channel uprights shall be spaced to accommodate Industry standard 19" mounting.
 - d. Rack must be constructed of aluminum and have either a coating or painted surface.

- e. Rack shall be double-side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per EIA/TIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
- f. Rack should be supplied with a supply of spare screws (minimum of 24).
- g. Base footprint should be no smaller than 15"x20".
- h. Rack should be supplied with a ground bar and #6 AWG Ground lug.

B. Jumper Management:

- 1. Rack shall be equipped with Vertical and Horizontal Jumper Management Hardware in the form of rings and guides, as to allow an orderly routing of twisted pair, optical fiber and coaxial jumpers from the patch panels to the customer provided network equipment. Jumper management hardware shall be as follows:
 - a. Horizontal Jumper Management Panels shall be painted steel (3.5" panel), have a minimum of five (5) Jumper distribution rings (1.75" x 3.75" minimum dimension) and incorporate jumper routing clips (plastic) for individual jumpers.
 - b. At minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of Jacks Data Patch Panels, (b) each grouping of two rows of "F" connectors on Coaxial Patch Panels and (c) above and below each Fiber Optic Patch Panel.
 - c. Vertical jumper management shall provide for cable routing on front and rear of each rack and be 3½" square (minimum). Vertical Jumper Management hardware shall mount on spacers attached to the rack uprights and not on the upright itself. Where multiple racks are to be installed, this hardware shall be mounted between the uprights of adjacent racks. Rack uprights and the spacers shall be secured together per manufacturer recommendations.
 - d. Each rack shall be supplied with a minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties.

C. NOTE: Where Cable Termination Hardware is wall mounted, the Contractor shall be responsible for establishing a cable pathway for jumpers routed from the Equipment Rack(s) to the wall. This shall be in the form of slotted ducts, troughs, "D" rings or other means. Routing of jumpers via the overhead ladder rack system is not acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Engineer prior to installation.

2.12 EQUIPMENT CABINETS (WALL MOUNT)

- A. Refer to the drawings for specific keyed notes for wall mounted rack manufacturer and model number.

2.13 MISCELLANEOUS MATERIALS

- A. Power Strip / Surge Suppressor:
 - 1. At each Telecommunications Room, one (1) Power Strip / Surge Suppressor shall be furnished and installed by the Contractor to provide for powering of the network electronics (by others).
 - 2. Power Strip / Surge Suppressor shall:
 - a. Be rack mountable (19-inch rack).
 - b. Be compliant with UL-1449, UL 1283 and UL-497A.
 - c. Provide Transient suppression to 13,000-A. Protection shall be in all 3 modes (hot-neutral, hot-ground & neutral-ground).
 - d. Shall meet or exceed IEEE 587 Category A & B specification.
 - e. Provide High Frequency Noise Suppression as follows:
 - 1) >20-dB @ 50-kHz.

- 2) >40-dB @ 150-kHz.
- 3) >80-dB @ 1-MHz.
- 4) >30-dB @ 6- to 1000-MHz.
- f. Provide a minimum of 320 Joules of AC Energy Absorption.
- g. Be equipped with a 12-foot power cord.
- h. Provide a minimum of six (6) outlets.

2.14 SURFACE RACEWAY

- A. It is anticipated that Surface raceway will be used in this project.
- B. With the agreement of the Architect/Engineer, if a need arises to add telecommunications outlets in areas where the walls cannot be fished, the station wire serving these outlets shall be covered with raceways. No exposed wire shall be permitted within offices, laboratories, corridors, conference rooms or like facilities.
- C. The non-metallic surface raceway shall have a screw applied base and have a snap on cover. Both the base and cover shall be manufactured of rigid natural PVC compounds.
- D. The raceway shall originate from a surface mounted box located fourteen inches (14") off the floor and be attached to the wall and terminate above the ceiling. Raceway for a wall-mounted location shall originate from a surface mounted box located 48" off the floor.
- E. The color of this raceway shall be electrical ivory or match the décor. All fittings including, but not limited to, extension boxes, elbows, tees, fixture boxes shall match the color of the raceway.
- F. The raceway and all system devices must be UL Listed, exhibit nonflammable self-extinguishing characteristics, tested to specifications of UL94V-0 and be Category Compliant as defined by TIA/EIA 568B.
- G. Refer to Section 26 05 33 "Raceway and Boxes for Electrical Systems" for metallic and/or non-metallic Raceway guidelines for this Project. Minimum bend radius shall be adhered to for UTP and fiber optic cable.

2.15 TELECOMMUNICATIONS GROUND

- A. At each Telecommunications Room, a "Telecommunications Grounding Busbar (TGB)" shall be installed by the Telecommunication Electrical Contractor. Refer to Section 26 05 26 "Grounding and Bonding for Electrical Systems".
- B. The telecommunication ground cable is to be an isolated grounding system pursuant to TIA/EIA 607 with the exception that the ground cable is not to be tied to building steel except at the electrical service entrance.

PART 3 EXECUTION

3.1 GENERAL

- A. Optical Fiber and Copper Pair counts of the cables to be supplied are detailed on the Project Drawings. Contractor shall furnish and install all cables, connectors and equipment as shown on drawings and as specified above. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.
- B. Refer to Project Drawings which indicate the cable routes to follow and the termination location(s) within each building. Duct allocation shall be coordinated as part of the construction.

- C. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified. This includes any modifications required to route and conceal horizontal distribution wiring.
- D. Beginning installation means Contractor accepts existing conditions.
- E. Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices, which may move or wear in a manner to pose a hazard to the cable, shall not be used.
- F. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to ensure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a "break-away" or other approved method.
- G. The Contractor will be responsible for identifying and reporting to the Site Coordinator(s) any existing damage to walls, flooring, tiles and furnishings in the work area prior to start of work. All damage to interior spaces caused by the installation of cable, raceway or other hardware must be repaired by the Contractor. Repairs must match preexisting color and finish of walls, floors and ceilings. Any Contractor-damaged ceiling tiles are to be replaced by the Contractor to match color, size, style and texture.
- H. Where unacceptable conditions are found, the Contractor shall bring this to the attention of the construction supervisor immediately. A written resolution will follow to determine the appropriate action to be taken.
- I. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.
- J. Cable pulling shall be done in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed. If any installed cable is kinked to a radius less than recommended dimension it shall be replaced by the Contractor with no additional cost to the project.
- K. All wiring shall be run "free-air", in conduit, in a secured metal raceway or in modular furniture as designated on the floor plan(s). All cable shall be free of tension at both ends.
- L. Avoid abrasion and other damage to cables during installation.
- M. Pulling Lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.
- N. The Cable system will be tested and documented upon completion of the installation as defined in the Section below.
- O. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

- P. Should it be found by the Engineer, that the materials or any portion thereof, furnished and installed under this contract, fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

3.2 SYSTEM TOPOLOGY AND CABLE SIZE REQUIREMENTS

A. Fiber Optic Backbone:

1. Fiber Optic Backbone cabling shall be sized based on the following minimum fiber counts. Cabling is to be terminated on Patch Panels.
 - a. Eqpt. Room 1207A - ER 1202A 06-fibers (multi-mode).

B. Fiber Optic Cable Installation:

1. Cable slack shall be provided in each Backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure. Slack required in the various subsystems is as follows:
 - a. Backbone Intra-Building: A minimum of 5-meters (approx. 15-feet) of slack cable (each cable if applicable) shall be coiled and secured at one (1) end - preferably at the Entrance Room and/or Main Equipment Room. Cable slack installed other than at each end of cable run shall not be allowed.
 - b. Exact cable termination locations shall be field verified with Owner.
 - c. Backbone Fiber Optic Cable shall] be installed in protective innerduct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g. between conduit & cable tray or into equipment racks). The innerduct should extend into the termination and/or storage enclosure(s) at system endpoints.

C. Station Cabling:

1. Information Outlets cables with copper media (Voice & Data UTP and "TV" coax) shall be located as detailed on the Project Drawings.
2. The Bidder in determining materials quantities and routing should utilize these documents.
3. Station Cabling on each Floor shall be routed to the Telecommunications Room (TR) on that floor or to the designated TR if on another floor.
4. Station cables shall be run to the Information Outlet from the Telecommunications Room serving each area in conduit, free-air above drop ceiling, in cable tray and/or in modular furniture.
5. The maximum station cable drop length for Data and Voice UTP (Category 5e or Category 6) shall not exceed 295-feet (90-meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing station cabling in a fashion as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Engineer prior to installation. Changes to the plan shall be approved by the Engineer. All cables shall be installed splice-free unless otherwise specified.

6. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.
7. Avoid abrasion and other damage to cables during installation.
8. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellom grips may be used to spread the strain over a longer length of cable.
9. Where installed free-air, installation shall consider the following:
 - a. Cable shall run at right angles and be kept clear of other trades work.
 - b. Cables shall be supported according to code utilizing "J-" or "Bridal-type" mounting rings anchored to ceiling concrete, piping supports or structural steel beams. Rings shall be designed to maintain cables bend to larger than the minimum bend radius (typically 4 x cable diameter).
 - c. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If cable "sag" at mid-span exceeds 6-inches, another support shall be used.
 - d. Cable shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
 - e. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.
10. Manufacturer's minimum bend radius specifications shall be observed in all instances.
11. Care should be taken in the use of cable ties to secure and anchor the station cabling. Ties should not be over tightened as to compress the cable jacket. No sharp burrs should remain where excess length of the cable tie has been cut.
12. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
13. A coil of 4 feet in each cable shall be placed in the ceiling at the last support (e.g. J-Hook, Bridal Ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each station cable under 250-feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
14. At all Telecommunication Rooms (TR), approximately 10-feet of slack shall be left in each station cable under 250-feet in length to allow for changes in the telecommunication room layout without re-cabling. These "service loops" shall be secured to the ladder rack, with "J" hooks, or "D" rings above the equipment, racks, and patch panels and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
15. To reduce or eliminate EMI, the following minimum separation distances from $\leq 480V$ Power lines shall be adhered to:
 - a. Twelve (12) inches from power lines of $< 5\text{-kVa}$.
 - b. Eighteen (18) inches from high voltage lighting (including fluorescent).
 - c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
 - d. Thirty-nine (39) inches from transformers and motors.
16. All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.

17. IMPORTANT: Within the room in which Data Cabling is to be terminated, Hook and Loop(e.g. "Velcro") ties only shall be used from room entry to the point of termination. This is to facilitate the addition of future cables.

D. Station Cabling on Modular Furniture:

1. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via existing conduit.
2. Where modular furniture is installed without wall contact, the Contractor shall install a power pole "poke-thru" and route the station cabling via the floor below (but terminate at the TR on the floor on which the jack appears)]. The selection of the "poke-thru" shall consider fill ratios, bend limits on the Category 5e/6 UTP and the eventual feed into the furniture partition.
3. Cabling shall be protected in the transition from the "Poke-thru" or Wall Fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the "Poke-thru" and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill Ratio (Cable Area vs. Conduit Area) in each feed shall not exceed 40%.
4. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.
5. For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and re-install the bottom molding panels on the modular furniture as required to accommodate the Communications cabling and SIOs. The panels shall be marked prior to installation by the Owner to identify the desired location of the SIOs. Any discrepancy between the Project Drawing identifying Outlet locations and the markings should be brought to the attention of the Site Coordinator(s).
6. The SIO shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the SIO to the panel shall not result in sharp protrusions (e.g. sheet metal screw tip) into the channel behind the panel.

E. Information Outlet:

1. General:
 - a. Information Outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on Surface Raceway and on modular furniture.
 - b. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Engineer. Nominal height (from finished floor to center line of Outlet) in new installation shall be as follows:
 - 1) Standard Voice & Data Outlet 18-inches.
 - 2) Wall-Mounted Telephone Outlet (Standard Voice only) 54-inches.
 - 3) Wall-mounted Telephone Outlets for Wheelchair Persons:
 - a) Approach head on per ADA regulations.
 - b) Approach parallel per ADA regulations.

F. Wireless Access Point (WAP) Locations:

1. General:
 - a. Unless noted otherwise on drawings, mount information outlet intended for use with a Wireless Access Point (WAP) as follows:
 - 1) Drop Ceilings – Cut ceiling tiles and deliver cabling into 2-gang outlet box mounted on a grid box hanger (a.k.a. "tile bridge")

- 2) Exposed Ceilings (surface mount) – cabling piped out of tray to a 2-gang outlet box.
 - 3) Drywall – deliver cable into flush mounted 2-gang outlet box.
 - b. Reduce opening to 1-gang using “mud ring”.
 - c. Provide cable slack at each location to allow for re-location of the SIO. Unless noted otherwise on the project drawings, slack length (each cable) shall be 20-feet.
2. WAP locations shown on drawings are approximate. Coordinate final locations with Owner.

3.3 INNERDUCT

- A. Innerduct shall be riser or plenum rated as required by the installation environment. At minimum, innerduct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, innerduct segments should be spliced using couplings designed for that purpose.
- B. All exposed innerduct is to be labeled at 35-foot (minimum) intervals with tags indicating Ownership, the cable type (e.g. "Fiber Optic Cable") and the cables it contains.
- C. Where required by the project design, fiber optic cable shall be installed in protective innerduct.
- D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation ensure that the mechanical limitations - including Minimum Bend Radius - of the cable are considered.
- E. The innerduct should extend into the termination enclosure at system endpoints.
- F. Where not installed in a continuous length, innerduct segments should be spliced using couplings designed for that purpose.

3.4 CABLE TERMINATION

- A. General:
 1. At the Telecommunications Rooms, all Data and Voice Cables shall be positioned on termination hardware in sequence of the Outlet I.D. starting with the lowest number. Exceptions to the sequencing of terminations is allowed only with the permission of the Owner and Architect/Engineer.
 2. Termination Hardware (Blocks and Patch Panels) Positioning and Layout must be reviewed and approved by the Engineer prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.
- B. Cable Termination - Data UTP:
 1. Data Patch Panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.
 2. Data Patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.
 3. At Information Outlets and Data Patch Panels, the installer shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for Data cables. The cable jacket shall be removed only to the extent required to make the termination.
- C. Cable Termination - Fiber Optic:
 1. ALL fibers shall be terminated using the specified connector type.

2. Fibers shall be positioned consecutively and mapped "position for position" between patch panels. There shall be no transpositions in the cabling.
 3. Connectors from two cables shall never share a common coupling panel. Multi-mode and single mode optical fibers (where applicable) shall be segregated on the panels as to clearly identify the distinction between the fiber types.
 4. All terminated fibers at the Telecommunications Rooms shall be mated to couplings mounted on patch panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.
 5. All couplings shall be fitted with a dust cap.
 6. Fibers from multiple locations may share a common enclosure, however, they must be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure provided that they are clearly identified as such. Fibers from different locations shall not share a common connector panel (e.g. "insert").
 7. Slack in each fiber shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1-meter (~39") of slack shall be retained regardless of panel position relative to the potential work area.
 8. Where "Loose Buffered" cables are installed, the 250um coated fibers contained in these cables may be terminated either by 1) splicing of factory terminated cable assemblies ("pigtailed") or 2) the use of a "fan-out" kit. In the latter approach, individual fiber are to be secured in a protective covering, an Aramid (e.g. Kelvar) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and sub assemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers and 0.1 dB for single mode fibers (if applicable). Direct termination of 250 um coated fibers shall not be permitted.
- D. Cable Termination RG-6 Coax:
1. Panels shall be sized to accommodate an additional 20% growth in the number of cables terminated at any given location.
 2. All cables shall be terminated in the specified connector type and mated to female feed-through couplers mounted on the panels. Coaxial cables shall be dressed neatly at the rear of the panel and secured to cable management brackets per manufacturer guidelines.
- E. Equipment Rack (Free Standing):
1. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. Rack shall also be stabilized by extending a brace extending to the wall. Alternately, overhead cable tray over which the cabling accesses the equipment rack(s) shall provide this function.
 2. A space between the rack upright and the wall (~4") should be planned to allow for cabling in that area. The rear of the rack should be ~40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Engineer for resolution prior to installation.

3. All hardware and equipment is to be mounted between 18" and 79" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Engineer and Site Coordinator(s) prior to installation.
 4. Equipment Rack shall be equipped with cable management hardware on both the front and back of rack as to allow an orderly and secure routing of twisted pair cabling to the data patch panels. At minimum, one such Horizontal Jumper Management Panel shall be placed below each Fiber Optic Patch Panel installed by the Contractor. Additional Jumper Management panels may be required pending installation of other cable types on the rack. Refer to other sections (in particular "Communications Cable & Equipment") for guidance.
 5. The rack(s) shall be grounded to the Telecommunications Ground Busbar (TGB) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket or GREEN jacket with one or more yellow stripes). (See NEC 2002, section 250.119.)
- F. Identification and Labeling:
1. Refer to Section 26 05 53 "Identification for Electrical Systems" for Identification and Labeling guidelines for this Project.
 2. All Copper Backbone and Station Cables, Outlet Faceplates and Termination components (e.g. Voice Field & Data Patch Panel) shall be clearly labeled.
 3. Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used.
- G. Work by Owner:
1. NONE.
- H. Cooperation:
1. The Contractor shall cooperate with other trades and Owner personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check the location of electrical outlets with respect to other installations before installing.

3.5 TESTING AND ACCEPTANCE

- A. General:
1. The Contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g. backbone, station, etc.) as it is completed.
 2. All tests shall be documented.
 3. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type including equipment to use used, set-up, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Engineer.
 4. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Engineer with a written certification that this inspection has been made

5. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week advance notice to the Engineer as to allow for such participation. The notification shall include a written description of the proposed conduct of the tests including copies of blank test result sheets to be used.
 6. IMPORTANT: Failure to provide the above information shall be grounds for the Owner/Engineer to reject any and all Documentation of Results on related testing and to require a repeat of the affected test.
 7. Tests related to connected equipment of others shall only be done with the permission and presence of Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.
 8. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Engineer, the Contractor shall provide copies of the original test results.
 9. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
 10. Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
- B. Data Station Cabling Category 6:
1. Testing shall be from the Jack at the SIO to the Data Patch Panel at the TR on which the cables are terminated. When the SIO is located on/in the wall behind modular furniture, a patch cord may be inserted into the SIO to allow the furniture to be returned to its normal location. Cat 5e and Cat 6 cable testing, in this case, will be done with the patch cord. The cabling must pass all Cat 5e or Cat 6 TIA requirements. If the cable test fails only due to the length of the patch cord, the Owner will accept the cable as passing.
 2. Horizontal "Station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on the Modular Jack). Any defective, split or mis-positioned pairs must be identified and corrected.
 3. Testing of the Cabling Systems rated at TIA Category 6 shall be performed to confirm proper functioning and performance.
- C. Category 6 Performance Testing:
1. "In addition to the above, Performance Testing shall be performed on all cables. Testing of the Transmission Performance of station cables Category 6 shall include the following:
 - a. Length.
 - b. Attenuation.
 - c. Pair to Pair NEXT Loss (new limits).
 - d. PSNEXT Loss.
 - e. Pair to Pair ELFEXT Loss (Equal Level Far End Cross-talk).
 - f. PSEFEXT Loss.

- g. Propagation Delay.
 - h. Delay Skew.
 - i. Return Loss.
2. Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify "PASS" on each cable and display the specified parameters - comparing test values with standards based "templates" integral to the unit.
 3. Category 5e testing shall be per ANSI/TIA/EIA 568B.1 Permanent Link test configurations and ANSI/TIA/EIA 568B.1 Category 5e.
 4. Category 6 testing shall be per ANSI/TIA/EIA 568B.2 Permanent Link test configurations and ANSI/TIA/EIA 568B.2 Category 6.
 5. The maximum length of station cable shall not exceed 90 meters which allows 10 meters for equipment and patch cables. Worst case performance at 20°C, based on a Horizontal Cable length of 90 meters and Equipment Cord length of 4 meters, shall be as follows:
 6. Category 6 Test Parameters:

**Category 6 Cable
Permanent Link Test**

Frequency Mhz	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1
	Insertion Loss Attenuation Max. dB	NEXT Worst Pair to Pair dB	PSNEXT Worst Case Loss dB	ELFEXT Worst Pair to Pair Loss DB	PSELFEXT Loss dB	Return Loss dB
1.00	1.9	65.0	62.0	64.2	61.2	19.1
4.00	3.5	64.1	61.8	52.1	49.1	21.0
8.00	5.0	59.4	57.0	46.1	43.1	21.0
10.00	5.5	57.8	55.5	44.2	41.2	21.0
16.00	7.0	54.6	52.2	40.1	37.1	20.0
20.00	7.9	53.1	50.7	38.2	35.2	19.5
25.00	8.9	51.5	49.1	36.2	33.2	19.0
31.25	10.0	50.0	47.5	34.3	31.3	18.5
62.50	14.4	45.1	42.7	28.3	25.3	16.0
100.00	18.6	41.8	39.3	24.2	21.2	14.0
200.00	27.4	36.9	34.3	18.2	15.2	11.0
250.00	31.1	35.3	32.7	16.2	13.2	10.0

D. Propagation Delay:

1. The maximum propagation delay determined in accordance with the ANSI/TIA/EIA–568B.2 for a Permanent Link configuration shall be less than 498-ns measured at 10MHz. (Note: In determining the permanent link propagation delay, the propagation delay contribution of connecting hardware is assumed to not exceed 2.5 ns from 1 MHz to 100MHz).

E. Delay Skew:

1. For all frequencies from 1 MHz to 250 MHz, Category 6 cable propagation delay skew shall not exceed 44ns/100m at 20 degrees C, 40 degrees C, and 60 degrees C. In addition, the propagation delay skew between all pairs shall not vary more than +/- 10ns from the measured value at 20 degrees C when measured at 40 degrees C and 60 degrees C. Compliance shall be determined using a minimum 100m of cable.
 2. In order to establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an 8-position Category 6 Modular plug (8-pin) to facilitate testing. Net Propagation Velocity (NPV) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NPV data is available from the cable manufacturer for the exact cable type under test.
 3. In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacement and changes as are necessary, and shall then repeat the test or tests which disclosed faulty or defective material, equipment or installation method, and shall make additional tests as the Engineer deems necessary at no additional expense to the project or Owner.
- F. Fiber Optic Cable:
1. General:
 2. The fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, the Contractor shall provide cable manufacturer's test report for each reel of cable provided. These test reports shall include (1) manufacturer's on the reel attenuation test results at the specified wavelengths for each optical fiber of each reel prior to shipment from the manufacturer and (2) on-the-reel Bandwidth performance as tested at the factory.
- G. Tests Prior to Installation:
1. The Contractor, at their discretion and at no additional cost to the Owner, may perform tests deemed necessary by the Contractor to ensure integrity of any Owner furnished optical fiber. Tests may range from a simple "flashlight test" to an OTDR of each optical fiber of each cable reel prior to installation. Upon request, the Contractor shall supply this test data to the Engineer prior to installation.
- H. Tests After Installation:
1. Upon completion of cable installation and termination, the Fiber Optic cabling shall be tested to include:
 - a. Optical Attenuation ("Insertion Loss" Method).
 - b. Verification of Link Integrity (OTDR).
- I. Optical Attenuation Testing:
1. Optical Attenuation shall be measured on all terminated optical fibers in both directions of transmission using the "Insertion Loss" method. Measurement shall be inclusive of the optical connectors and couplings installed at the system endpoints. 100 foot access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made.
 2. Multi-mode fibers shall be tested in accordance with the EIA/TIA 526-14A, Method B at 850±30 nm. Single mode fibers (if applicable) shall be tested in accordance with the EIA/TIA 526-7-1998. Method A.1. Testing shall be at 1300±20 nm.
 3. Attenuation of optical fibers shall not exceed the values calculated at follows:
 - a. Attenuation (max.) = 2*C+L*F+S dB.

- b. Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers) and F is the maximum allowable fiber loss (in dB/km). S is the total splice loss (# of splices * max. attenuation per splice).

J. OTDR Testing:

1. All fibers even those that are left unterminated (if applicable) shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multi-mode fibers shall be tested at 850-nm (nominal). Single mode fibers (if applicable) shall be tested at 1300nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used.
2. OTDR traces revealing a point discontinuity greater than 0.2-dB in a multi-mode fiber, or 0.1-dB in a single mode fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that fiber by the Owner. The installation of that cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that cable and the associated terminations shall be replaced at the expense of the Contractor.

K. RG-6 – Testing: (This paragraph may be edited to fit current technology)

1. A Time Domain Reflectometer (TDR) shall be used to verify cable length and to test for cable faults and breaks. A step-function high resolution Time Domain Reflectometer shall be employed for this test, such as the TEKTRONIX 1502C or the HEWLETT-PACKARD 1415A. The results shall be automatically plotted on an X-Y plotter with a Y axis voltage reflection coefficient resolution of .001 per division. The X axis will resolve down to 1" of cable. The TDR will sweep the cable at a rate no greater than 50' per second, or such lower rate as necessary to resolve cable faults to the 1" and .001 VRC level.
2. The cables shall be terminated with its characteristic impedance, and in the case of 70-75 ohm cable, an appropriate matching pad shall be used to match the analyzer to the cable. Cable shall be rejected if any single fault is observed of amplitude greater than .003 voltage reflection coefficient. Characteristic impedance shall also be measured at 5% of nominal value.
3. Cyclic faults (such as cable reel stress and tie drawdown) shall be limited to a voltage reflection coefficient of .005.

3.6 DOCUMENTATION

A. General:

1. Upon completion of the installation, the Contractor shall provide three (3) full Documentation Sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.
2. The Engineer may request that a 10% random field re-test be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

B. Test Data - Copper Media:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. Printouts generated for each cable by the wire test instrument (e.g. *PentaScanner*) shall be submitted as part of the documentation package. Alternately the Contractor may furnish this information in electronic form on CD-ROM (preferred) or (3.5" diskette).
- C. Test Data - Fiber Optic Media:
1. Test results shall include a record of test wavelengths, cable type, fiber (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
 2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer for review. Trace files shall be so named as to identify each individual fiber by location in the cable system and fiber number or color.
 3. IMPORTANT: Where paper copy documentation of OTDR traces is provided, the vertical and horizontal scales shall be set as to maximize the detail in each backscatter trace. The portion of the trace which depicts the fiber under test shall extend a minimum of 50% of the display area.
 4. Cross-Connect Data:
 5. As noted above, it shall be the responsibility of the Contractor to work with the Owner and Site Coordinator(s) and provide the necessary assistance to allow Owner and/or Telephone Company personnel to make the necessary connections to establish telephone service on the new cable system. These activities include but are not limited to (1) a general wiring overview and (2) detailed cross connect documentation (relating SIO I.D., Room Number and Riser pair). The latter shall be in the form of an electronic format database (dBase, MS Excel or convertible format).

3.7 AS-BUILT CONSTRUCTION DRAWINGS

- A. Drawings included with the specifications set shall be modified by the Contractor to denote as-built information.
- B. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.
- C. The Contractors shall annotate the base drawings and return to the Architect/Engineer in hard copy (same plot size as originals) and electronic (AutoCAD rel. 2006) form.
- D. Each drawing submitted by the Contractor as part of the Project Documentation shall be identified as an "As-built" drawing and include the following (1) The Contractor name and/or logo (2) The date of the drawing.

3.8 WARRANTY

- A. This Contractor shall guarantee all materials, equipment, etc., two (2) years from date of substantial completion of this work. In the case of data cabling the Contractor shall furnish complete Category 6 system warranty consisting of no less than fifteen (15) years. This guarantee shall include all labor, material and travel time. In the case of multi-mode fiber cabling the Contractor shall furnish a complete system warranty consisting of no less than fifteen (15) years. See section 01 78 00 Closeout Submittals for further requirements.

3.9 CONSTRUCTION VERIFICATION ITEMS

- A. Contractor is responsible for utilizing the construction verification checklists supplied under Division 1 in accordance with the procedures defined for construction verification checklists.

END OF SECTION 27 00 05

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SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SCOPE

- A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations associated with the installation of the new Fire Alarm System as shown on the drawings and as herein specified. Included are the following topics:
1. PART 1 – GENERAL.
 - a. Scope.
 - b. Related Requirements.
 - c. Reference Standards.
 - d. Submittals.
 - e. Quality Assurance.
 - f. Warranty.
 2. PART 2 – PRODUCTS.
 - a. Existing Components.
 - b. Components.
 3. PART 3 – EXECUTION.
 - a. Installation.
 - b. Inspection and Testing for Completion.
 - c. Owner Personnel Instruction.
 - d. Closeout.
 - e. Maintenance.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping: Materials and methods for work to be performed by this installer.
- B. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.

1.3 REFERENCE STANDARDS

- A. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits; 2002 (R2008).
- B. NFPA 70 - National Electrical Code; 2008.
- C. NFPA 72 - National Fire Alarm Code and Signaling Code; 2010.
- D. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; 2009.
- E. NFPA 601 - Standard for Security Services in Fire Loss Prevention; 2005.

1.4 SUBMITTALS

- A. Refer to Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Proposal Documents: Submit the following with cost/time proposal:
1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.

3. Certification by Contractor that the system design will comply with the contract documents.
 4. Proposed maintenance contract.
- C. Drawings must be prepared using most recent version of AutoCAD.
1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.
- D. Evidence of designer qualifications.
- E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
1. Copy (if any) of list of data required by authority having jurisdiction.
 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 4. System zone boundaries and interfaces to fire safety systems.
 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 10. Detailed drawing of graphic annunciator(s).
 11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 12. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
 13. Certification by Contractor that the system design complies with the contract documents.
 14. Do not show existing components to be removed.
- F. Submit all required documents to the appropriate agencies for plan approval/permitting along with fees.
- G. Evidence of installer qualifications.
- H. Evidence of instructor qualifications; training lesson plan outline.
- I. Evidence of maintenance contractor qualifications, if different from installer.
- J. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.

- K. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.
 2. Complete set of specified design documents, as approved by authority having jurisdiction.
 3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 4. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 5. List of recommended spare parts, tools, and instruments for testing.
 6. Replacement parts list with current prices, and source of supply.
 7. Detailed troubleshooting guide and large scale input/output matrix.
 8. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 9. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- L. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- M. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Certificate of Occupancy.
 4. Maintenance contract.
 5. Report on training results.
- N. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 3. In addition to the items in quantities indicated in PART 2, furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory.

1.5 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 - 4. Contract maintenance office located within 50 miles of project site.
 - 5. Certified in the State in which the Project is located as fire alarm installer.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- E. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 EXISTING COMPONENTS

- A. Clearly label components that are "Not In Service."
- B. Remove unused existing components and materials from site and dispose of properly.
- C. HVAC:
 - 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

2.2 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.

2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed by Underwriters Laboratories as suitable for the purpose intended.
- C. Initiating Devices:
1. Manual Pull Stations: Match existing.
 - a. Provide 1 extra.
 2. Smoke Detectors: Match existing.
 - a. Provide 1 extra.
 3. Duct Smoke Detectors: Match existing.
 - a. Provide 1 extra.
 4. Addressable Interface Devices: Match existing.
 - a. Provide 1 extra.
- D. Notification Appliances:
1. Speakers: Match existing.
 - a. Provide 1 extra.
 2. Strobes: Match existing.
 - a. Provide 1 extra.
- E. Circuit Conductors: Copper; provide 200 feet extra; color code and label.
- F. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- G. Locks and Keys: Deliver keys to Owner.
1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type.
 2. Provide a different standard lock and key for each key operated alarm initiating device; provide 25 keys of each type.
- H. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 2. Provide one for each control unit where operations are to be performed.
 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 4. Provide extra copy with operation and maintenance data submittal.
- I. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
1. Padlock eye and hasp for lock furnished by Owner.
 2. Locate as directed by Owner.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Owner will provide the services of an independent fire alarm engineer or technician to observe all tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- D. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- E. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- F. Provide all tools, software, and supplies required to accomplish inspection and testing.
- G. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- H. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- I. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.3 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
 - 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
 - 3. Factory Instruction: At control unit manufacturer's training facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Refresher Training: 1 session post-occupancy.

- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Refresher Training: 1 session post-occupancy.
- D. Detailed Operation: Two-hour sessions for engineering staff; assume NICET level I qualifications or equivalent; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
 - 2. Refresher Training: 1 session post-occupancy.
- E. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
 - 1. Initial Training: One 3-day session, pre-closeout.
 - 2. Refresher Training: One 1-day session post-occupancy.
- F. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- G. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Occupancy of the project will not occur prior to Substantial Completion.
- C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.
 - 4. All aspects of operation have been demonstrated to Owner.
 - 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 - 6. Occupancy permit has been granted.
 - 7. Specified pre-closeout instruction is complete.
- D. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.5 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

- C. Provide to Owner, a proposal as an alternate to the base bid, for a maintenance contract for entire warranty period, to include the work described below; include the total cost of contract, proposal to be valid at least until 30 days after date of Substantial Completion.
- D. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 - 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 - 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- E. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 2 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- F. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- G. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- H. Comply with Owner's requirements for access to facility and security.

END OF SECTION 28 31 00



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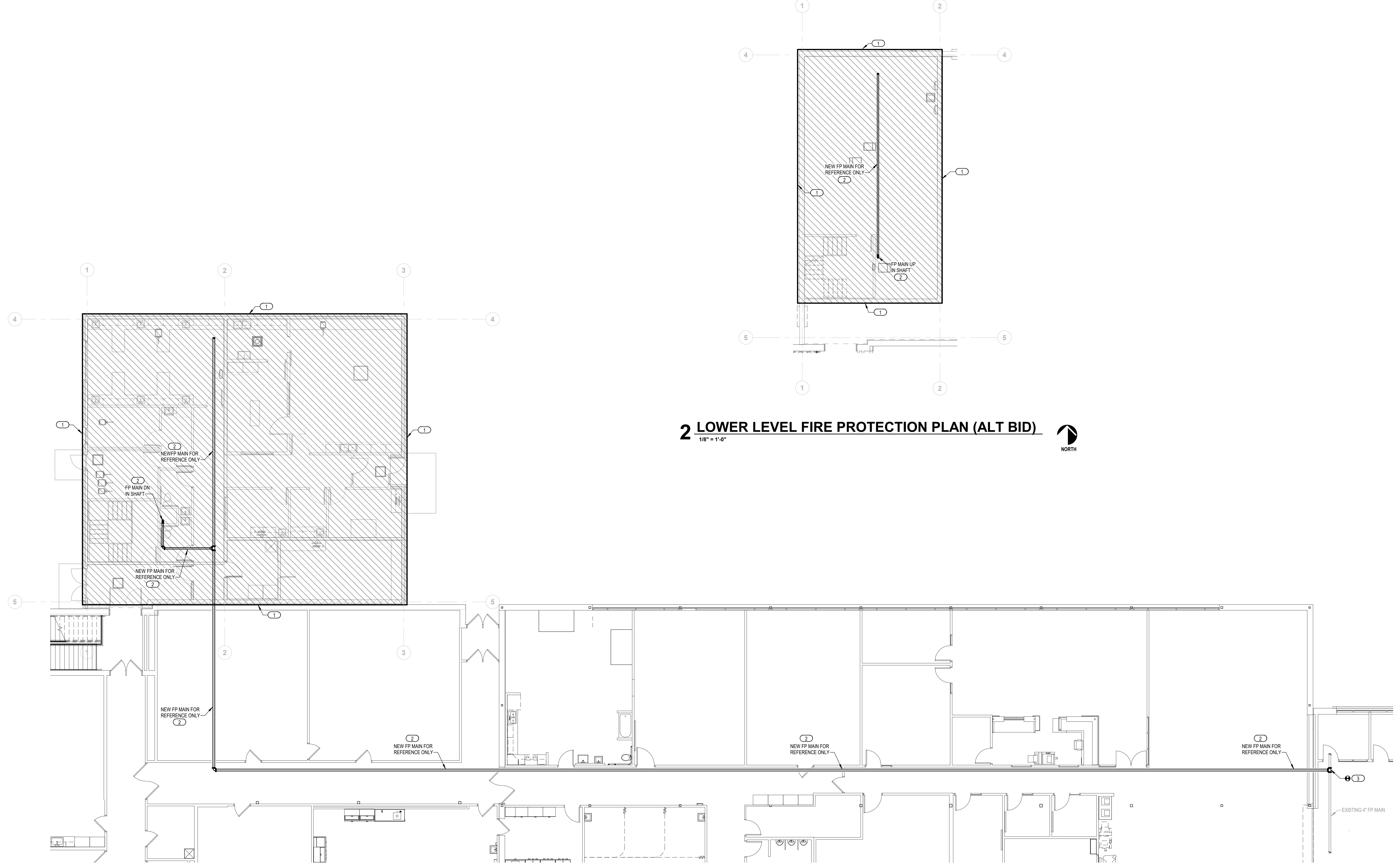


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MEP PROJECT NO.: H08.19.02

KEYED NOTES	
1	PROVIDE FIRE PROTECTION SYSTEM PER NFPA #13 FOR LOWER LEVEL AND FIRST FLOOR OF NEW ADDITION AS DEDUCT ALTERNATE BID.
2	FIRE PROTECTION MAINS AS SHOWN ARE FOR REFERENCE AND BID PURPOSES ONLY. FIRE PROTECTION CONTRACTOR SHALL PROVIDE COMPLETE DESIGN AND CALCULATIONS FOR NEW ADDITION FIRE PROTECTION SYSTEM. SPRINKLE COMBUSTIBLE CONCEALED SPACES THROUGHOUT ADDITION.
3	CONNECT NEW FIRE PROTECTION MAIN TO EXISTING MAIN. VERIFY EXISTING CONDITIONS PRIOR TO BID.

FIRE PROTECTION GENERAL NOTES	
1. COORDINATE INSTALLATION OF SPRINKLER PIPING AND ALL COMPONENTS WITH OTHER TRADES, OWNER, AND GENERAL CONTRACTOR.	7. PROVIDE MINIMUM 5 PSI SAFETY FACTOR.
2. FIRE PROTECTION CONTRACTOR IS RESPONSIBLE FOR REMOVING AND REINSTALLING ALL CEILING COMPONENTS AS REQUIRED TO CONNECT NEW MAIN TO EXISTING.	8. WORKING DRAWINGS INDICATING SPRINKLER HEAD LOCATIONS AND EXPOSED AND CONCEALED PIPING ROUTING SHALL BE PROVIDED TO THE ARCHITECT/ENGINEER PRIOR TO INSTALLATION FOR APPROVAL.
3. FIRE PROTECTION SYSTEM TO COMPLY WITH NFPA #13R, INSURANCE CARRIER AND ALL APPLICABLE STATE AND LOCAL CODES.	9. FIRE PROTECTION CONTRACTOR IS RESPONSIBLE FOR ORGANIZING A COORDINATION MEETING WITH OTHER TRADES AND OWNER PRIOR TO INSTALLATION.
4. FIRE PROTECTION CONTRACTOR SHALL VISIT SITE PRIOR TO BID TO VERIFY ALL EXISTING CONDITIONS PRIOR TO BIDDING TO INSURE THE COORDINATION OF THE FIRE SERVICES WITH EXISTING CONDITIONS.	10. SYSTEM PIPING LOCATION, WET SYSTEM PIPING SHALL BE INSTALLED AT HIGHEST ELEVATION POSSIBLE. PIPING SHALL BE INSTALLED ABOVE ALL MECHANICAL EQUIPMENT, DUCTWORK, AND ALL PLUMBING SYSTEM PIPING. PROVIDE ADEQUATE CLEARANCE TO MECHANICAL UNITS. FIRE PROTECTION CONTRACTOR SHALL COORDINATE FIRE PROTECTION PIPING PRIOR TO INSTALLATION.
5. CUTTING OF STRUCTURAL AND/OR ARCHITECTURAL MEMBERS TO BE DONE ONLY WITH THE WRITTEN APPROVAL OF THE ARCHITECT AND STRUCTURAL ENGINEER.	11. ALL GRID MOUNTED SPRINKLER HEADS SHALL BE INSTALLED CENTER OF TILE.
6. VERIFY STRUCTURAL, MECHANICAL, ELECTRICAL INSTALLATIONS AND AVOID OBSTRUCTIONS OR INTERFERENCES.	12. PROPERLY TORQUE MECHANICAL TEES TO MANUFACTURER'S RECOMMENDATIONS.

FIRE PROTECTION SHEET INDEX
FP101 FIRE PROTECTION PLANS (DEDUCT ALTERNATE BID)



1 FIRST FLOOR FIRE PROTECTION PLAN (ALT BID)
1/8" = 1'-0"

2 LOWER LEVEL FIRE PROTECTION PLAN (ALT BID)
1/8" = 1'-0"

**WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
 Project Location: 1019 SOUTH KNOWLES AVENUE
 NEW RICHMOND, WISCONSIN 54017
 Sheet Title: FIRE PROTECTION PLANS (DEDUCT ALTERNATE BID)

HSR Project Number:	18043-6
Project Date:	JULY, 2019
Drawn By:	NCF

No.	Description	Date

CONSTRUCTION DOCUMENTS

Graphic Scale:	VARIES
Last Update:	7/12/2019 10:48:51 AM

FP101

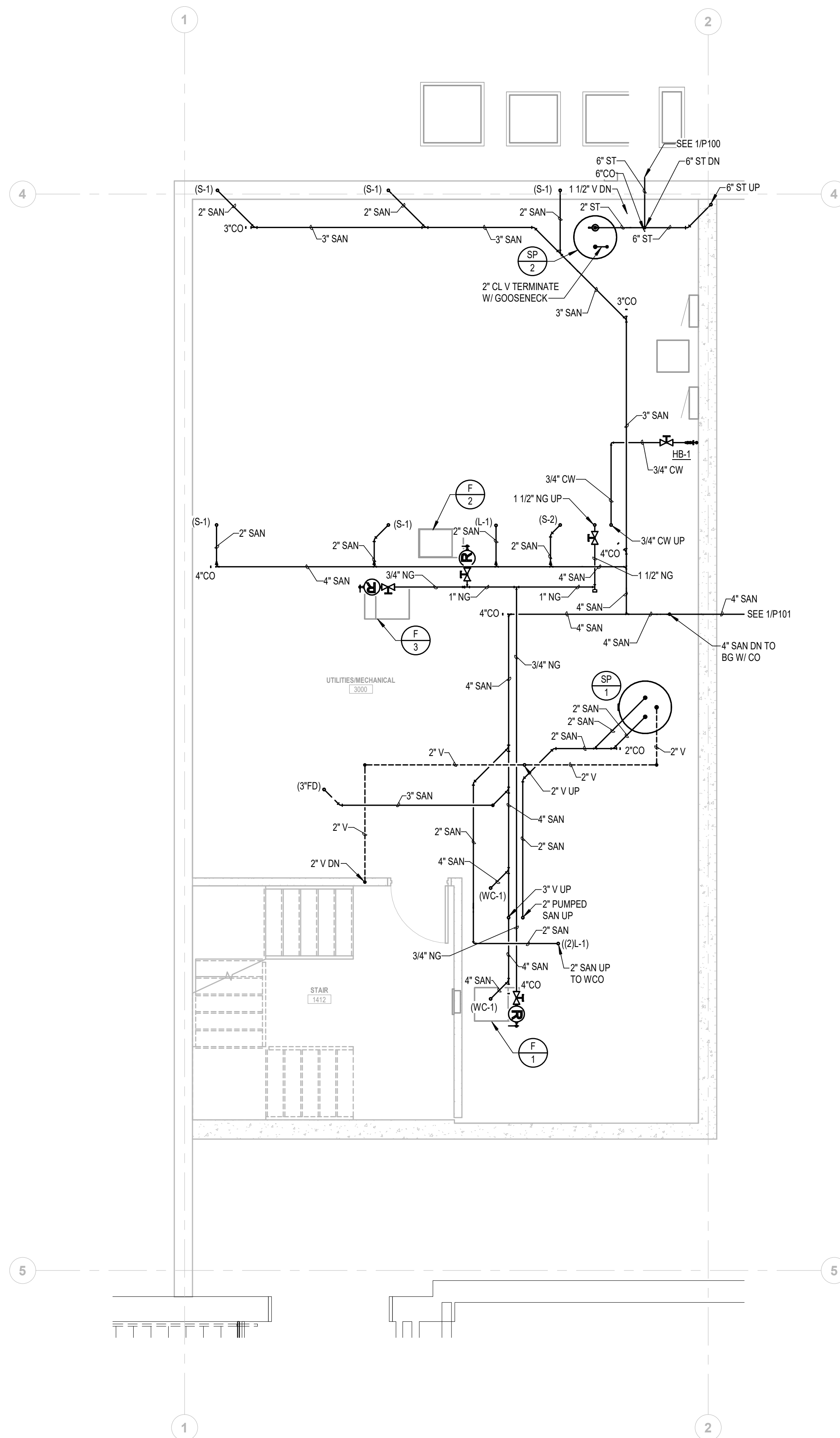




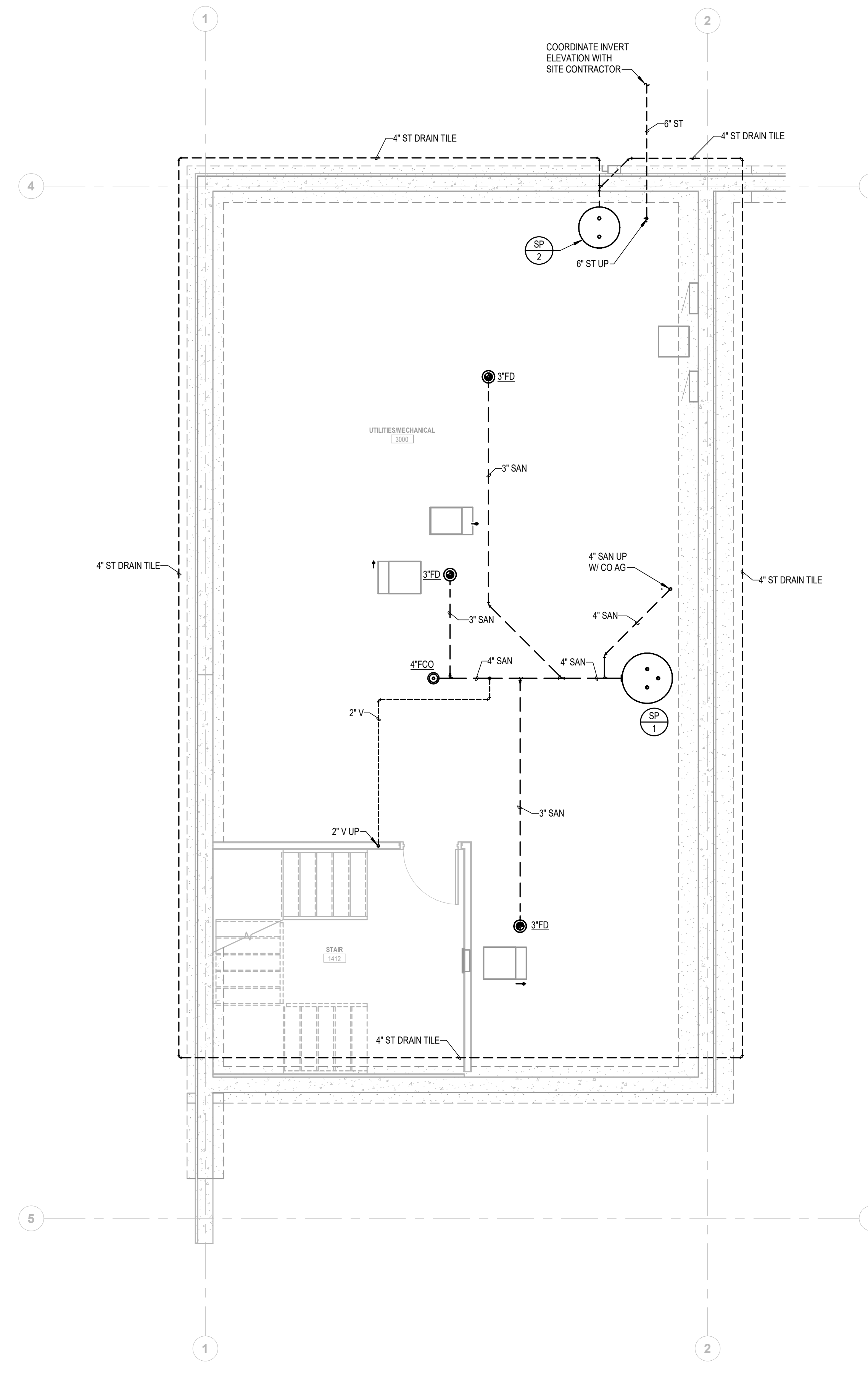
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2 LOWER LEVEL PLUMBING PLAN - ABOVE GRADE
1/4" = 1'-0"



1 LOWER LEVEL PLUMBING PLAN - BELOW GRADE
1/4" = 1'-0"



Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**

Project Location: **1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017**

Sheet Title: **LOWER LEVEL PLUMBING PLANS**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **NCF**

Key Plan:

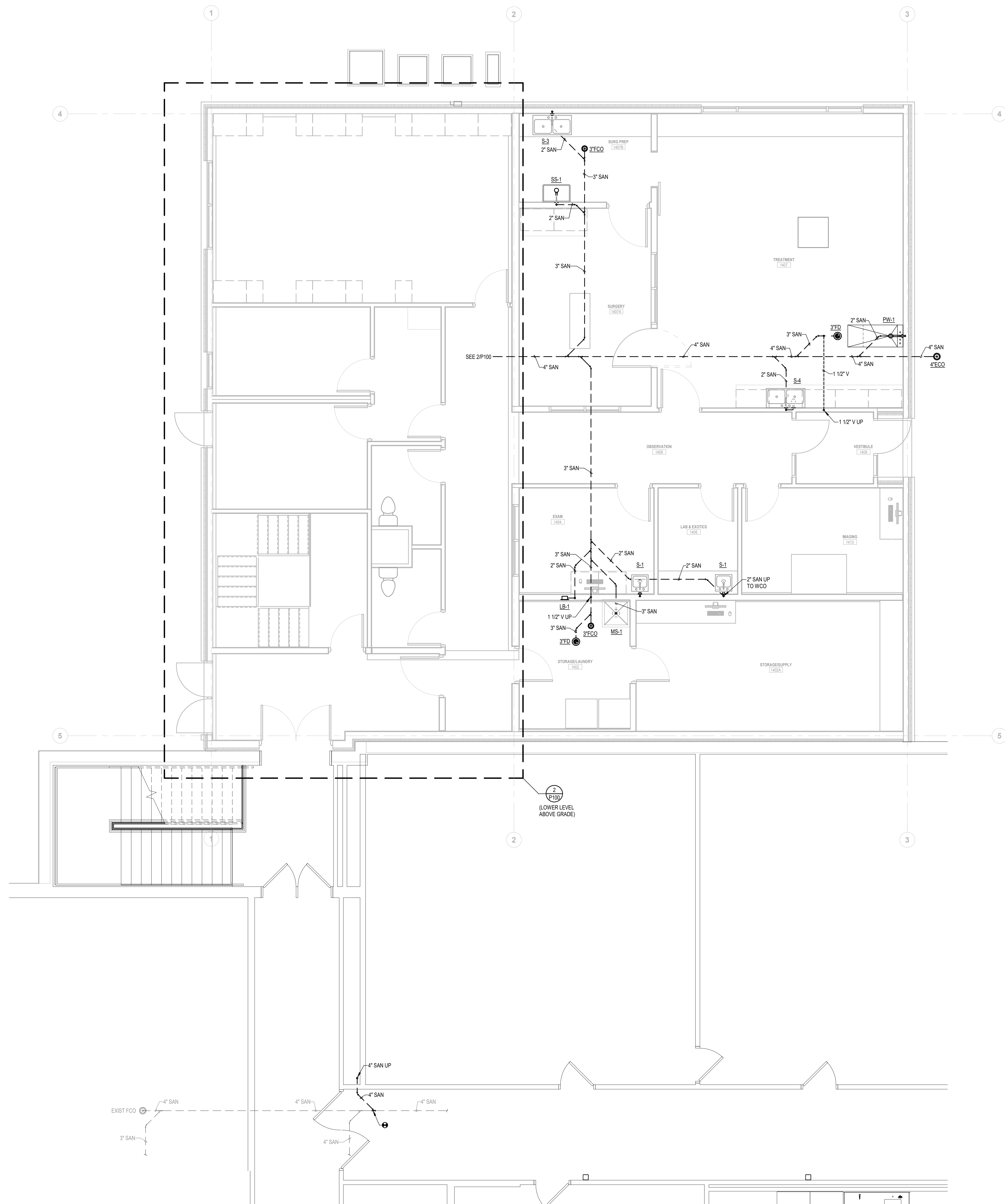
**CONSTRUCTION
DOCUMENTS**

No.	Description	Date

Graphic Scale: **VARIES**

Last Update: **7/12/2019 10:51:55 AM**

P100



1 FIRST FLOOR BELOW GRADE PLUMBING PLAN
1/4" = 1'-0"



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VETERINARY TECHNICIAN ADDITION**
Project Title: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **FIRST FLOOR BELOW GRADE PLUMBING PLAN**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **NCF**

Key Plan:

**CONSTRUCTION
DOCUMENTS**

No.	Description	Date

Graphic Scale: **VARIES**

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P101



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Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **FIRST FLOOR ABOVE GRADE PLUMBING PLAN**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **NCF**

Key Plan:

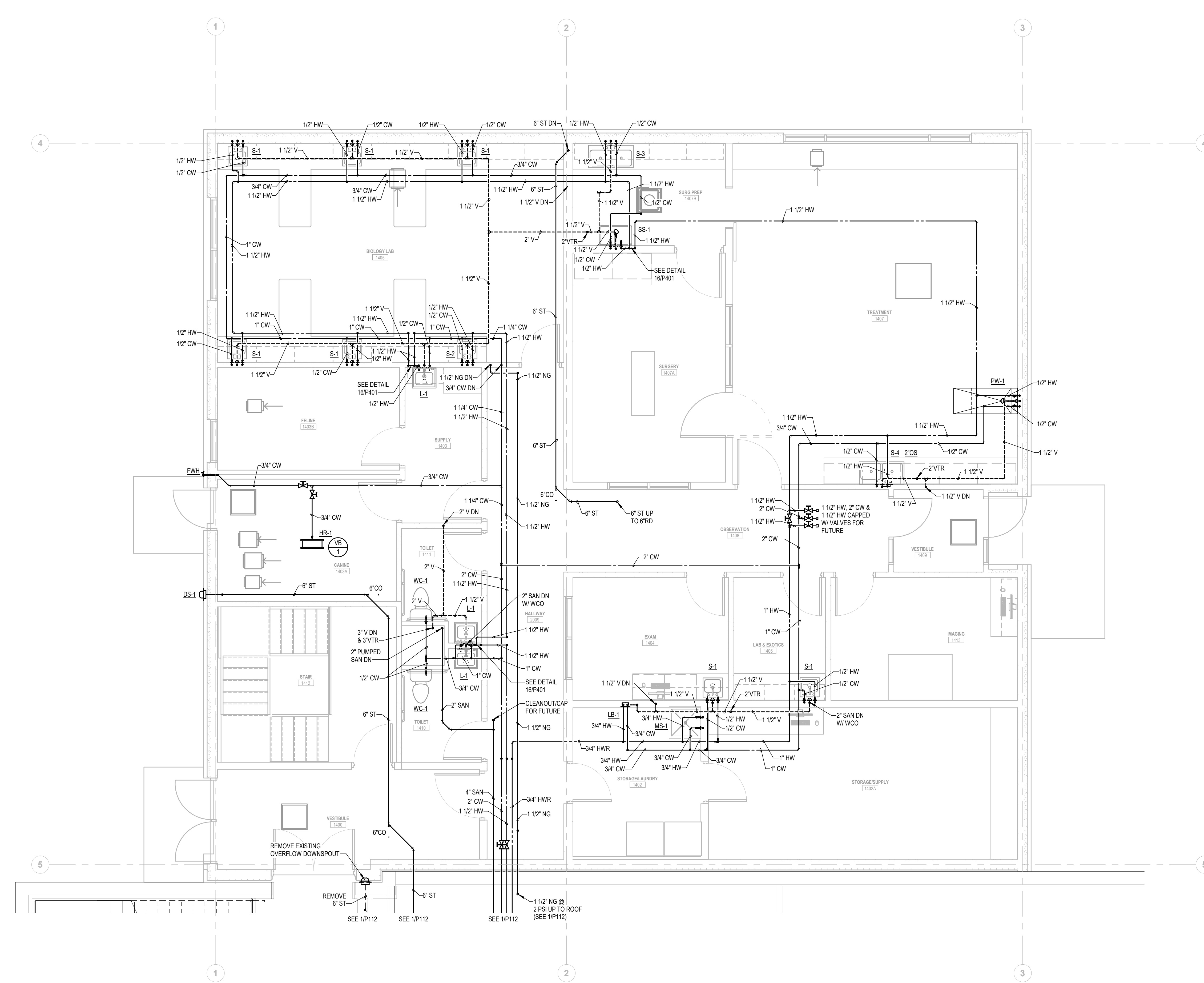
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DOCUMENTS**

No.	Description	Date

Graphic Scale: **VARIES**

Last Update: **7/12/2019 10:51:58 AM**

P111



1 FIRST FLOOR ABOVE GRADE PLUMBING PLAN
1/4" = 1'-0"





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MEP PROJECT NO.: H08.19.02

Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **FIRST FLOOR PLUMBING PLAN - EXISTING BUILDING**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **NCF**

Key Plan:

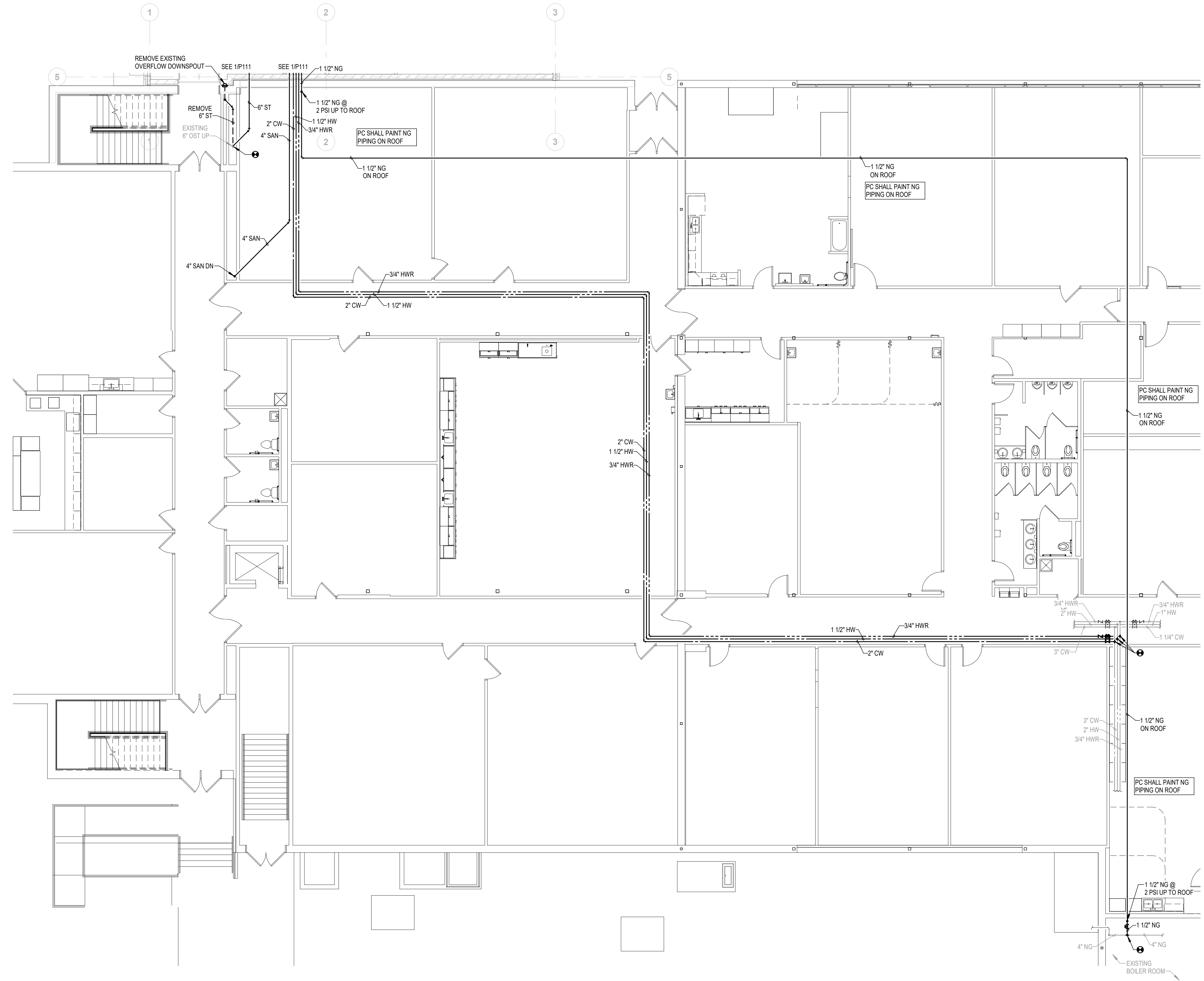
**CONSTRUCTION
DOCUMENTS**

No.	Description	Date

Graphic Scale: **VARIES**

Last Update: **7/12/2019 10:52:00 AM**

P112



1 FIRST FLOOR PLUMBING PLAN - EXISTING BUILDING
1/8" = 1'-0"





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MEP PROJECT NO.: H08.19.02

Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **ROOF PLUMBING PLAN**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **NCF**

Key Plan:

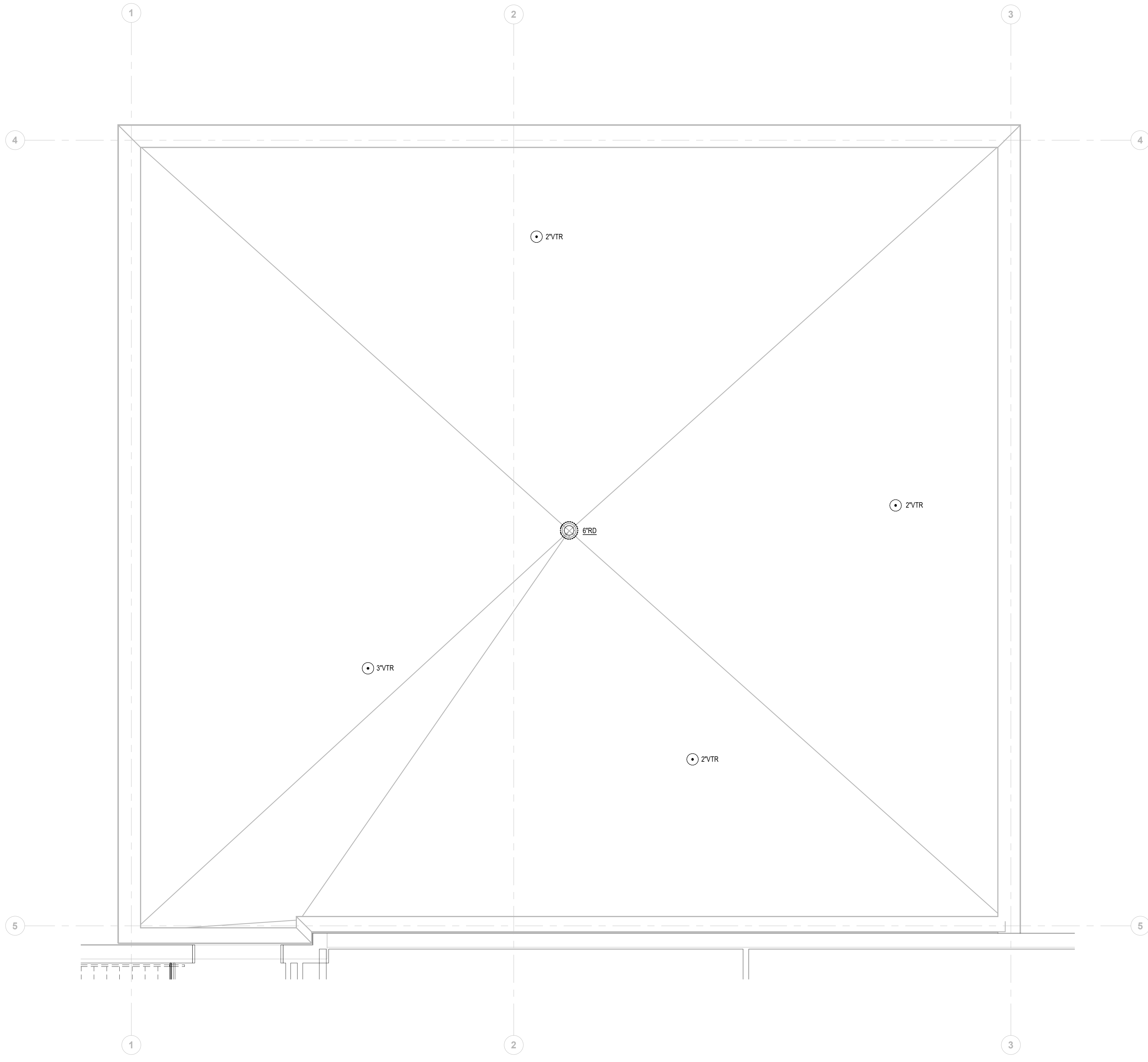
**CONSTRUCTION
DOCUMENTS**

No.	Description	Date

Graphic Scale: **VARIES**

Last Update: **7/12/2019 10:52:01 AM**

P121



1 ROOF PLUMBING PLAN
1/4" = 1'-0"





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MEP PROJECT NO.: H08.19.02

Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **MEDICAL GAS PLAN**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **NCF**

Key Plan:

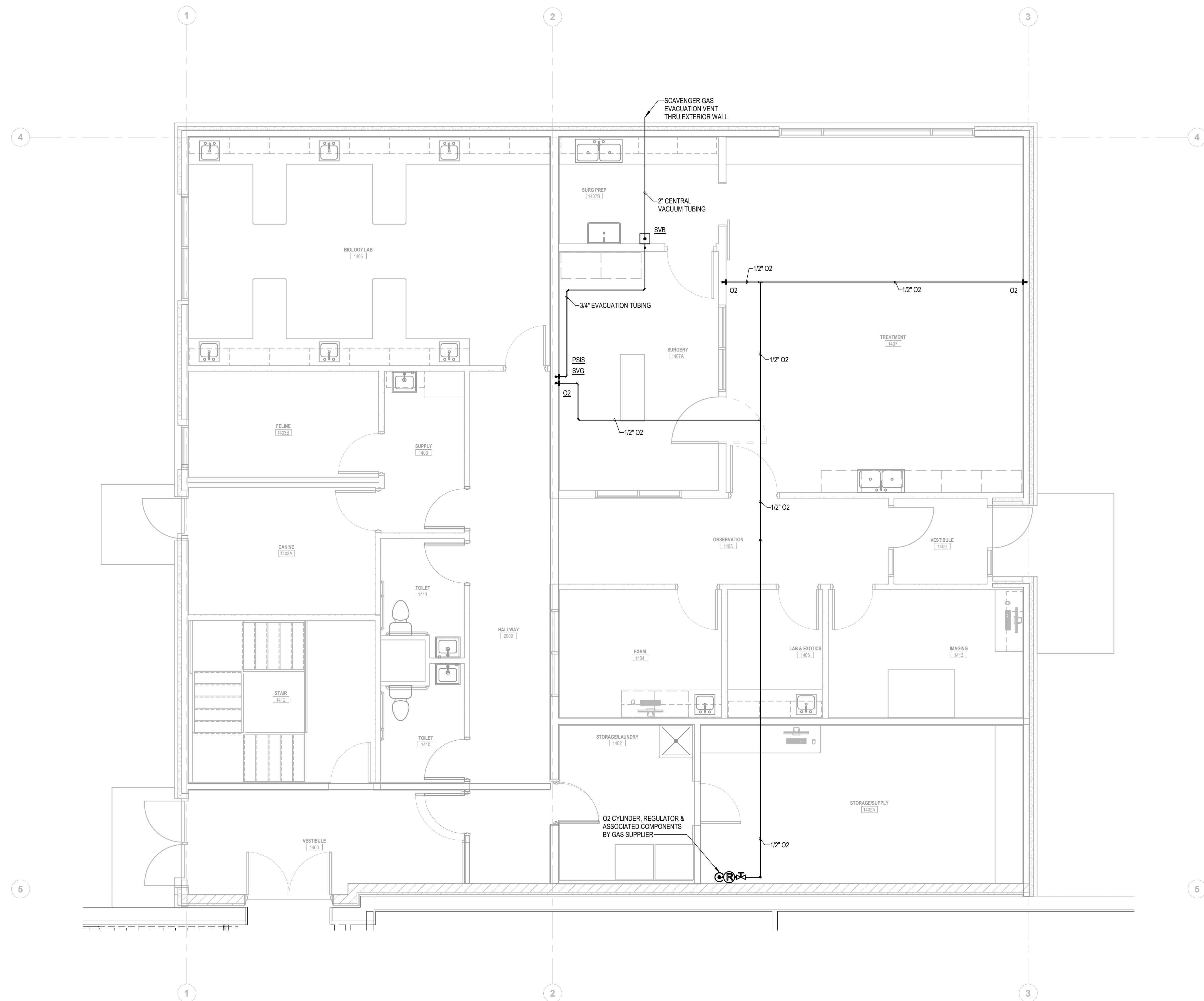
**CONSTRUCTION
DOCUMENTS**

No.	Description	Date

Graphic Scale: **VARIES**

Last Update: **7/12/2019 10:52:02 AM**

P201



1 MEDICAL GAS PLUMBING PLAN
1/4" = 1'-0"

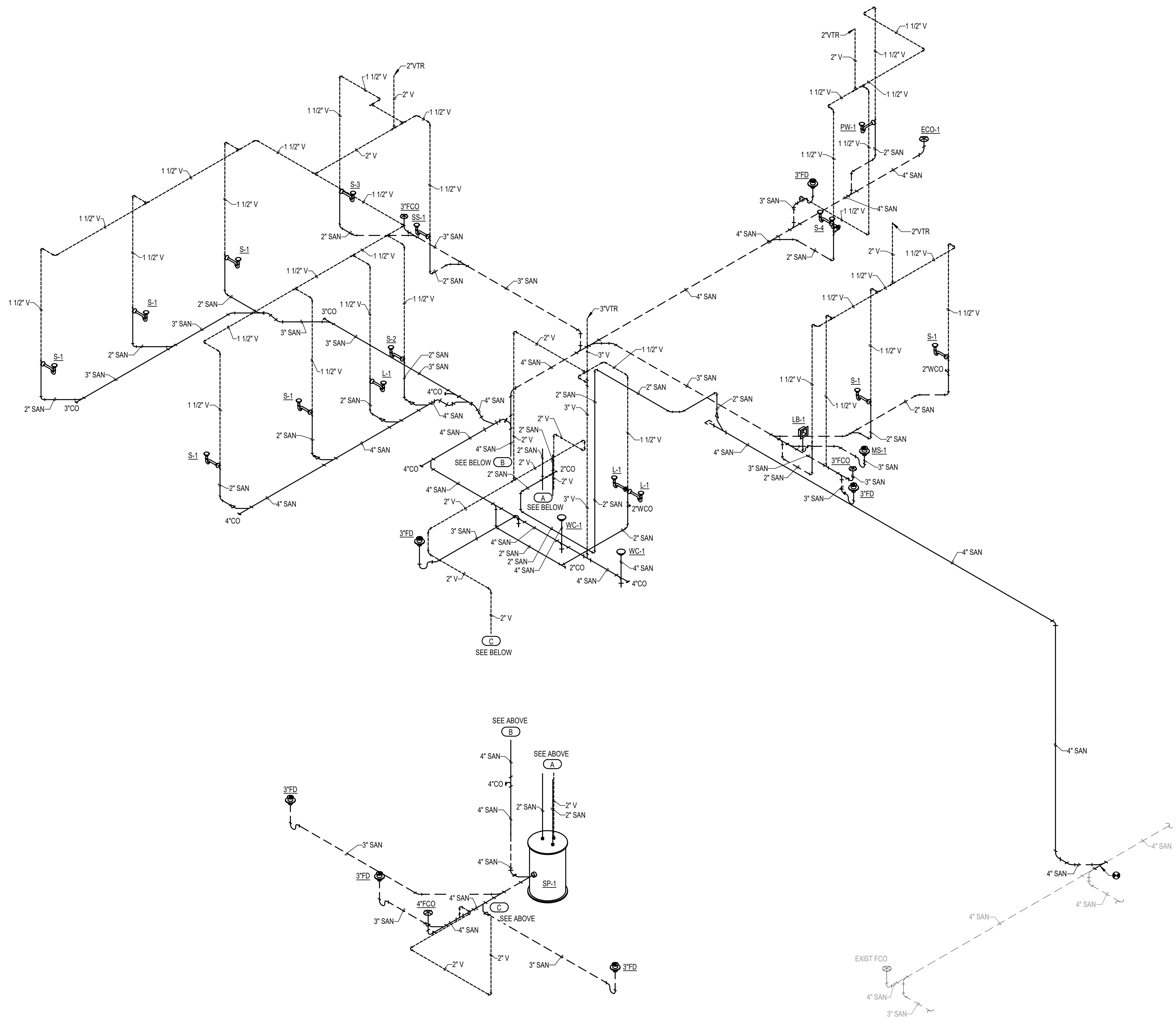




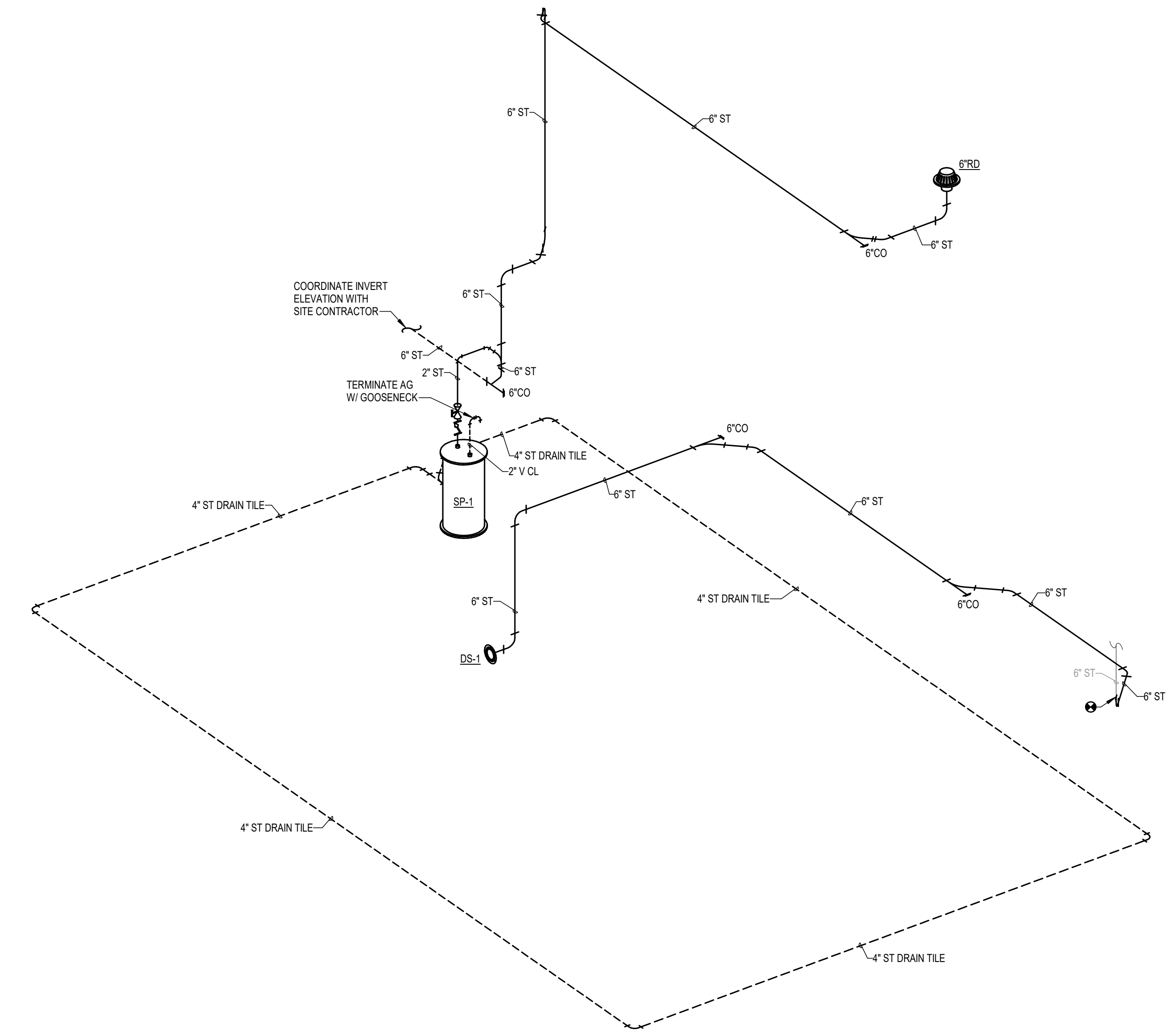
Consultant:



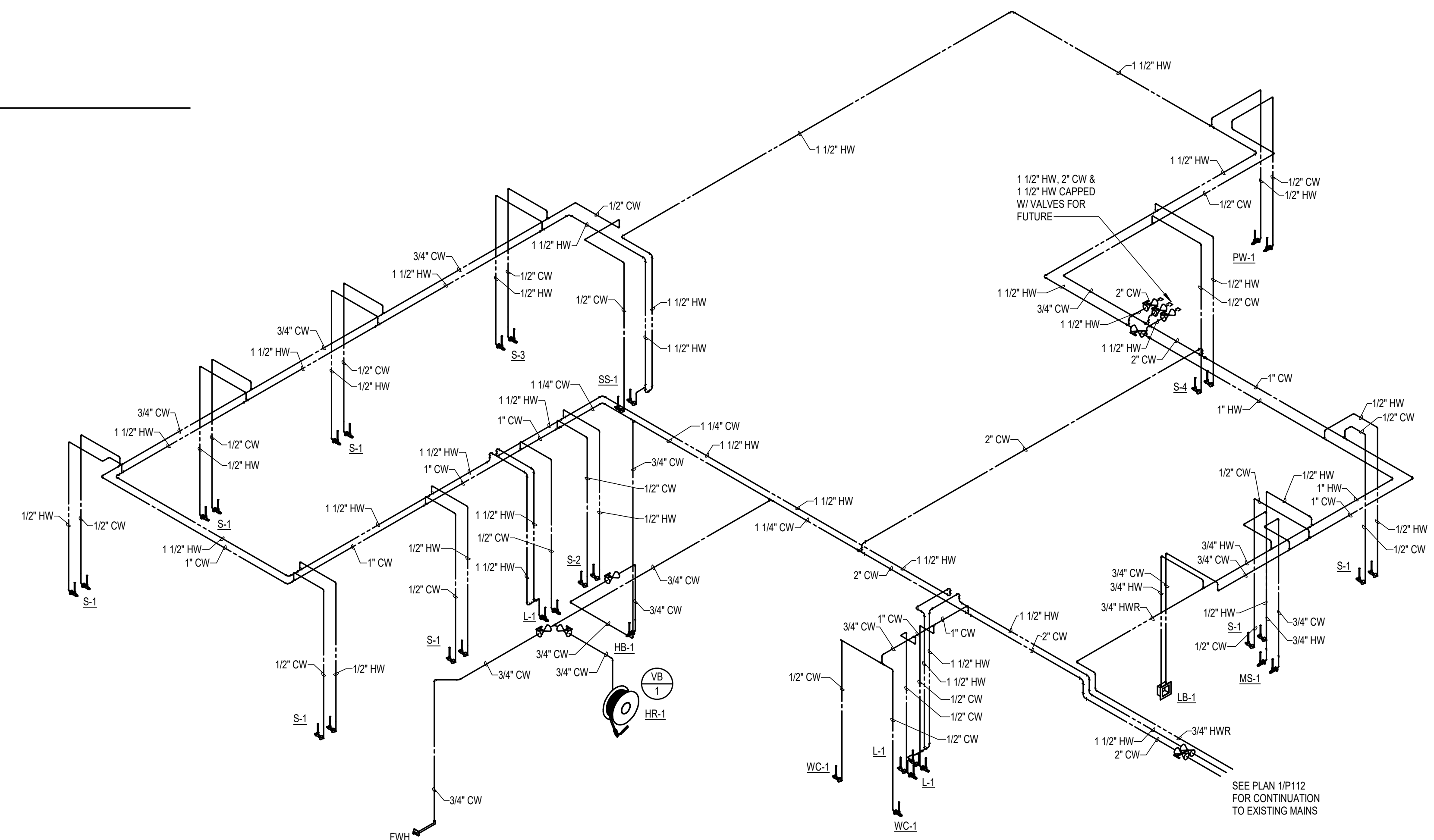
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MEP PROJECT NO.: H08.19.02



2 SANITARY PLUMBING ISOMETRIC



1 STORM PLUMBING ISOMETRIC



3 WATER PLUMBING ISOMETRIC

Project Title: **WITC - NEW RICHMOND CAMPUS VETERINARY TECHNICIAN ADDITION**
Project Location: **1019 SOUTH KNOWLES AVENUE, NEW RICHMOND, WISCONSIN 54017**
Project Number: **18043-6**
Project Date: **JULY, 2019**
Drawn By: **NCF**
Key Plan:

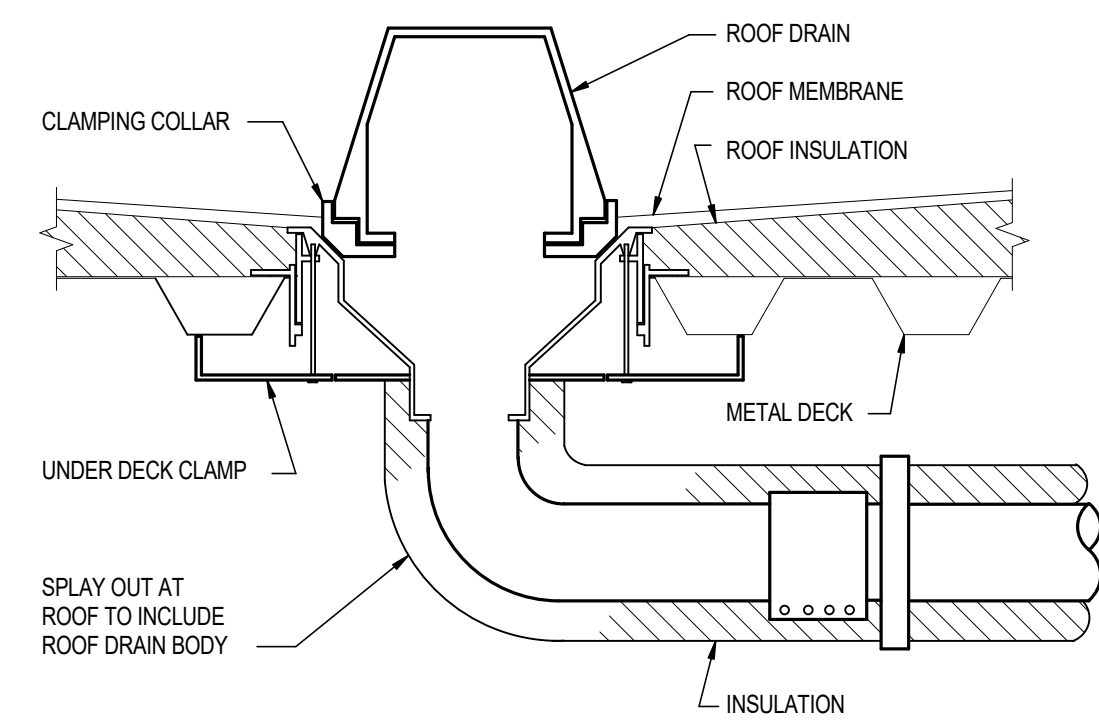
CONSTRUCTION DOCUMENTS

No.	Description	Date

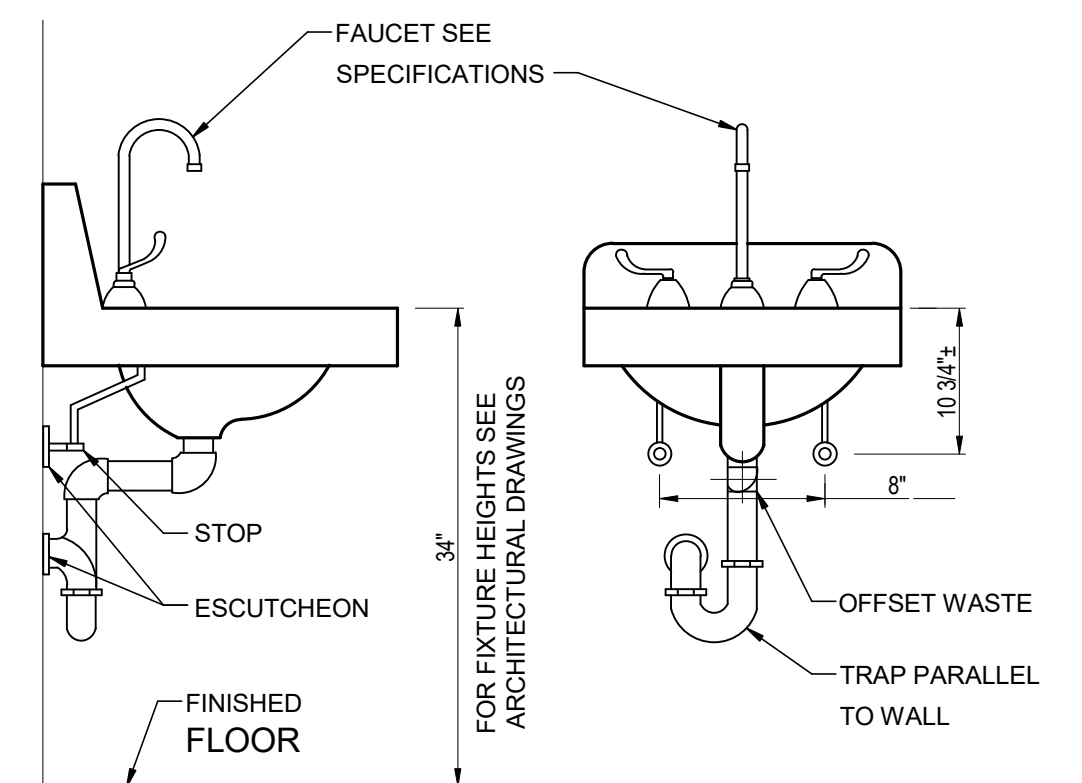
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Last Update: **7/12/2019 10:52:03 AM**

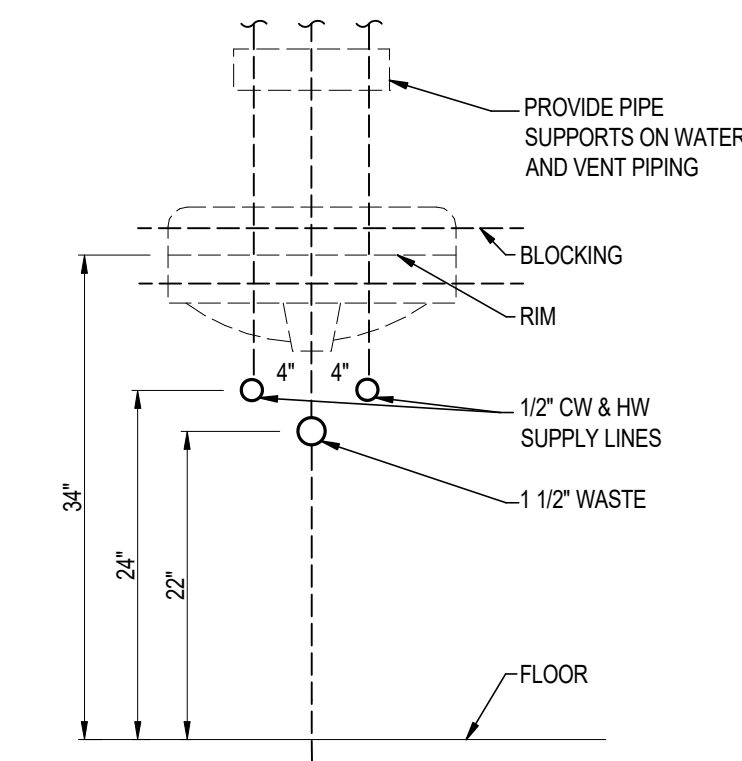
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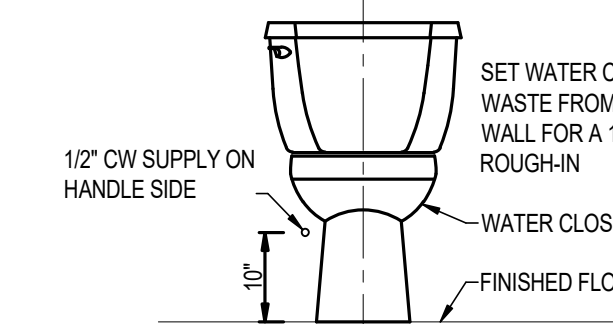
4 TYPICAL ROOF DRAIN DETAIL
NOT TO SCALE



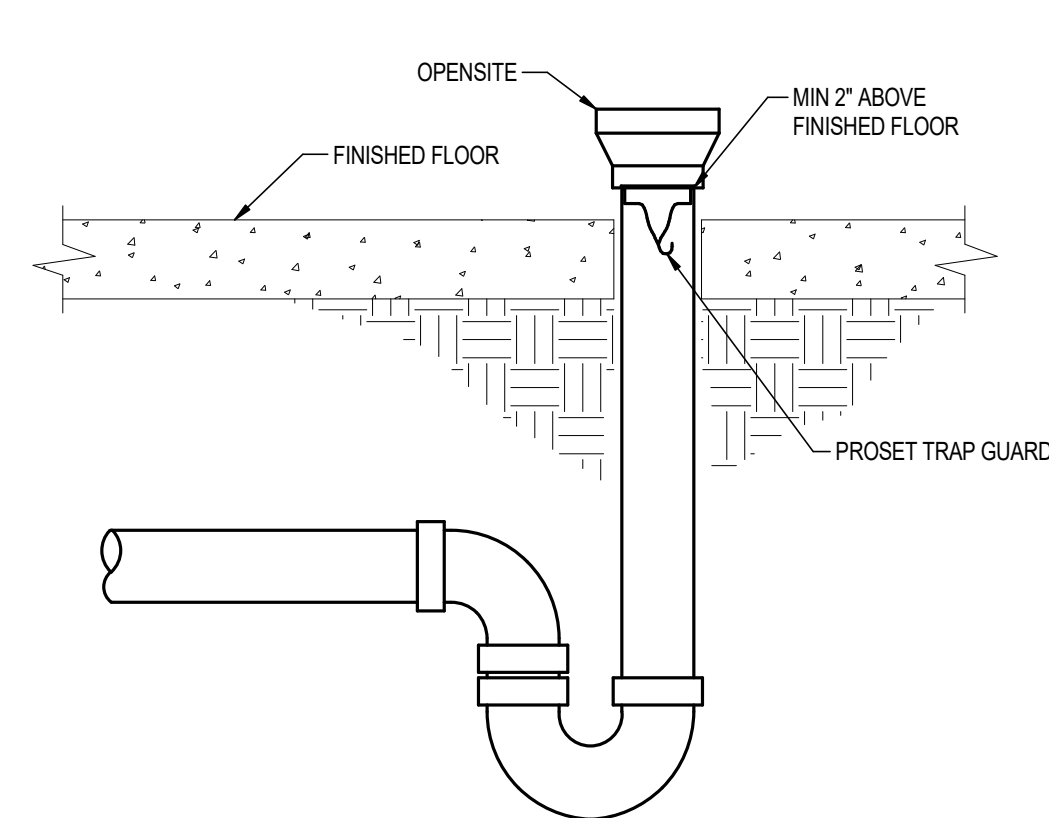
3 TYPICAL WHEELCHAIR LAVATORY DETAIL
NOT TO SCALE



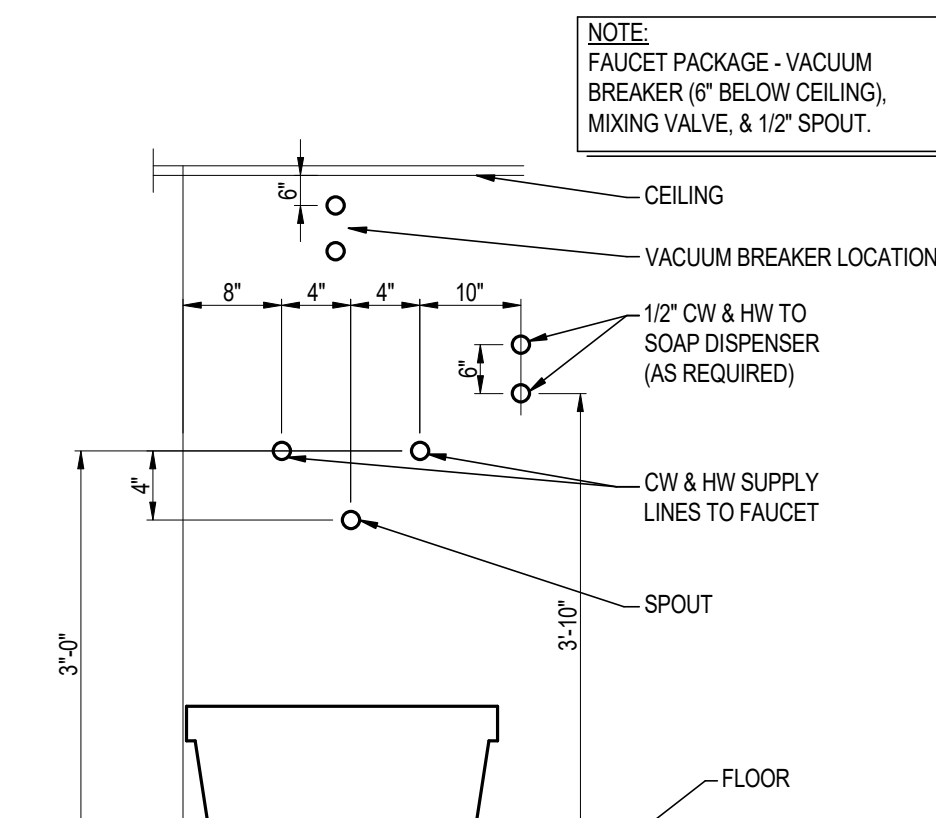
2 LAVATORY DETAIL
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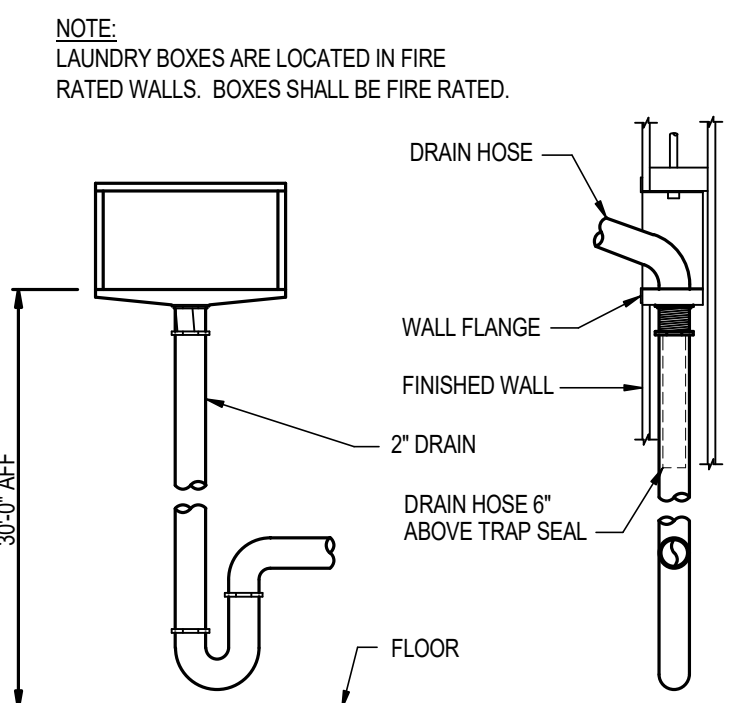
1 ADA WATER CLOSET ROUGH-IN DETAIL
NOT TO SCALE



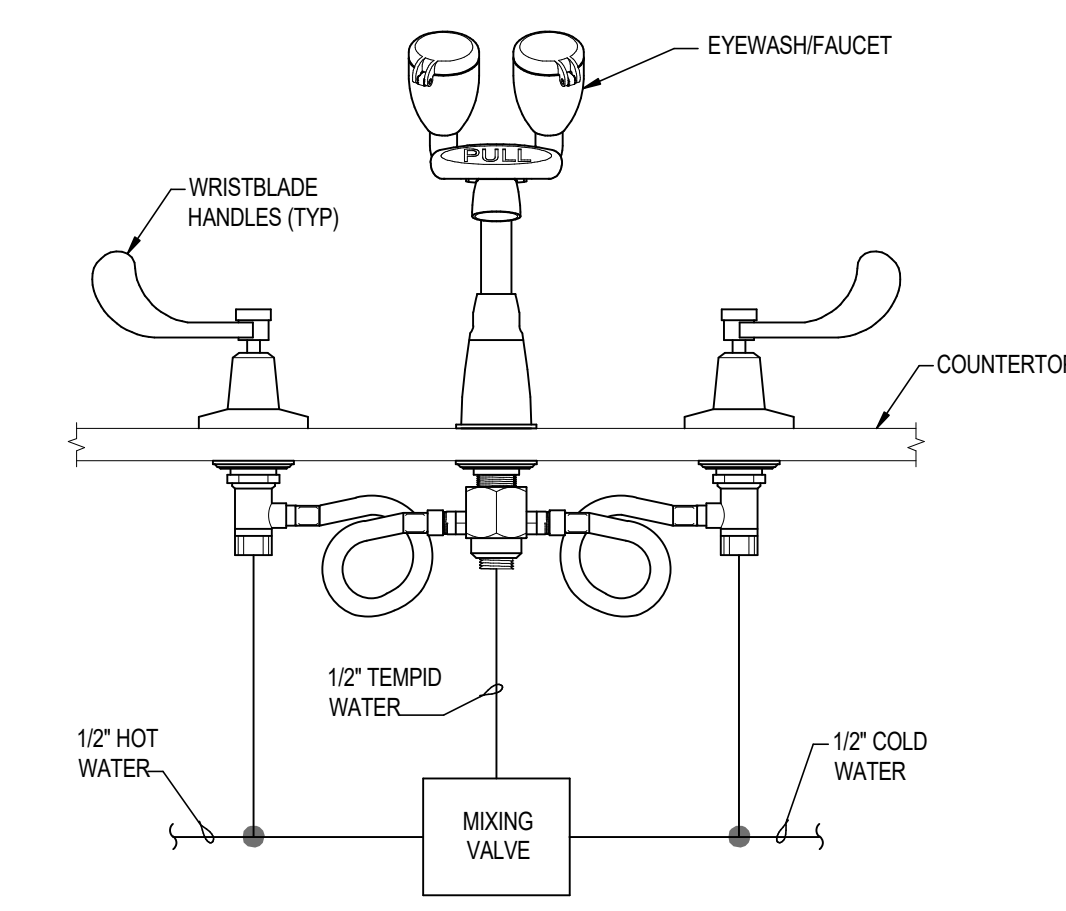
9 OPENSITE DETAIL
NOT TO SCALE



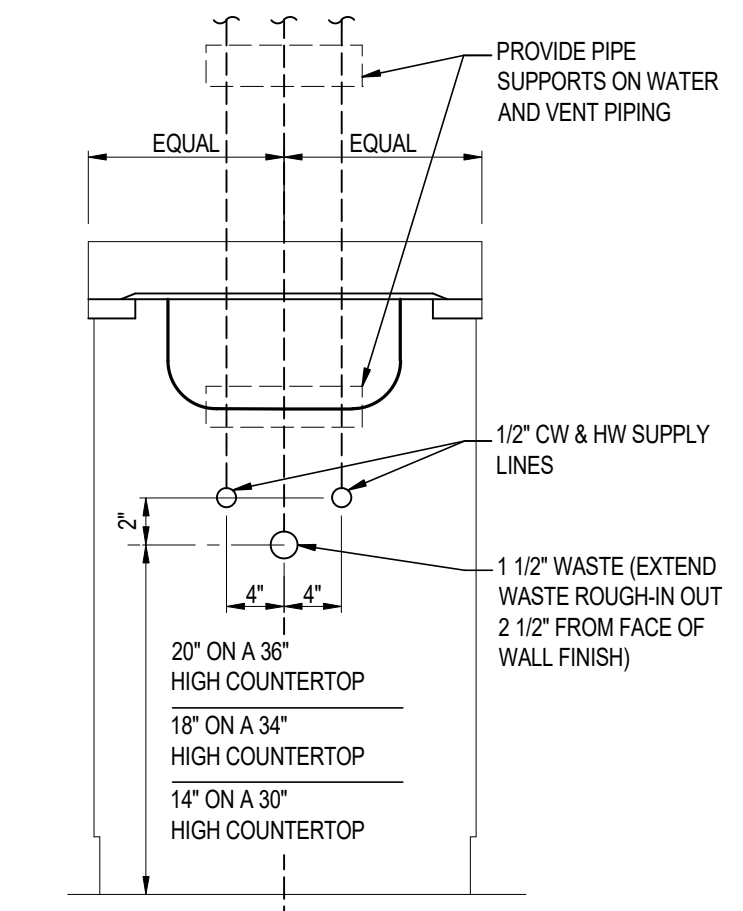
8 MOP BASINS DETAIL
NOT TO SCALE



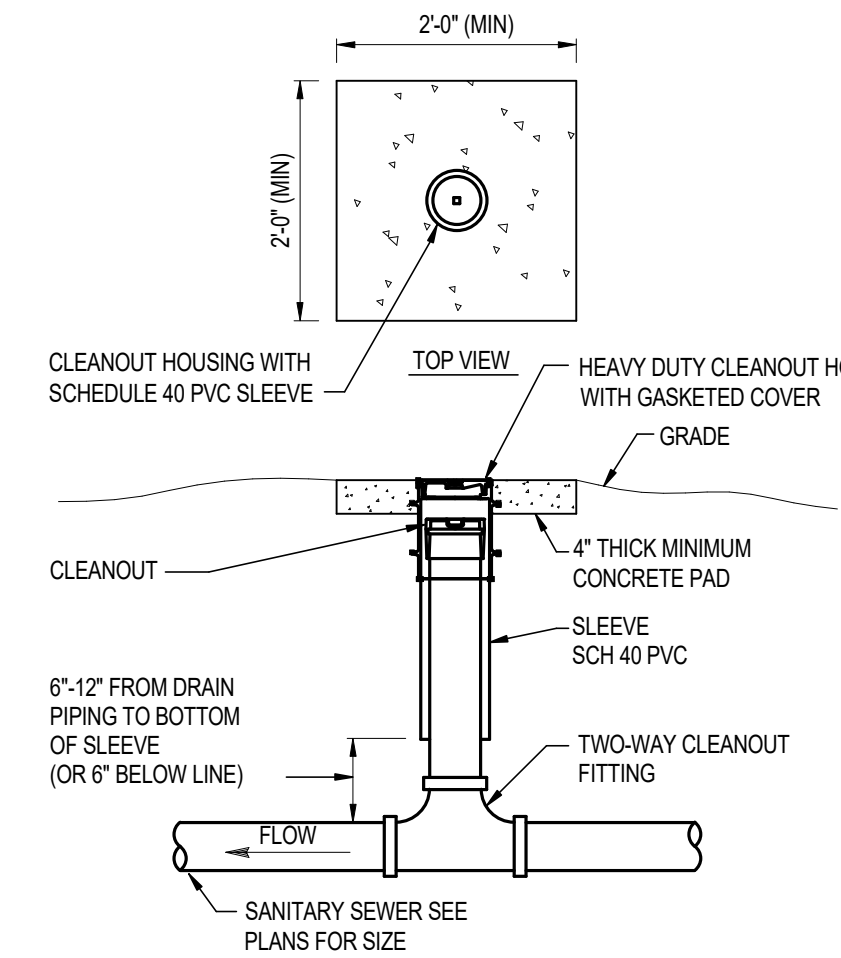
7 CLOTHES WASHER DRAIN DETAIL
NOT TO SCALE



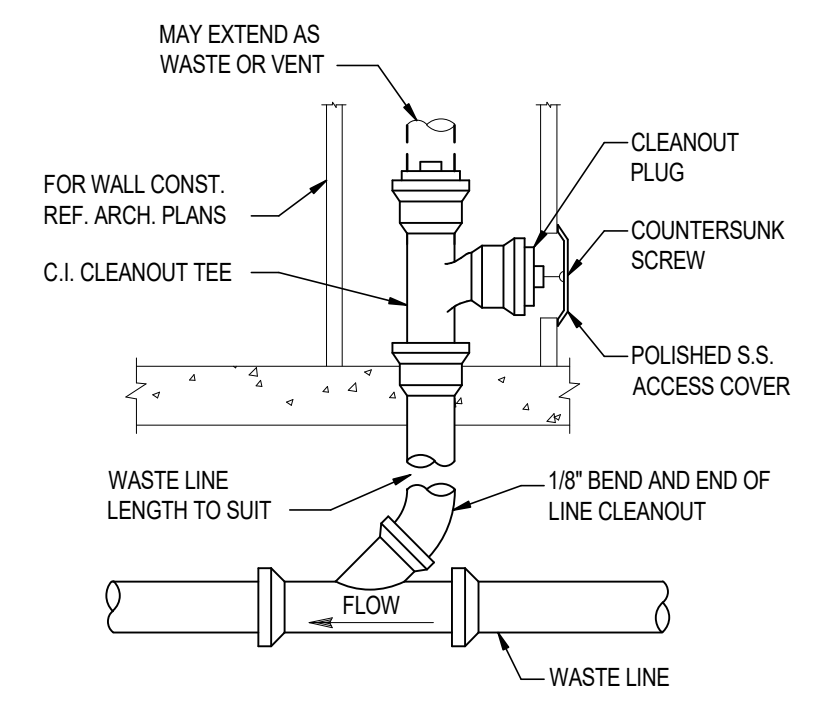
6 EYEWASH/FAUCET PIPING DETAIL
NOT TO SCALE



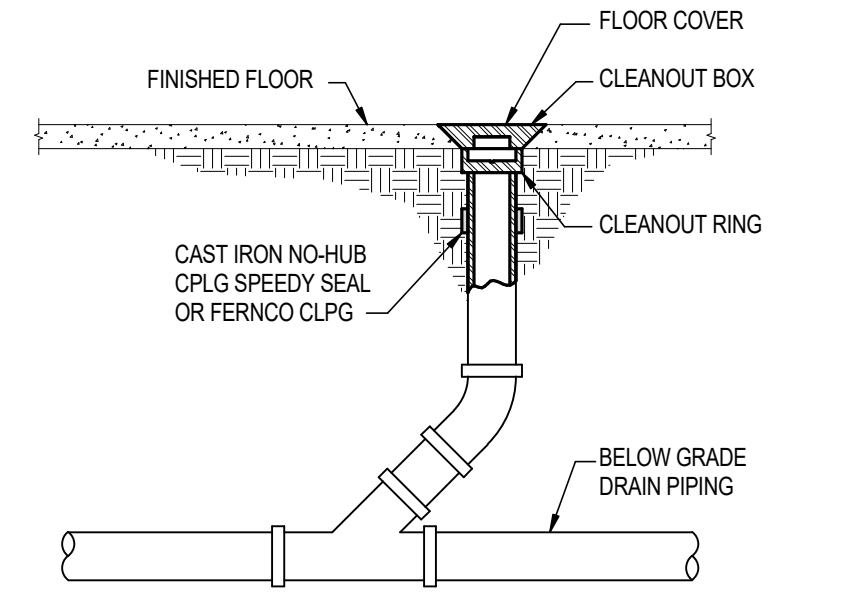
5 SINK ROUGH-IN DETAIL
NOT TO SCALE



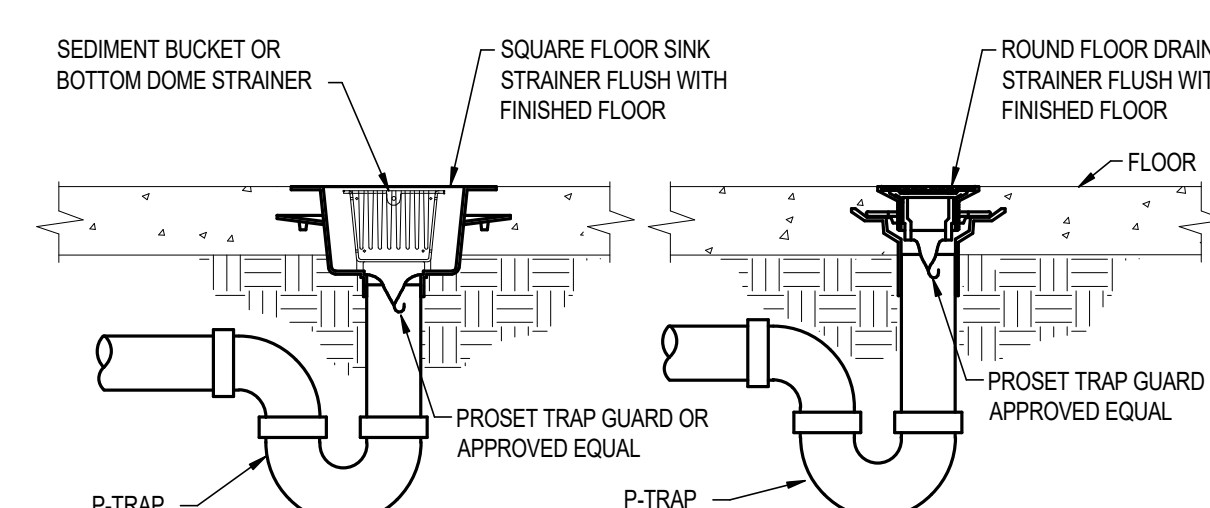
14 EXTERIOR CLEANOUT DETAIL
NOT TO SCALE



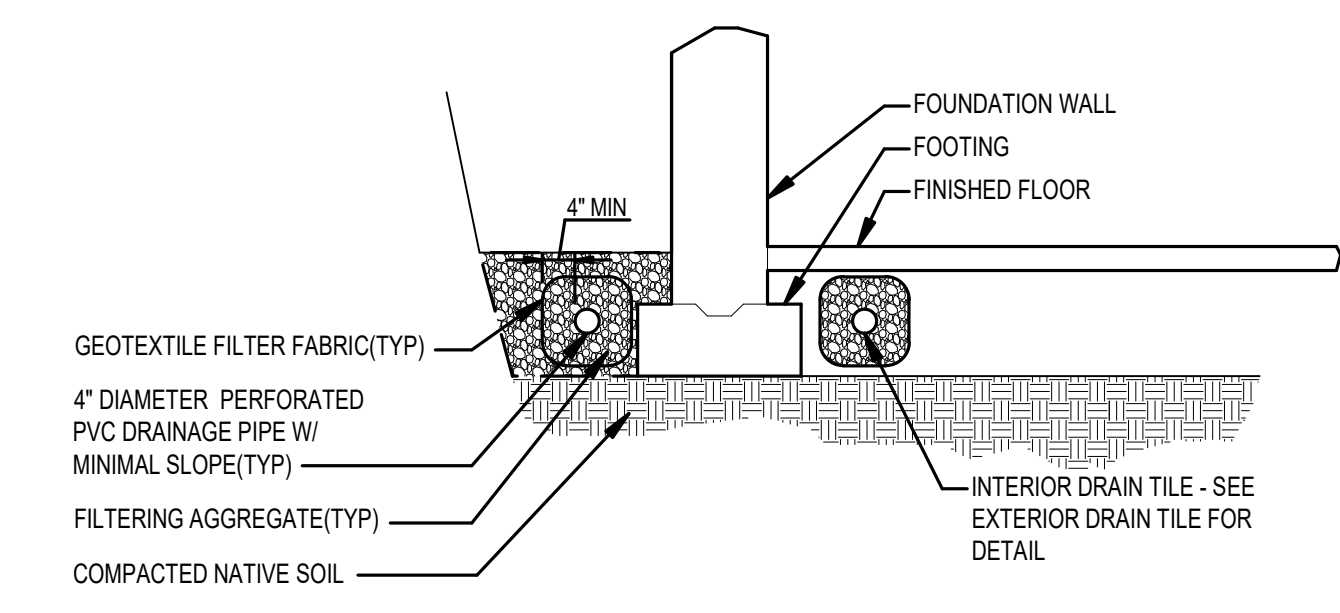
13 WALL CLEANOUT DETAIL
NOT TO SCALE



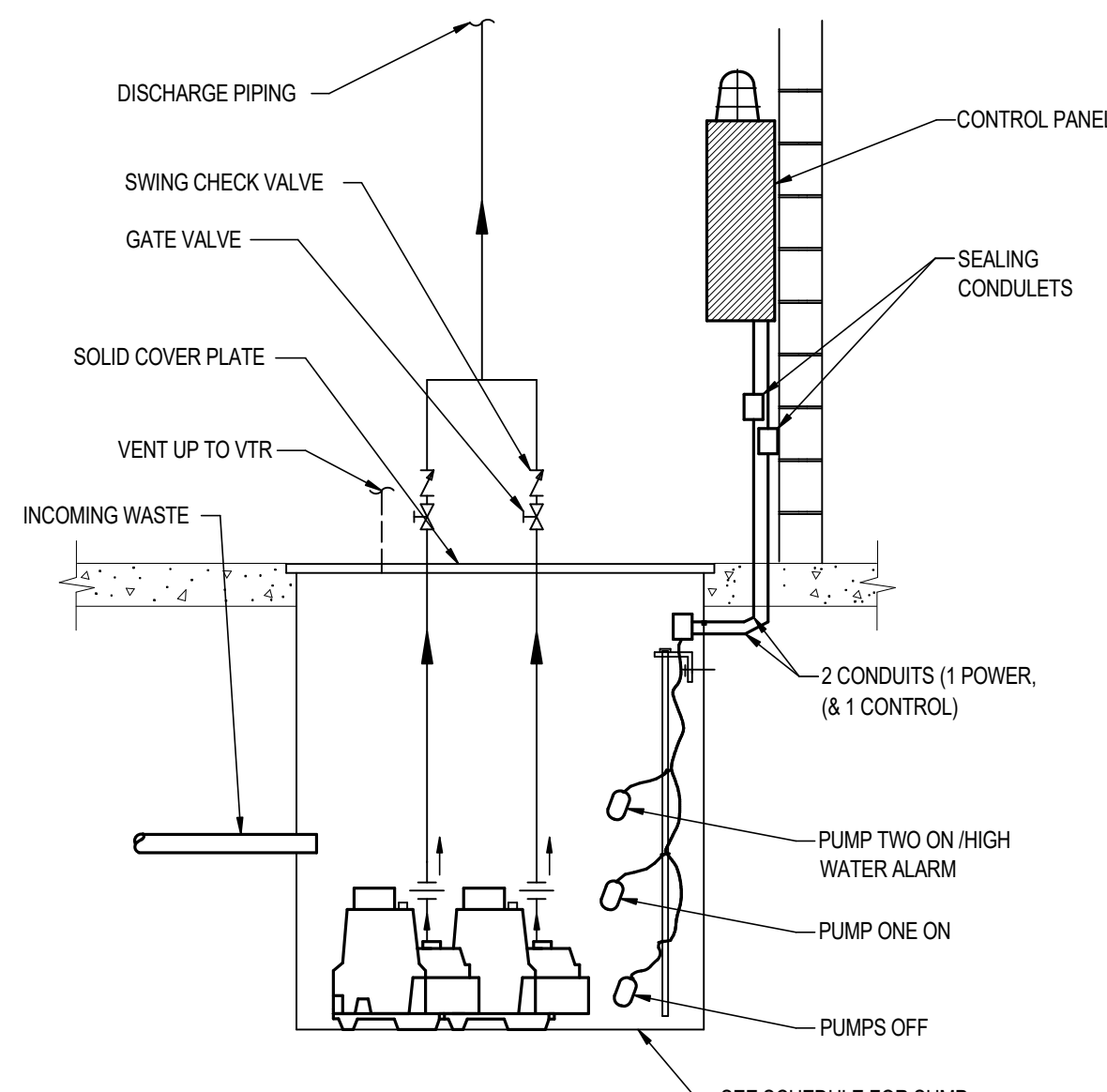
12 INTERIOR CLEANOUT DETAIL
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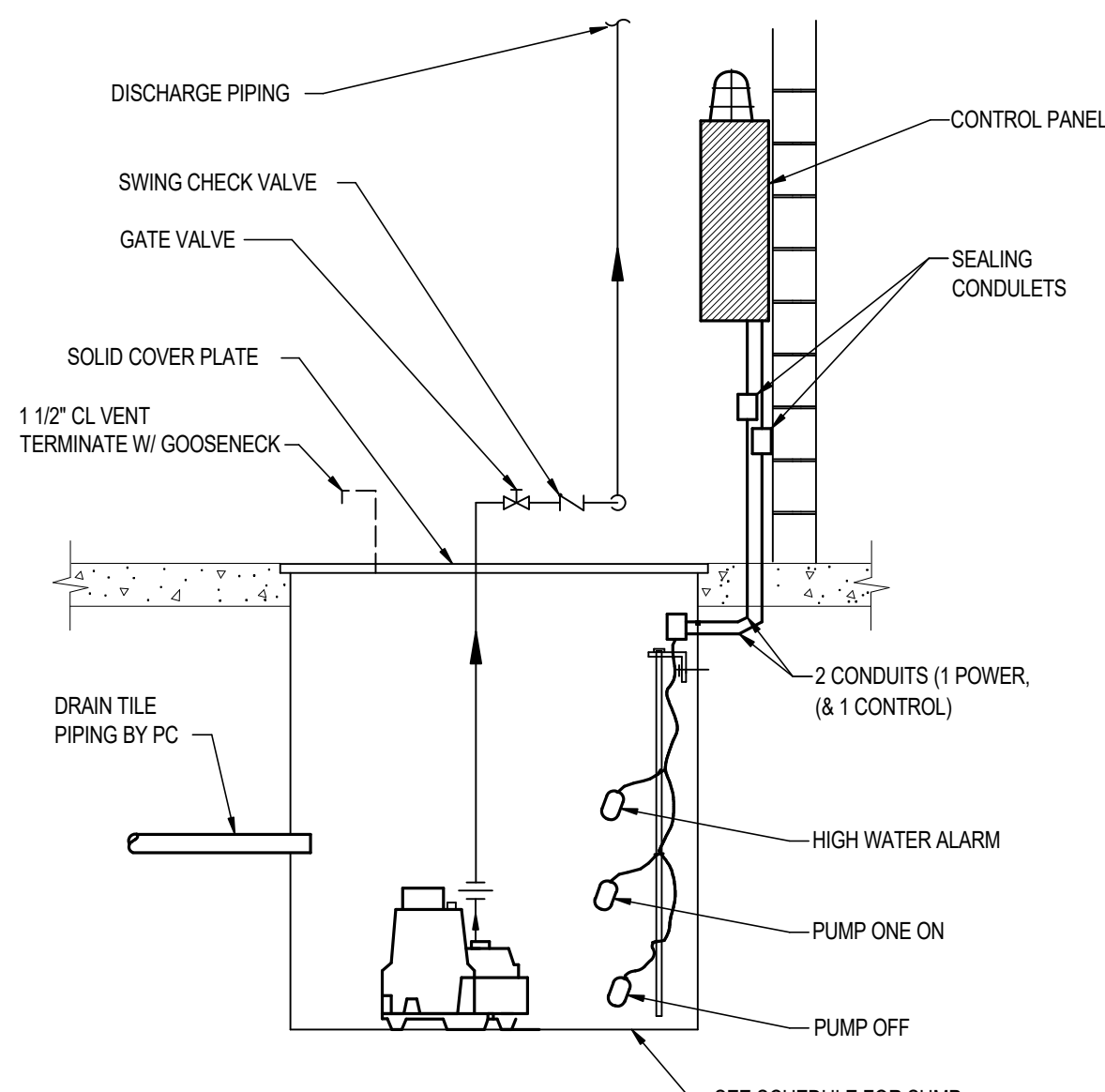
11 FLOOR DRAIN & FLOOR SINK DETAIL
NOT TO SCALE



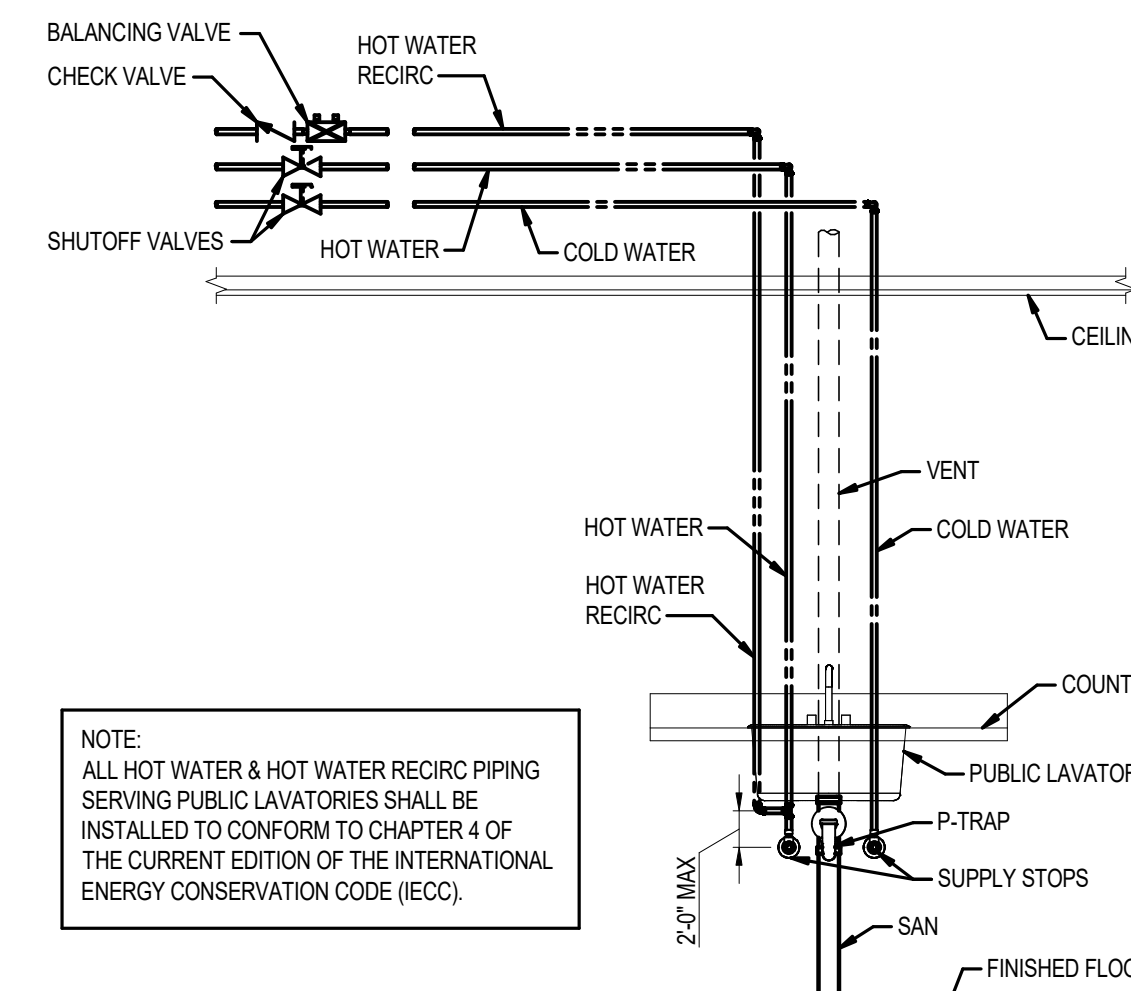
10 FOUNDATION/UNDERFLOOR DRAINAGE PLAN
NOT TO SCALE



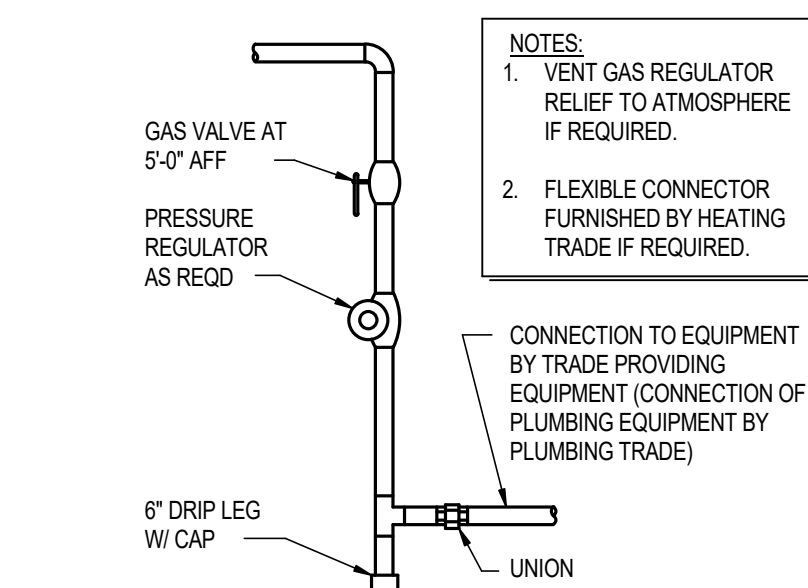
18 SANITARY DUPLEX SUMP PUMP DETAIL
NOT TO SCALE



17 STORM SUMP PUMP DETAIL
NOT TO SCALE



16 PUBLIC LAVATORY HW RECIRC DETAIL
NOT TO SCALE



15 GAS CONNECTION DETAIL
NOT TO SCALE

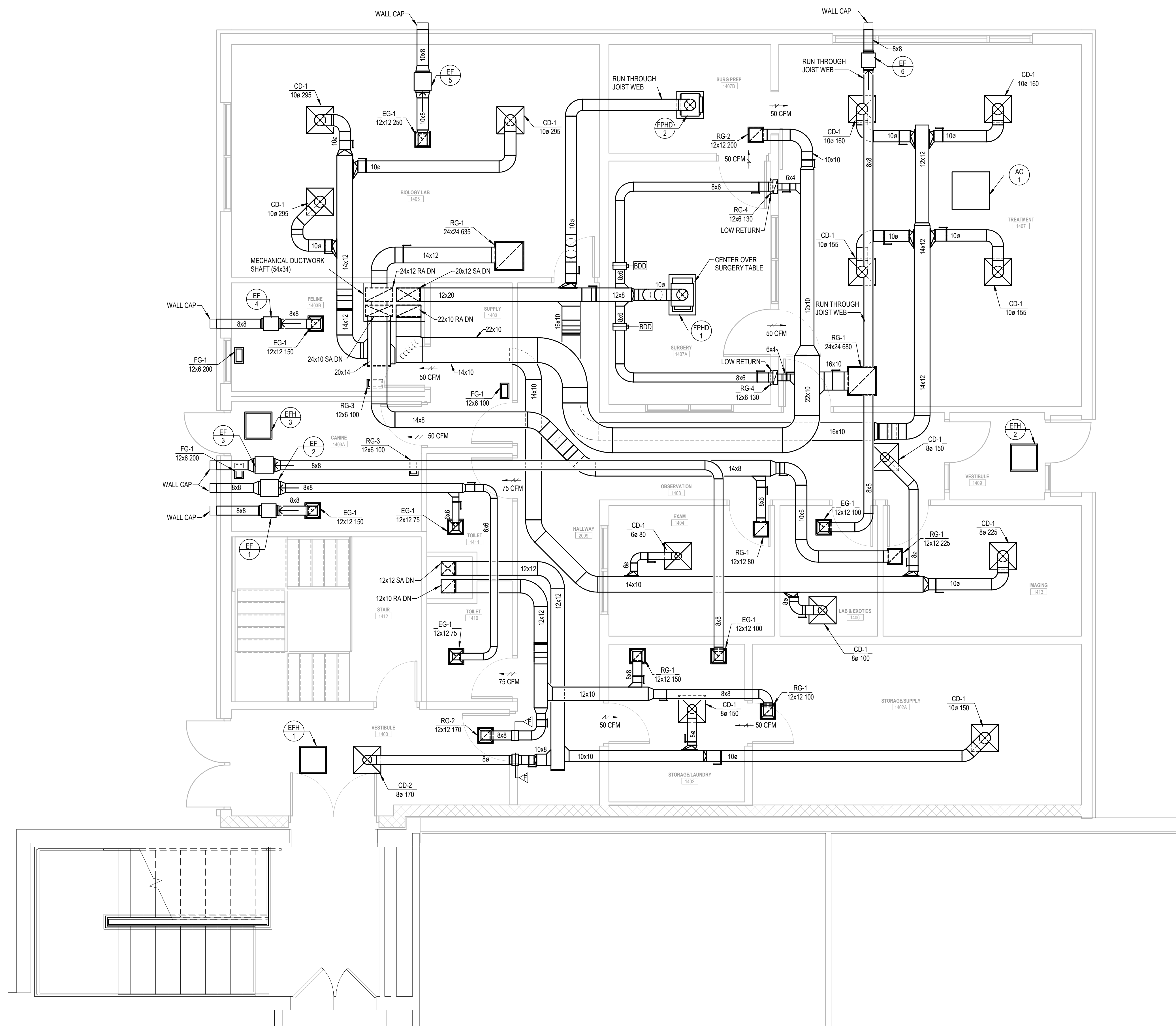
Revisions:	No.	Description	Date



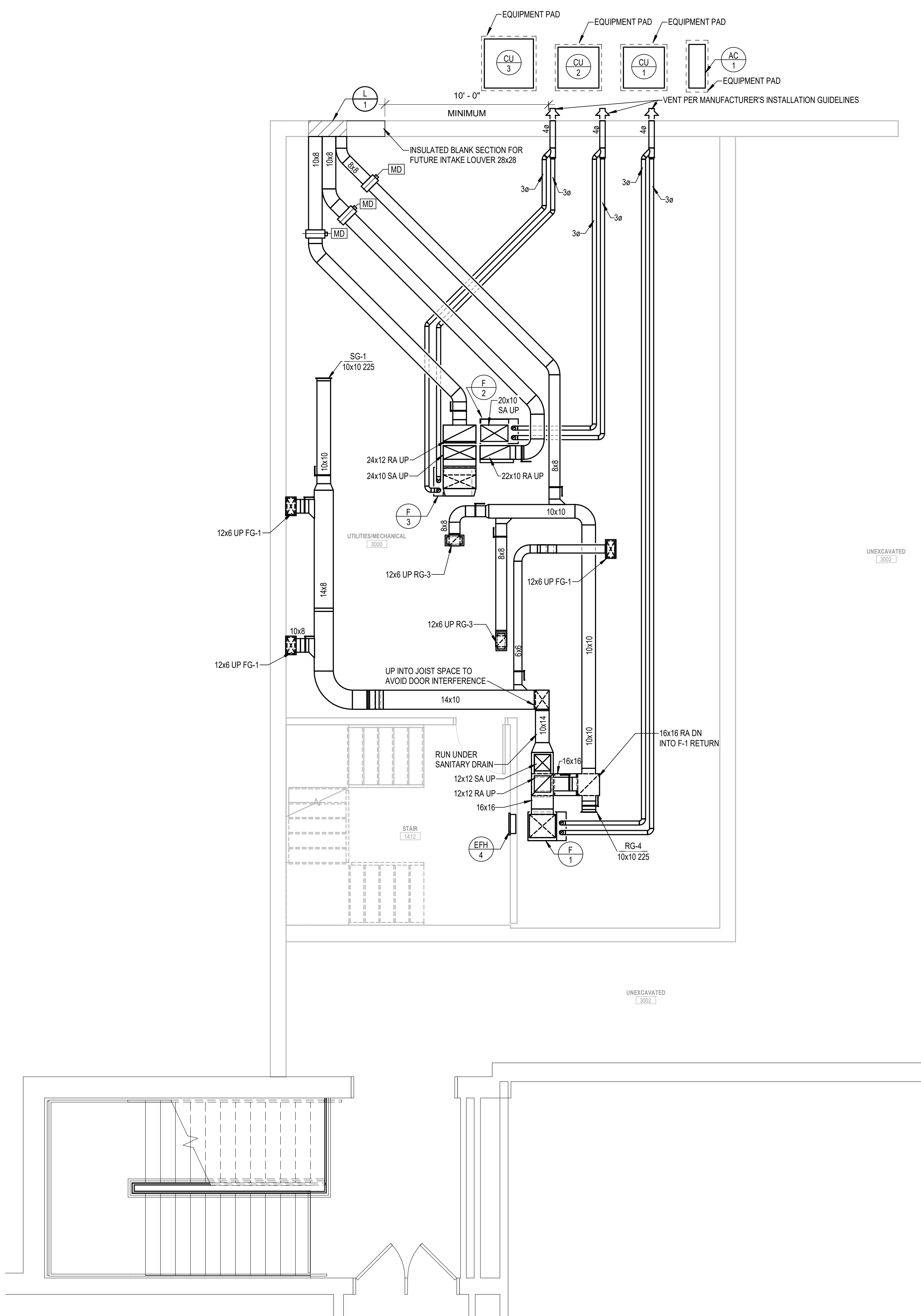
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MEP PROJECT NO.: H08.19.02



2 MECHANICAL DUCTWORK PLAN FIRST LEVEL
1/4" = 1'-0"



1 MECHANICAL DUCTWORK PLAN LOWER LEVEL
1/4" = 1'-0"



Project Title: **WITC - NEW RICHMOND CAMPUS VETERINARY TECHNICIAN ADDITION**
Project Location: **1019 SOUTH KNOWLES AVENUE, NEW RICHMOND, WISCONSIN 54017**
Project Number: **18043-6**
Project Date: **JULY, 2019**
Drawn By: **ACE**
Key Plan:

CONSTRUCTION DOCUMENTS

No.	Description	Date

Graphic Scale: **VARIES**
Last Update: **7/12/2019 10:39:39 AM**

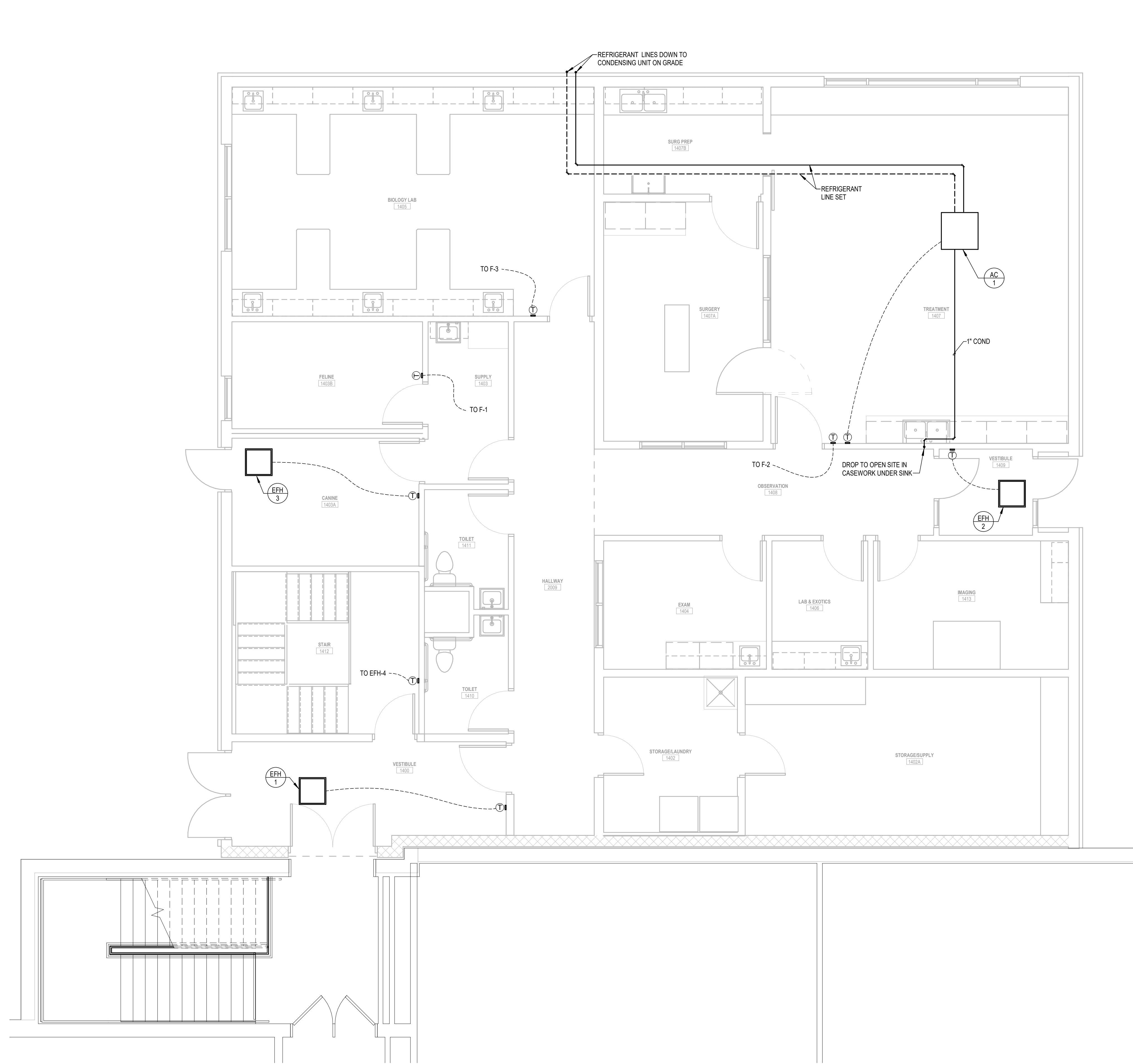
M101



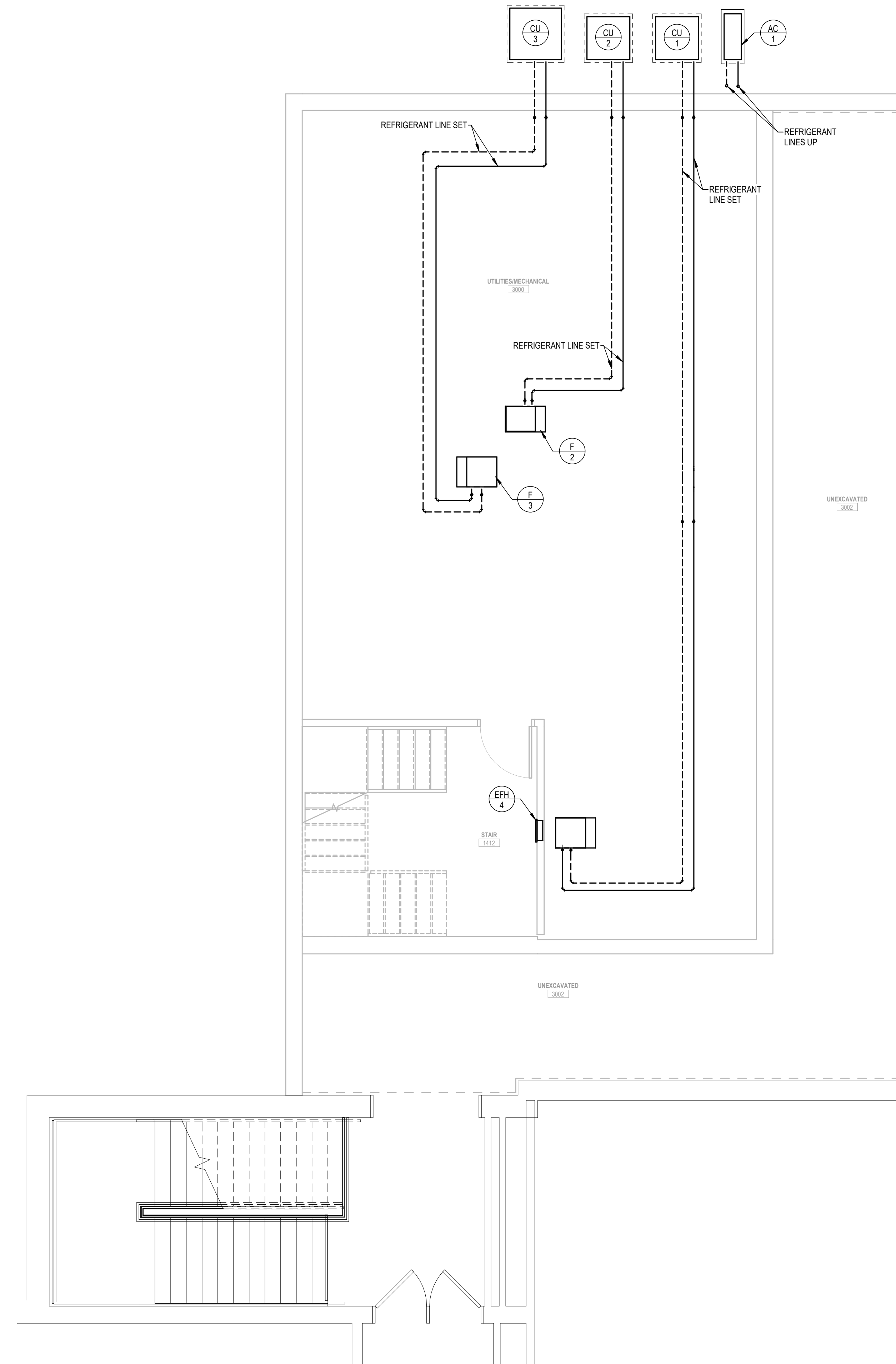
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MEP PROJECT NO.: H08.19.02



2 MECHANICAL PIPING PLAN FIRST LEVEL
1/4" = 1'-0"



1 MECHANICAL PIPING PLAN LOWER LEVEL
1/4" = 1'-0"



Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **MECHANICAL PIPING PLAN**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **ACE**

Key Plan:

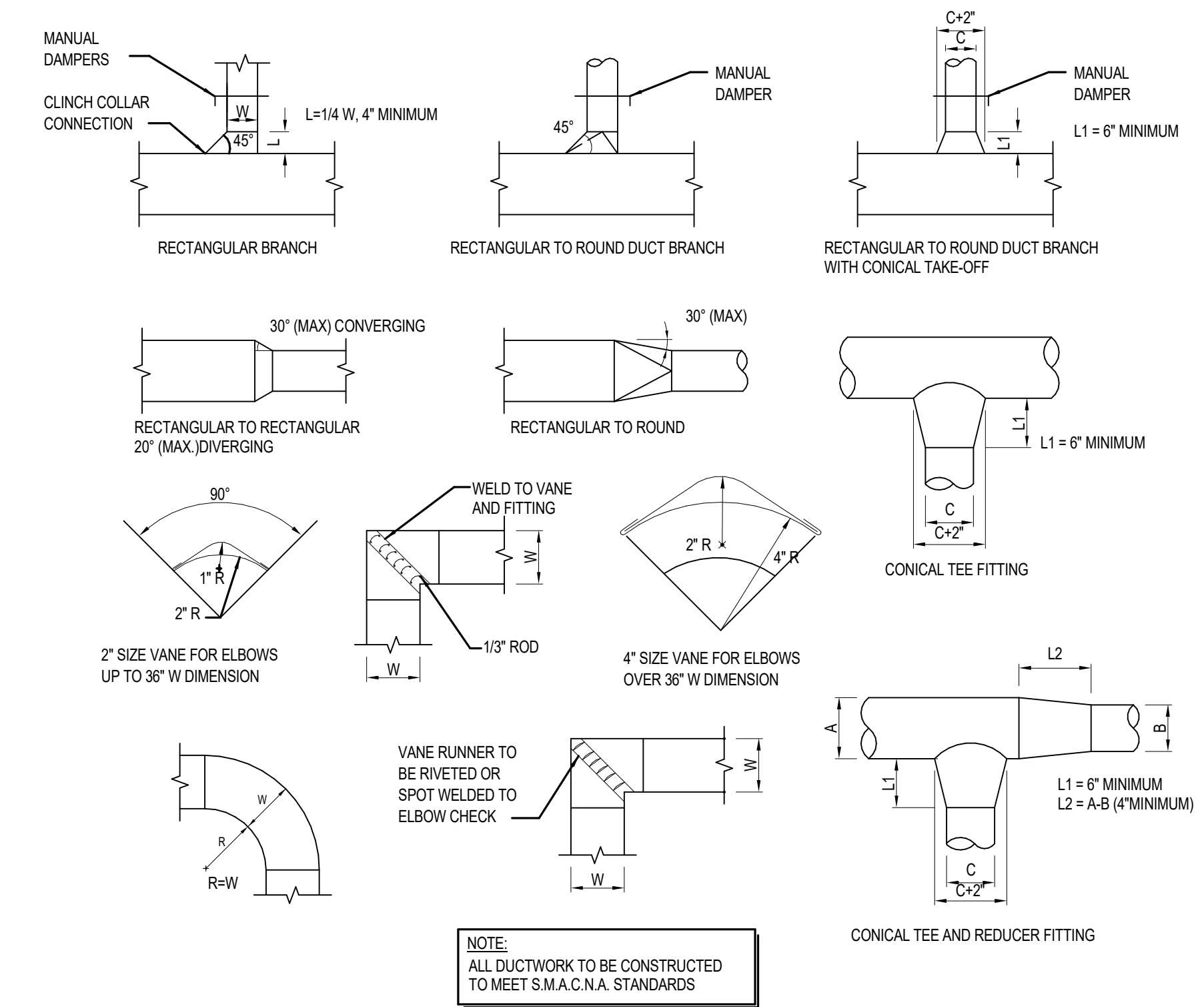
**CONSTRUCTION
DOCUMENTS**

No.	Description	Date

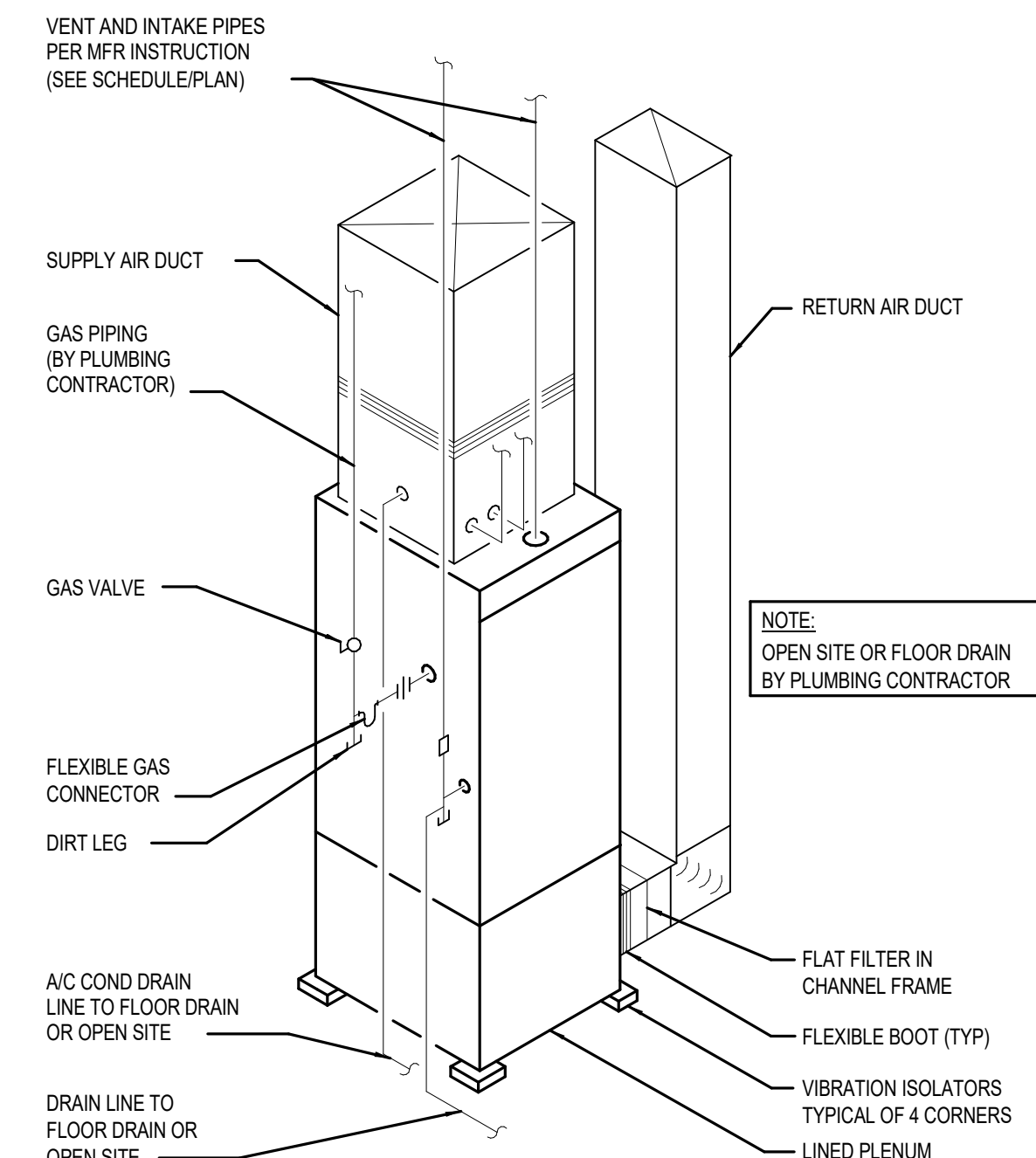
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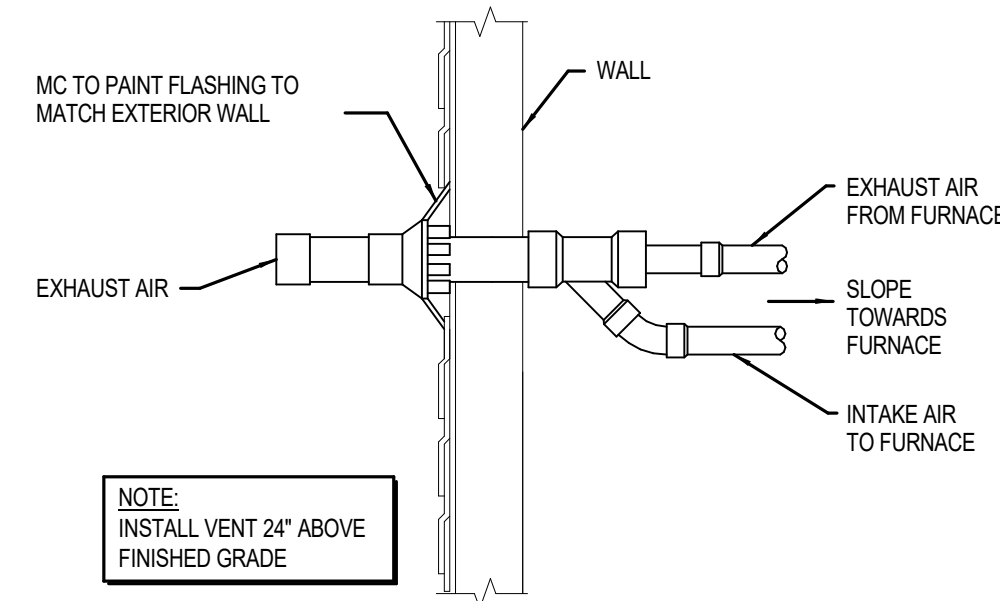
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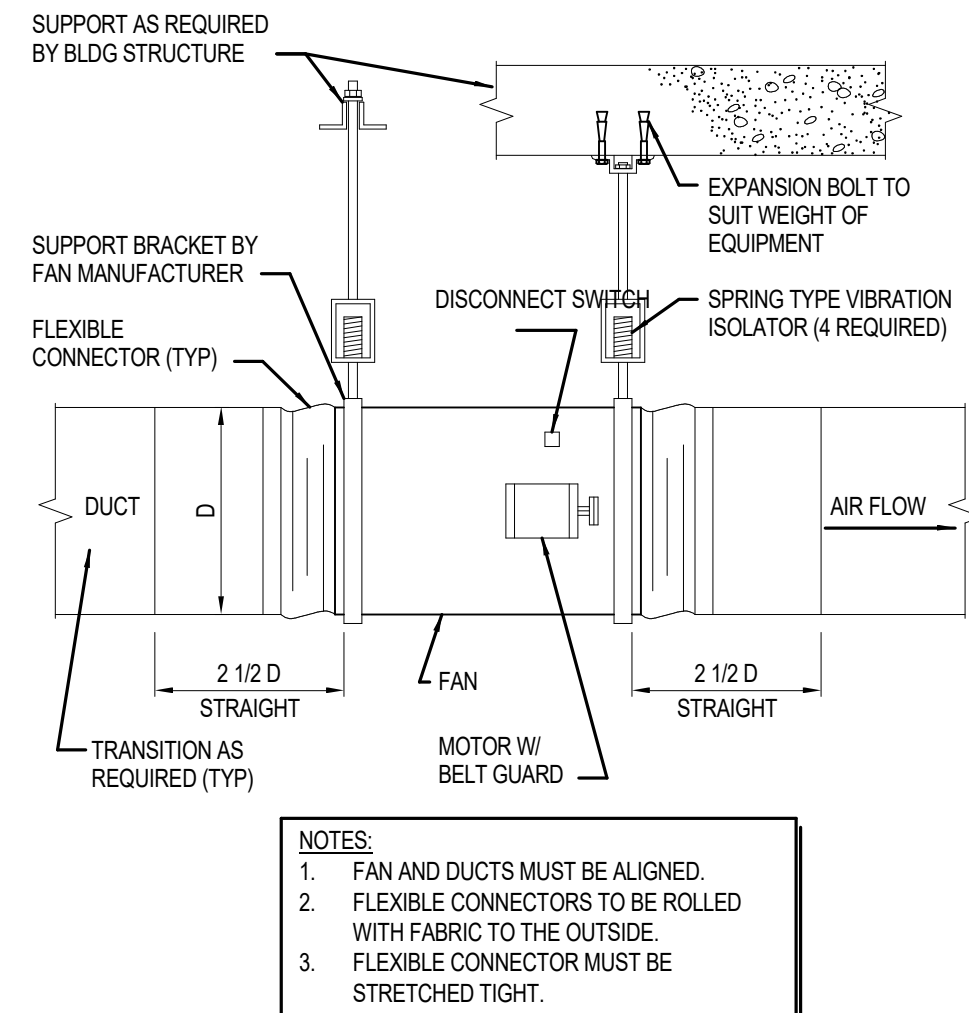
1 TYPICAL DUCTWORK DETAILS
NOT TO SCALE



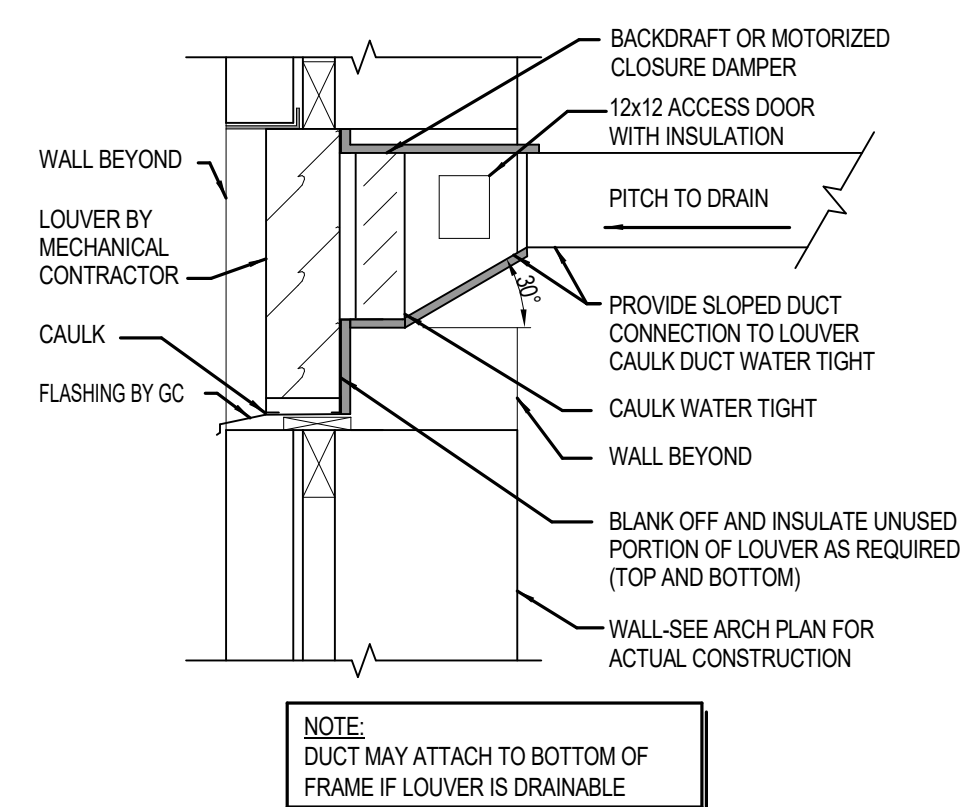
2 GAS FURNACE DETAIL
NOT TO SCALE



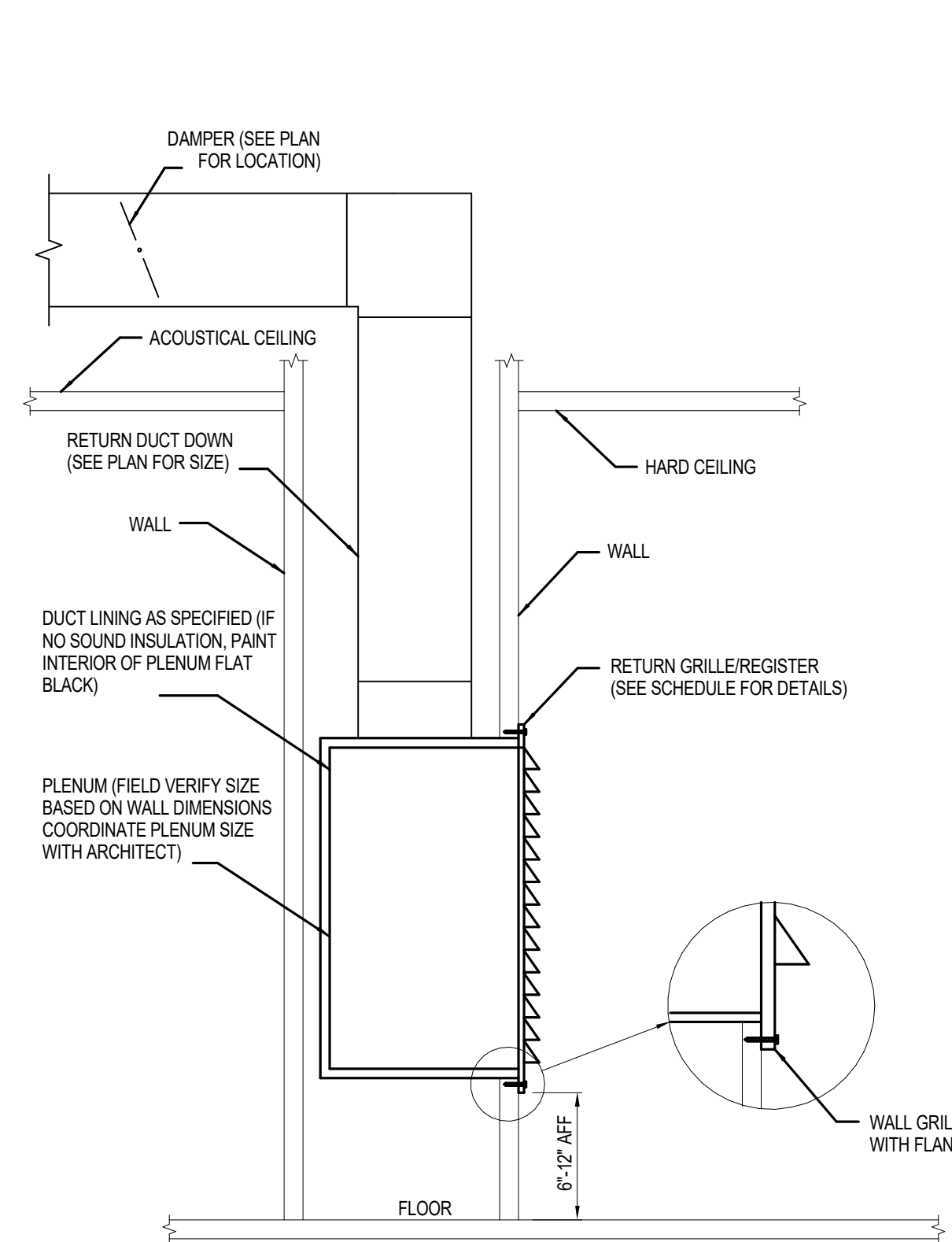
3 WALL VENT TERMINATION DETAIL
NOT TO SCALE



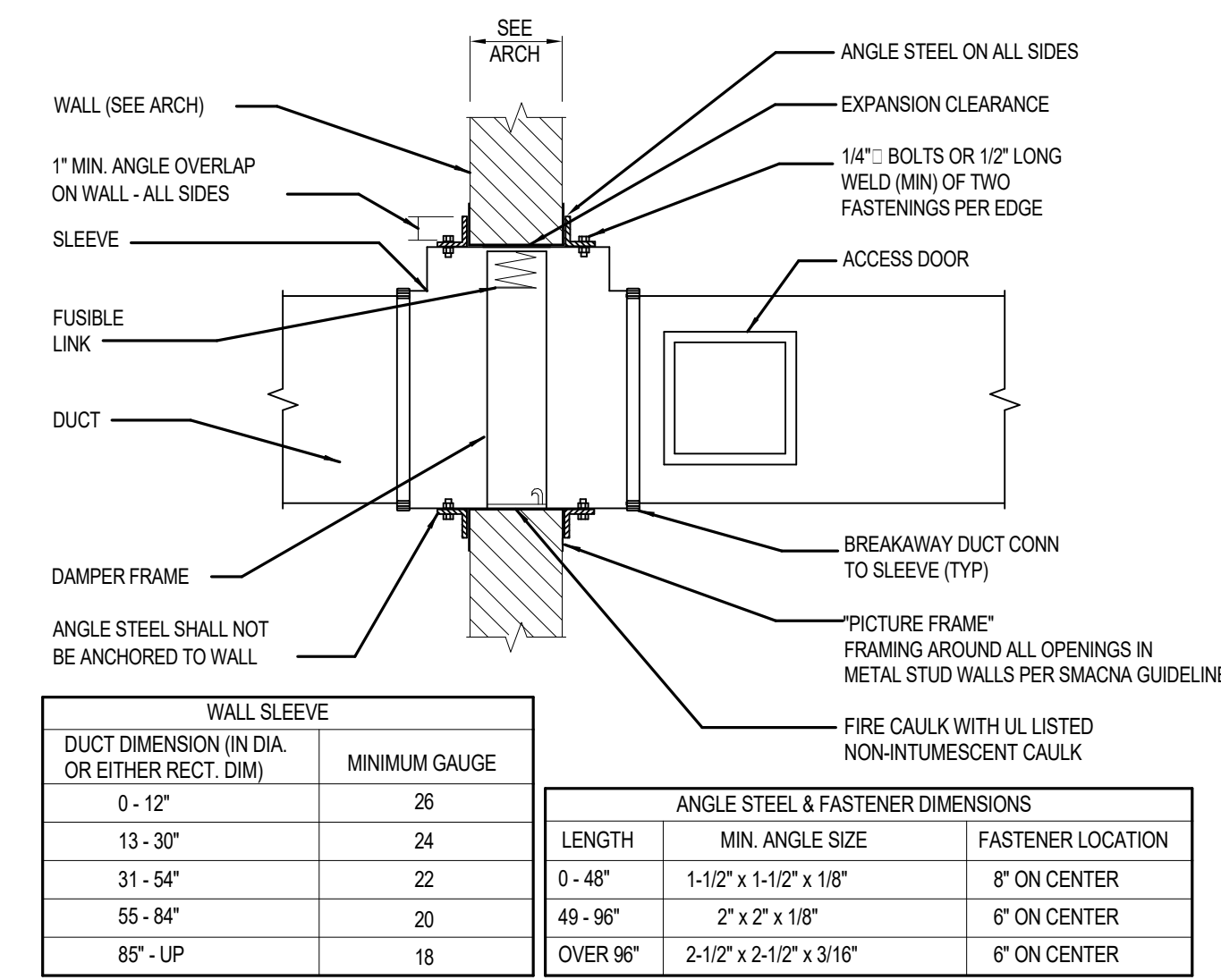
4 IN-LINE FAN MOUNTING DETAIL
NOT TO SCALE



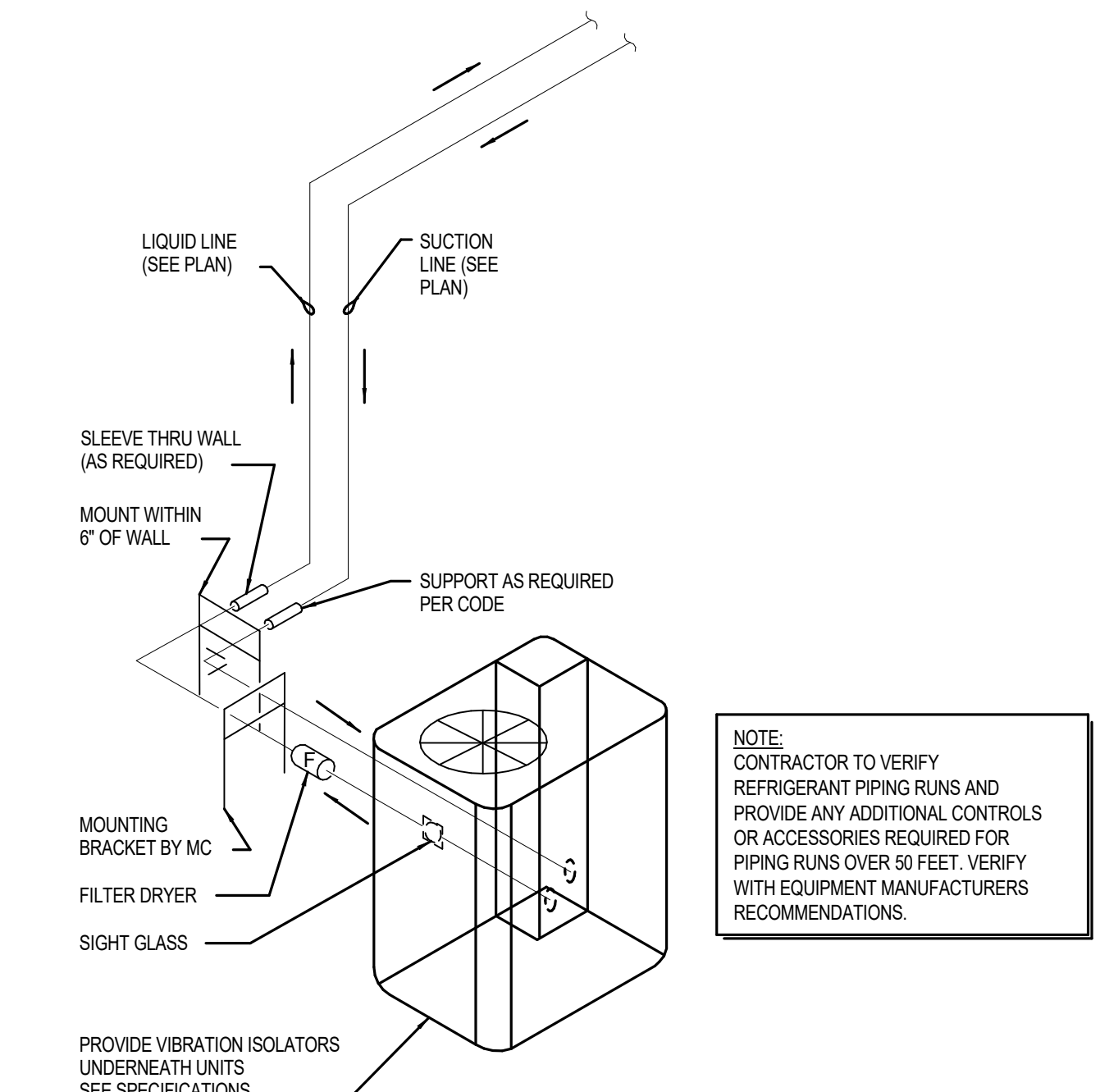
8 LOUVER CONNECTION DETAIL
NOT TO SCALE



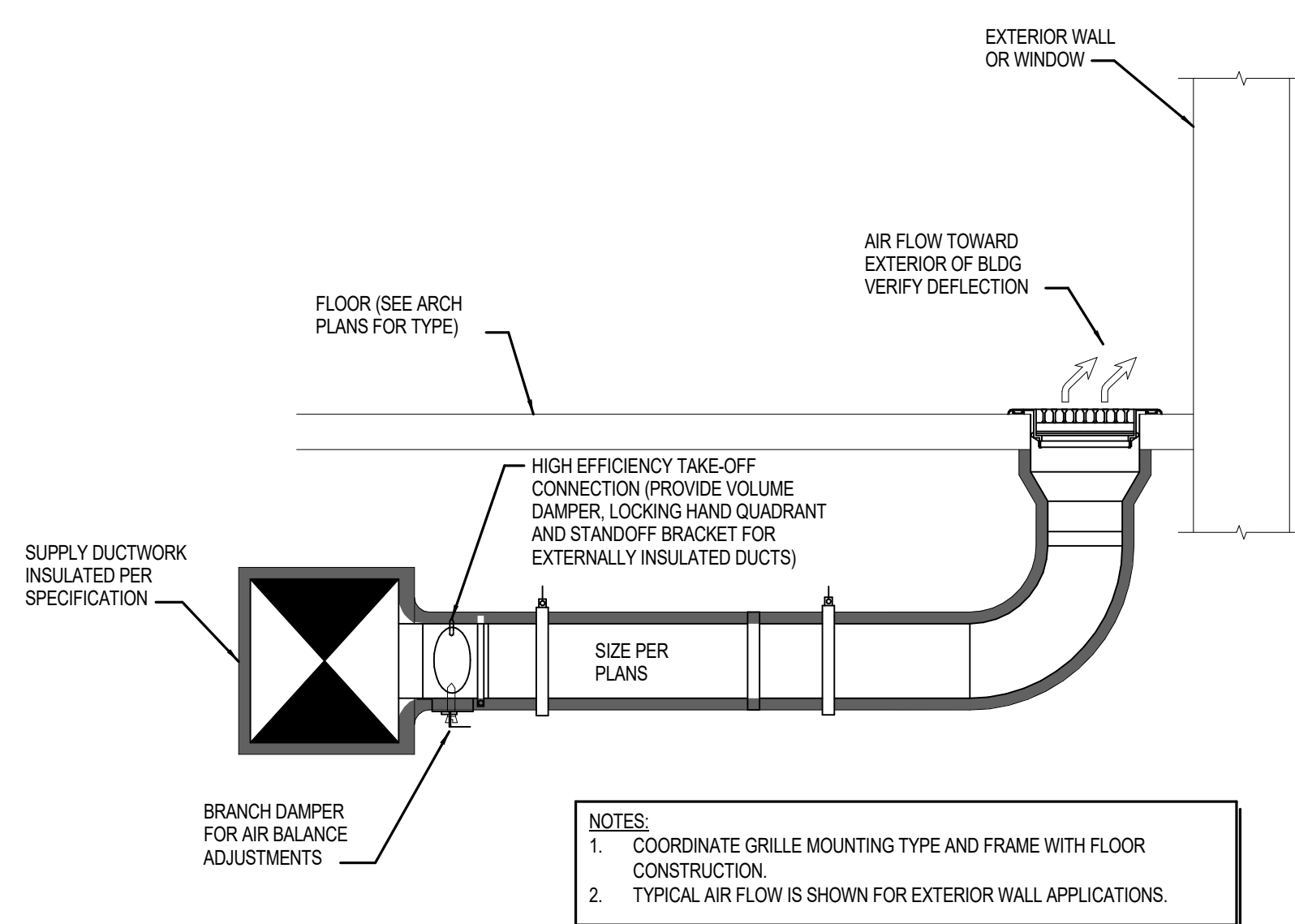
7 RETURN/EXHAUST WALL CONNECTION DETAIL
NOT TO SCALE



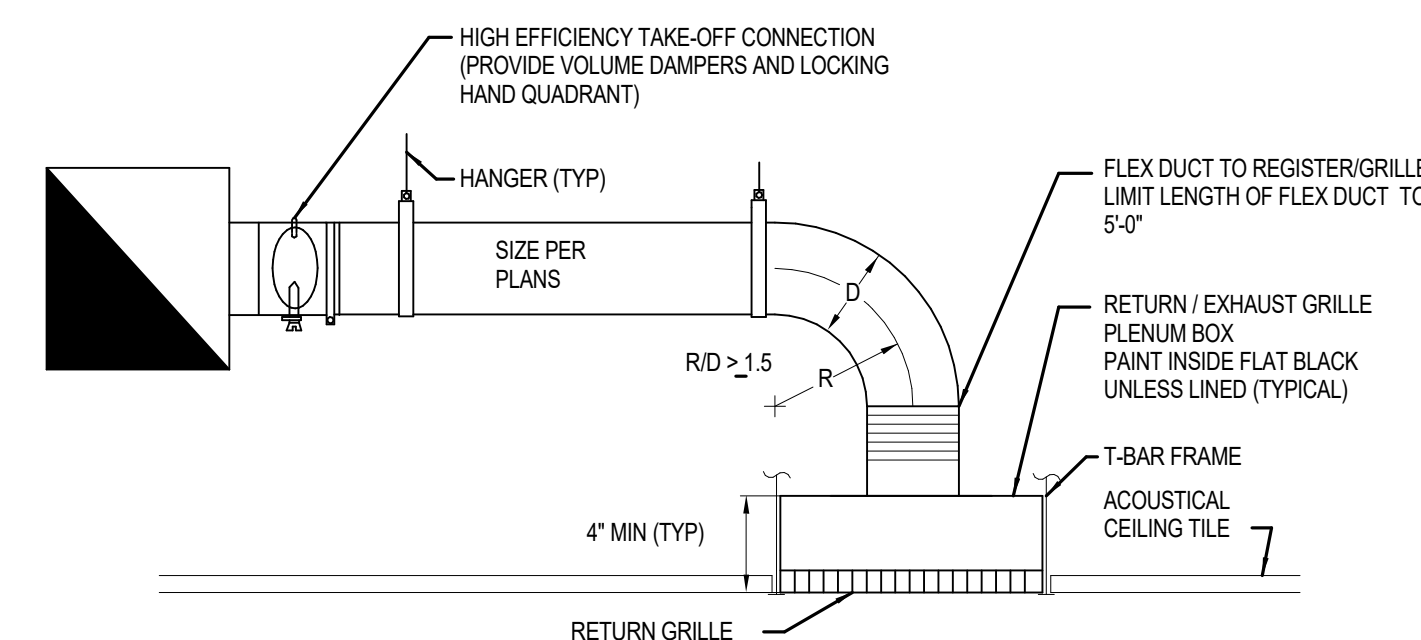
6 TYPE-B FIRE DAMPER DETAIL (VERTICAL)
NOT TO SCALE



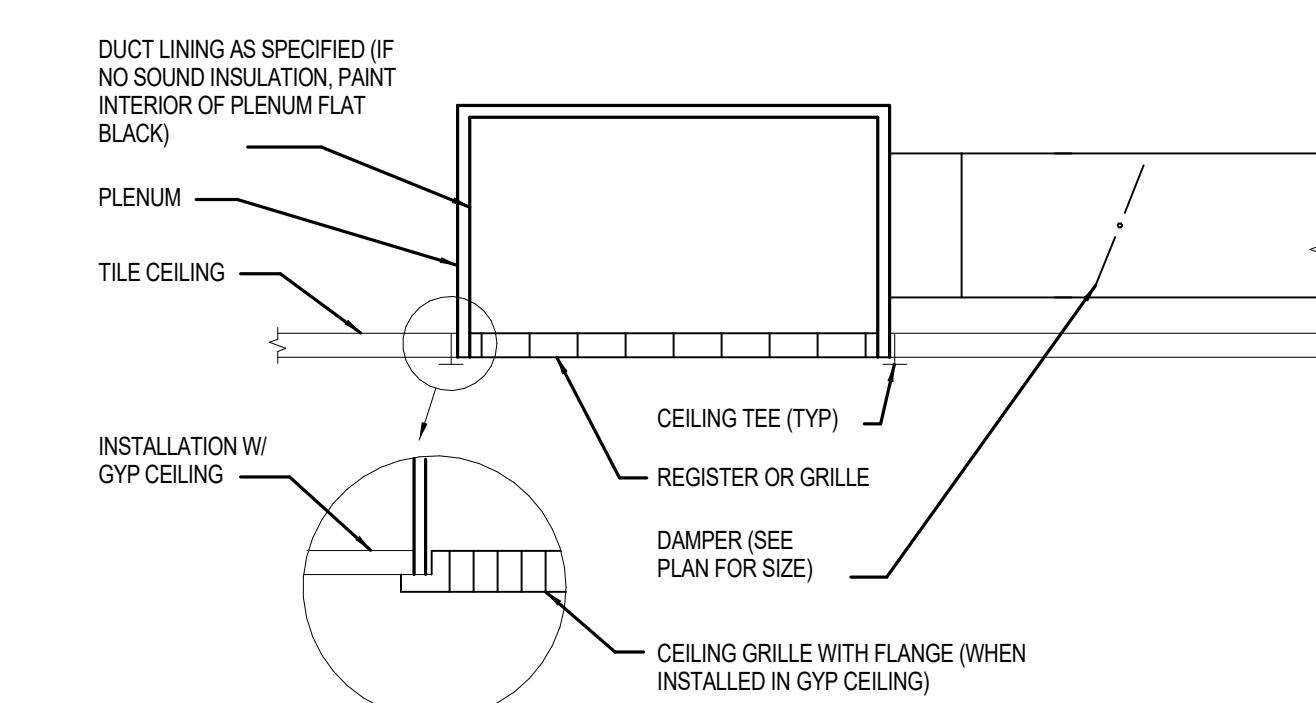
5 CONDENSING UNIT PIPING DETAIL
NOT TO SCALE



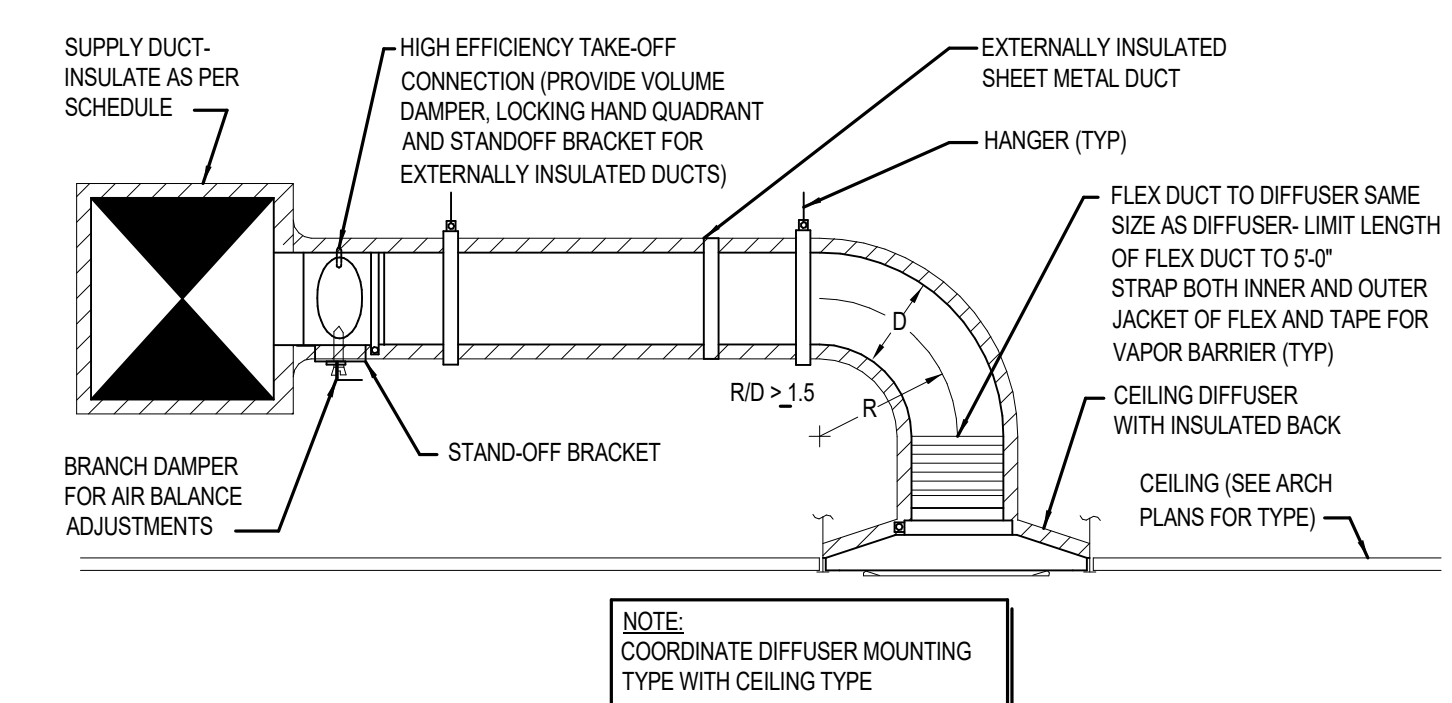
12 FLOOR MOUNTED SUPPLY GRILLE DETAIL
NOT TO SCALE



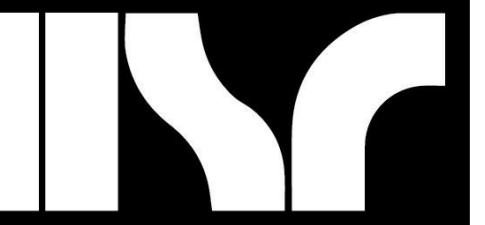
11 RETURN / EXHAUST AIR GRILLE PLENUM BOX
NOT TO SCALE



10 RETURN/EXHAUST CONNECTION DETAIL
NOT TO SCALE



9 CEILING DIFFUSER DETAIL
NOT TO SCALE



ELECTRIC FAN FORCED HEATER SCHEDULE												
EFH #	LOCATION	CFM	RECESS	WALL OR CEILING	KW	MBH	AMPS	ELEC. CHVR	CONTROL	WEIGHT	MANUFACTURER & MODEL NO.	NOTES
1	1400	300		CEILING	5	17.1	24	208/160	THERMOSTAT	27	MARLEY FFCH58	1-4
2	1403A	300	YES	CEILING	3	10.2	14.2	208/160	THERMOSTAT	27	MARLEY FFCH58	1-4
3	1409	300	YES	CEILING	3	10.2	14.2	208/160	THERMOSTAT	27	MARLEY FFCH58	1-4
4	1412	100	YES	WALL	1.8	6.1	15	120/160	THERMOSTAT	23	MARLEY FRA1812	1-3

NOTES:
1. COORDINATE UNIT COLOR WITH ARCHITECT.
2. FACTORY MOUNTED DISCONNECT SWITCH.
3. THERMOSTAT IN SPACE CONTROLS FAN ONLY ON A CALL FOR HEAT. THERMOSTAT PROVIDED BY TEMPERATURE CONTROLS CONTRACTOR.
4. FULLY RECESSED UNIT IN CEILING.

LOUVER SCHEDULE											
L #	CONNECTED TO	OA INTAKE OR EXHAUST LOUVER	SIZE DIMENSION (IN)	MIN. FREE AREA	CFM	FLANGE	CONSTRUCTION	MOD INCLUDED?	MANUFACTURER & MODEL NO.	COMMENTS	NOTES
1	F-1,2,3	OA INTAKE	28x16	1.26	640	NO	EXTRUDED ALUMINUM	NO	GREENHECK ESO-403	COLOR BY ARCHITECT	1-2

NOTES:
1. MOTORIZED DAMPER BY TEMPERATURE CONTROL. POWER TO ACTUATOR BY E.C.
2. M.C. TO PROVIDE LOUVER WITH BIRSCREEN OPTION.

GRILLE, REGISTER, AND DIFFUSER SCHEDULE							
PLAN SYMBOL	DESCRIPTION	MANUFACTURER & MODEL NO.	MATERIAL	FINISH	NOISE CRITERIA	ACCESSORIES	
CD-1	24x24 SQUARE FACE, ROUND NECK, 4-WAY DEFLECTION CEILING DIFFUSER. SPRING LOCK INNER CORE, FOR LAY-IN CEILING INSTALLATION.	KRUEGER 1400	STEEL	WHITE	-	-	-
CD-2	24x24 SQUARE FACE, ROUND NECK, 4-WAY DEFLECTION CEILING DIFFUSER. SPRING LOCK INNER CORE, FOR SURFACE MOUNT INSTALLATION.	KRUEGER 1400	STEEL	WHITE	-	-	-
FG-1	LINEAR BAR GRILLE, 7/32" THICK FIXED BARS AT 0° DEFLECTION. 7/16" BAR SPACING (PENCIL PROOF), FOR FLOOR INSTALLATION.	KRUEGER 1800	ALUMINUM	ALUMCAN	-	-	-
SG-1	SIDEWALL GRILLE, ADJUSTABLE HORIZONTAL FRONT BLADES, 3/4" O.C. FLAT FRAME WITH 1 1/4" MARGIN, HORIZONTAL FRONT.	KRUEGER 930	ALUMINUM	WHITE	-	-	-
RG-1	SQUARE PATTERN GRILLE, FIXED CORE OF 1/2"x1/2"x1/2" FABRICATED ALUMINUM SQUARES, FLAT FRAME WITH 1 1/4" MARGIN, FOR LAY-IN CEILING INSTALLATION.	KRUEGER EGC-5-TB	ALUMINUM	WHITE	-	-	-
RG-2	SQUARE PATTERN GRILLE, FIXED CORE OF 1/2"x1/2"x1/2" FABRICATED ALUMINUM SQUARES, FLAT FRAME WITH 1 1/4" MARGIN, FOR SURFACE MOUNT INSTALLATION.	KRUEGER EGC-5-TB	ALUMINUM	WHITE	-	-	-
RG-3	LINEAR BAR GRILLE, 7/32" THICK FIXED BARS AT 0° DEFLECTION. 7/16" BAR SPACING (PENCIL PROOF), FOR FLOOR INSTALLATION.	KRUEGER 1800	ALUMINUM	ALUMCAN	-	-	-
RG-4	SIDEWALL GRILLE, STATIONARY DEFLECTION VANES, 3/4" O.C., 35° ANGLE. FLAT FRAME WITH 1 1/4" MARGIN, HORIZONTAL FRONT.	KRUEGER SS80H	ALUMINUM	WHITE	-	-	-
EG-1	SQUARE PATTERN GRILLE, FIXED CORE OF 1/2"x1/2"x1/2" FABRICATED ALUMINUM SQUARES, FLAT FRAME WITH 1 1/4" MARGIN, FOR LAY-IN CEILING INSTALLATION.	KRUEGER EGC-5	ALUMINUM	WHITE	-	-	-

NOTES:
1. PROVIDE SPEED CONTROLLER OPTION.
2. FAN INTERLOCKED WITH AHU OCCUPIED MODE. FAN TO RUN WHENEVER AIR HANDLING UNIT IS IN OCCUPIED MODE.
3. INCLUDED IN BASE BID, PROVIDE "ALTERNATE BID" TO REMOVE FAN AND ASSOCIATED DUCTWORK.
4. FURNISH WALL SWITCH OR 6-60 MIN. TIMER, INSTALLED BY ELECTRICAL CONTRACTOR.

DUCTWORK/INSULATION SCHEDULE											
SYSTEM	LOW PRESSURE			MED. PRESS.		HIGH PRESS.		INSULATION		NOTES	
	MAX. PRES.	SEAL	C	MAX. PRES.	SEAL	MAX. PRES.	SEAL	INTERNAL THICKNESS	EXTERNAL THICKNESS		
SUPPLY AIR WITHIN 10 FEET OF F-1, F-2, F-3	2"	-	X	-	-	-	-	YES	1"	NO	1.2
SUPPLY AIR BEYOND 10 FEET OF F-1, F-2, F-3	2"	X	-	-	-	-	-	NO	-	YES	1 1/2" FSK
RETURN AIR TO MIXED AIR	2"	X	-	-	-	-	-	NO	-	NO	1.2
MIXED AIR WITHIN 10 FEET OF F-1, F-2, F-3	2"	-	X	-	-	-	-	YES	1"	NO	1.2
MIXED AIR BEYOND 10 FEET OF F-1, F-2, F-3	2"	-	X	-	-	-	-	NO	-	YES	1 1/2" FSK
OUTSIDE AIR TO F-1, F-2, F-3	2"	-	X	-	-	-	-	NO	-	YES	3" FSK
EXHAUST AIR	2"	-	X	-	-	-	-	NO	-	YES	1 1/2" FSK

NOTES:
1. PROVIDE RIGID INSULATION ON ALL DUCTWORK IN MECHANICAL ROOMS THAT REQUIRE INSULATION.
2. EXPOSED DUCTWORK SHALL BE PRIMED AND PAINTED BY PAINTING CONTRACTOR TO COLOR SPECIFIED BY ARCHITECT.

GAS FURNACE SCHEDULE																				
F #	TYPE	INPUT MBH	OUTPUT MBH	A/FUE	C.F.M.	MIN. F.A.	BURNER STAGES	EXT. S.P.	HEAT EXCH. MT.	BLOWER SIZE	DRIVE	H.P.	ELEC. CHVR	MCA	MOP	PILOT	VENT	FILTER	MANUFACTURER & MODEL NO.	NOTES
1	GAS	80	76.8	96	1280	100	2	0.8	STAINLESS STEEL	11x10	ECM	3/4	115/80/1	11.6	15	NA	3	NOTE #3	DAIKIN DM8V6080CN	1-5
2	GAS	80	57.6	96	1070	230	2	0.8	STAINLESS STEEL	11x8	ECM	1/2	115/80/1	8.0	15	NA	3	NOTE #3	DAIKIN DM8V6080CN	1-5
3	GAS	80	76.8	96	1440	210	2	0.8	STAINLESS STEEL	11x10	ECM	3/4	115/80/1	11.6	15	NA	3	NOTE #3	DAIKIN DM8V6080CN	1-5

NOTES:
1. PROVIDE CONCENTRIC VENT KIT. INSTALL PER MANUFACTURER INSTRUCTIONS. MAINTAIN MINIMUM CLEARANCES: 30" BETWEEN VENTS, 10" FROM ANY FRESH AIR INTAKE.
2. MFR PROVIDED TWINNING KIT.
3. MANUFACTURER'S SIDE RETURN FILTER RACK.
4. CONDENSATE NEUTRALIZER KIT.
5. PROVIDE CONDENSATE LINE TO FLOOR DRAIN.

CONDENSING UNIT SCHEDULE														
CU #	NOMINAL TONNAGE	CONDENSING UNIT							EVAPORATOR COOL		MANUFACTURER & MODEL NO.		NOTES	
		ELEC. CHVR	MCA/MOCP	RLA	E.E.R.	FAN QUANTITY	COMPRESSOR STAGE	SOUND PWR dBA	CFM	S.P.	CFM	S.P.		
1	3	208/160	19.7	30	15.3	12.5	1	2	73	DAIKIN DX16T0361	1260	0.32	DAIKIN CAPF3636B6	1-3
2	3	208/160	19.7	30	15.3	12.5	1	2	73	DAIKIN DX16T0361	1070	0.28	DAIKIN CAPF3636B6	1-3
3	4	208/160	26.7	45	21.2	12.5	1	2	74	DAIKIN DX16T0481	1440	0.30	DAIKIN CAPF4860C6	1-3

NOTES:
1. PROVIDE FACTORY MOUNTED DISCONNECT SWITCH OPTION.
2. PROVIDE MANUFACTURER INSTALLED FIELD POWERED GF RECEPTACLE OPTION.
3. MOUNT CONDENSING UNIT ON PADS PROVIDED BY GENERAL CONTRACTOR IN LOCATION SHOWN ON M100

EXHAUST FAN SCHEDULE															
EF #	ROOM NO.	SYSTEM	CFM	ESP	WHEEL TYPE & SIZE	RPM	MOTOR H.P.	ELECTRICAL CHAR	BACK DRAFT DAMPER	DRIVE	FAN TYPE	CONTROL	MANUFACTURER & MODEL NO.		NOTES
													CFM	ESD	
1	1403A	GENERAL EXHAUST	150	.25	BI	1123	1/12	115/160	YES	DIRECT	CENTRIFUGAL	WALL SWITCH	GREENHECK SO-80-D	1-2,5	
2	1403A	GENERAL EXHAUST	150	.375	BI	1331	1/12	115/160	YES	DIRECT	CENTRIFUGAL	INTERLOCK WITH LIGHT SWITCHES	GREENHECK SO-80-D	1-2	
3	1403A	GENERAL EXHAUST	100	.25	BI	1365	1/30	115/160	YES	DIRECT	CENTRIFUGAL	INTERLOCK WITH F-1	GREENHECK SO-70-D	1-3	
4	1403B	GENERAL EXHAUST	150	.25	BI	1123	1/12	115/160	YES	DIRECT	CENTRIFUGAL	WALL SWITCH	GREENHECK SO-80-D	1-2,5	
5	1405	GENERAL EXHAUST	250	.25	BI	1326	1/12	115/160	YES	DIRECT	CENTRIFUGAL	0-60 MIN. TIMER	GREENHECK SO-80-D	1-4,5	
6	1407	GENERAL EXHAUST	100	.25	BI	1355	1/30	115/160	YES	DIRECT	CENTRIFUGAL	WALL SWITCH	GREENHECK SO-70-D	1-2,5	

NOTES:
1. FACTORY MOUNTED DISCONNECT SWITCH.
2. PROVIDE SPEED CONTROLLER OPTION.
3. FAN INTERLOCKED WITH AHU OCCUPIED MODE. FAN TO RUN WHENEVER AIR HANDLING UNIT IS IN OCCUPIED MODE.
4. INCLUDED IN BASE BID, PROVIDE "ALTERNATE BID" TO REMOVE FAN AND ASSOCIATED DUCTWORK.
5. FURNISH WALL SWITCH OR 6-60 MIN. TIMER, INSTALLED BY ELECTRICAL CONTRACTOR.

FAN POWERED HEPA DIFFUSER SCHEDULE													
FPHD #	LOCATION	CFM	DIFFUSER SIZE	MOTOR TYPE	DUCT SIZE CONNECTION	ELEC. CHVR	WATTS	AMPS	CONTROL	WEIGHT	MANUFACTURER & MODEL NO.		NOTES
											CFM	ESD	
1	1407A	360	24x36	ECM	10a	115/1	130	2.1	WALL SWITCH	64	PRICE FFU-RSR		1-8
2	1407B	200	24x24	ECM	10a	115/1	130	2.4	WALL SWITCH	53	PRICE FFU-RSR		1.6,8-11

NOTES:
1. PROVIDE WITH ROOM SIDE FAN MOTOR ACCESS.
2. PROVIDE WITH ROOMSIDE REPLACEABLE HEPA FILTER.
3. PROVIDE WITH ROOMSIDE PRESSURE TEST PORT ACCESS.
4. PROVIDE WITH OPTIONAL AIRFLOW (RUNNING) LED STATUS LIGHT.
5. PROVIDE WITH HEPA FILTER LOADING/CHANGE INDICATOR LIGHT.
6. FAN SPEED SHALL BE LOCKED AT SCHEDULED AIRFLOW.
7. ELECTRICAL CONTRACTOR TO PROVIDE DISCONNECT.
8. PROVIDE WITH AEROSOL TEST SYSTEM FOR CHALLENGING HEPA FILTER INTEGRITY WITH ROOM-SIDE ACCESSIBLE PORT TO INJECT TRACER GAS.
9. PROVIDE WITH 10' DUCT COLLAR ACCESSORY.
10. PROVIDE WITH NECESSARY ACCESSORIES FOR INSTALLATION IN A HARD PLASTER CEILING.
11. MECHANICAL CONTRACTOR TO FURNISH WALL SWITCH, INSTALLED BY ELECTRICAL CONTRACTOR FOR FPHD-1.

SPLIT SYSTEM COOLING UNIT SCHEDULE															
SCU #	LOCATION	NOMINAL TONNAGE	OUTDOOR CONDENSING UNIT (SCU)							INDOOR EVAPORATOR UNIT (SEU)					
			ELEC. CHVR	MCA	S.E.E.R.	MOP	FAN SIZE	MANUFACTURER & MODEL NO.	CFM	WEIGHT (LBS)	ELEC. CHVR	MOP	MANUFACTURER & MODEL NO.		
1	1407	1	208/160	13	14.0	15	N/A	MITSUBISHI PLV-A12NH6	390-430	49	0.51	24V DC	N/A	MITSUBISHI PLV-A12NH6	1-8

NOTES:
1. CAPACITY BASED ON 80/67 °F (DB/WB) ENTERING AIR AT EVAPORATOR, 95/75 °F (DB/WB) AMBIENT OUTDOOR AIR AT CONDENSING UNIT.
2. CEILING MOUNTED INDOOR UNIT. GROUND MOUNTED OUTDOOR UNIT.
3. OUTDOOR UNIT TO BE CAPABLE OF OPERATING IN AMBIENT TEMPERATURES BETWEEN 20°F AND 115°F FOR YEAR-ROUND COOLING.
4. MECHANICAL CONTRACTOR TO INCLUDE PRE-CHARGE LINE KIT, INSULATE SUCTION LINE.
5. MECHANICAL CONTRACTOR TO INCLUDE HARD-WIRED WALL MOUNTED THERMOSTAT.
6. ELECTRICAL CONTRACTOR TO PROVIDE AND INSTALL DISCONNECT FOR INDOOR & OUTDOOR UNITS.
7. INTERCONNECTING POWER WIRING BY ELECTRICAL CONTRACTOR.
8. CONDENSATE DRAIN PUMP INCLUDED AS STANDARD ACCESSORY IN SCHEDULED MODEL.

No.	Description	Date

LIGHT FIXTURE SCHEDULE table with columns: TYPE, DESCRIPTION, MANUFACTURER, REFERENCE CATALOG #, LAMPS, VOLTS. Rows include various LED troffer and recessed fixtures.

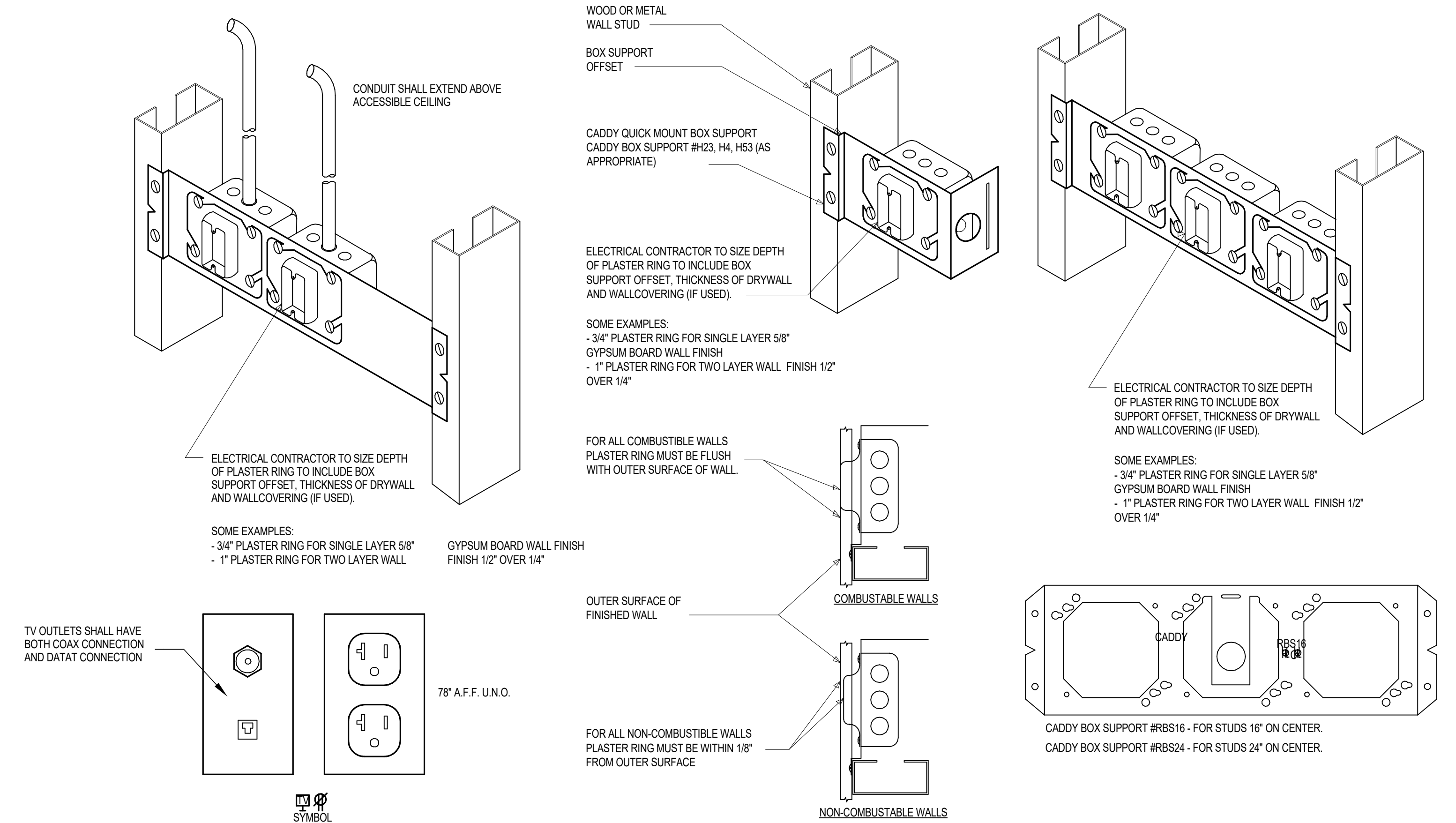
GENERAL ELECTRICAL NOTES. 16 numbered notes detailing installation requirements, coordination, and safety procedures for electrical work.

ELECTRICAL ABBREVIATIONS table listing codes for components like ABOVE COUNTERTOP, MAIN DISTRIBUTION PANEL, etc.

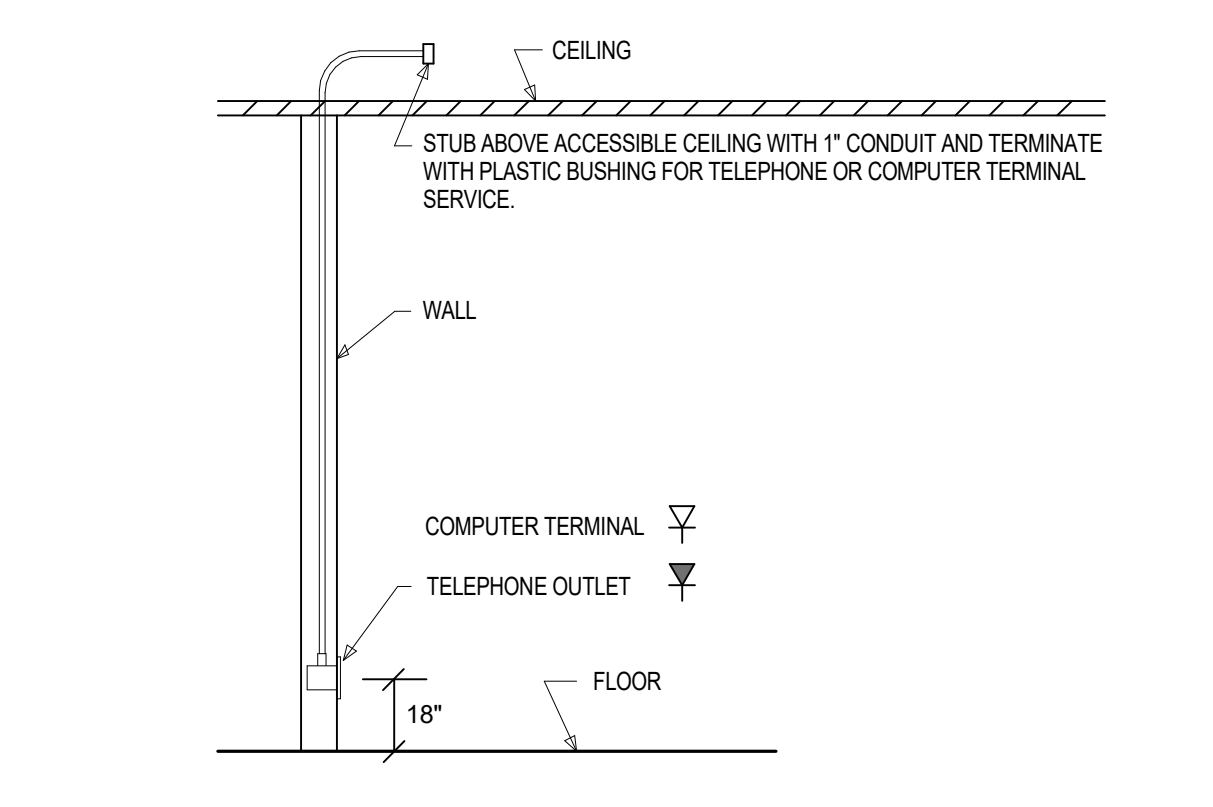
OCCUPANCY SENSOR SCHEDULE table with columns for sensor type, location, and manufacturer. Includes notes on sensor placement and installation.

ELECTRICAL SHEET INDEX table listing sheet numbers and titles: E001 ELECTRICAL NOTES, LEGENDS & ABBREVIATIONS, E101 ELECTRICAL SITE PLAN, etc.

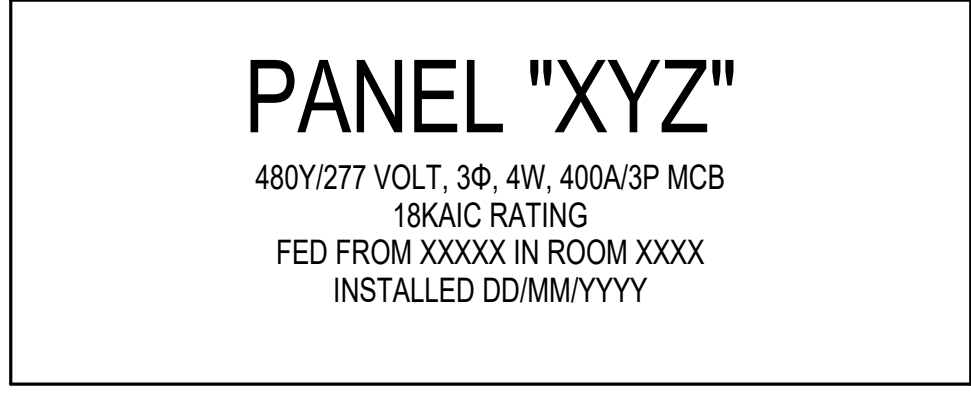
ELECTRICAL SYMBOLS LEGEND table. Divided into RECEPTACLES, LIGHTING, COMMUNICATIONS, POWER, FIRE ALARM, SECURITY. Includes symbols and descriptions for various electrical components.



1 MONITOR OUTLET DETAIL NO SCALE
2 BOX SUPPORT DETAIL NO SCALE
3 MULTIPLE BOX SUPPORT DETAIL NO SCALE



4 VOICE/DATA ROUGH-IN NO SCALE



ALL NEW PANELBOARDS SHALL BE IDENTIFIED USING AN ENGRAVED 2-PLEX ACRYLIC LABEL... EQUIPMENT NAMEPLATES SHALL BE 2" TALL x 5" WIDE... 1. EQUIPMENT NAME IN 3/16" MINIMUM HEIGHT LETTERING...

5 PANEL LABEL NO SCALE

EQUIPMENT COORDINATION SCHEDULE - MECHANICAL table. Columns include TAG, DESCRIPTION, HP / KW, MCA, VOLTS, CONDUCTORS, CONDUIT, LOCATION, PANEL, BREAKER SIZE, STARTER, DISCONNECT, NOTE.

GENERAL NOTES: 1. COORDINATE INSTALLATION OF MOTORS WITH MECHANICAL CONTRACTOR... 2. PROVIDE WATERPROOF (NEMA 3R) DISCONNECT SWITCH AT UNIT... 3. WALL SWITCH OR 0-60 MIN TIMER PROVIDED BY MC, INSTALLED BY EC.

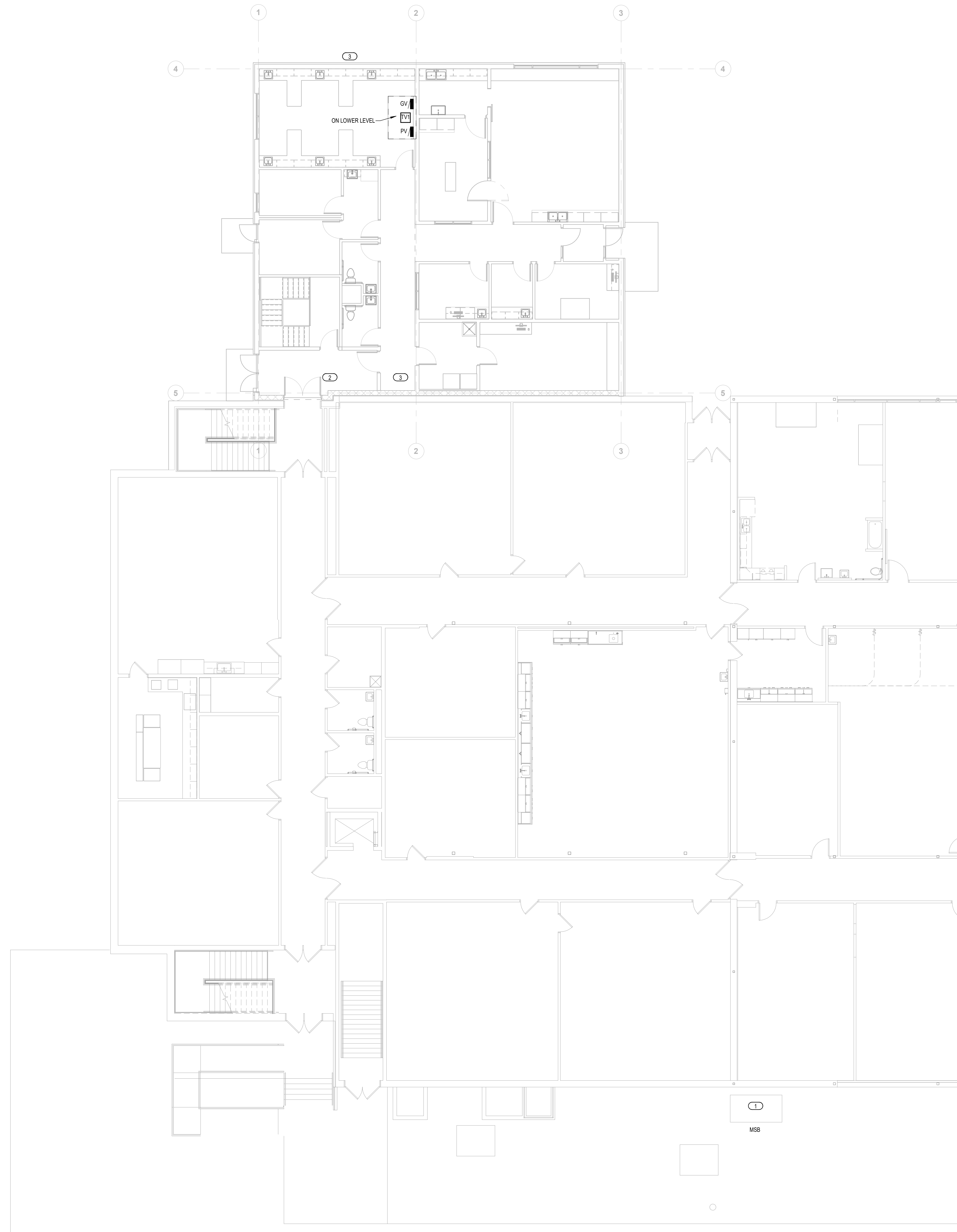


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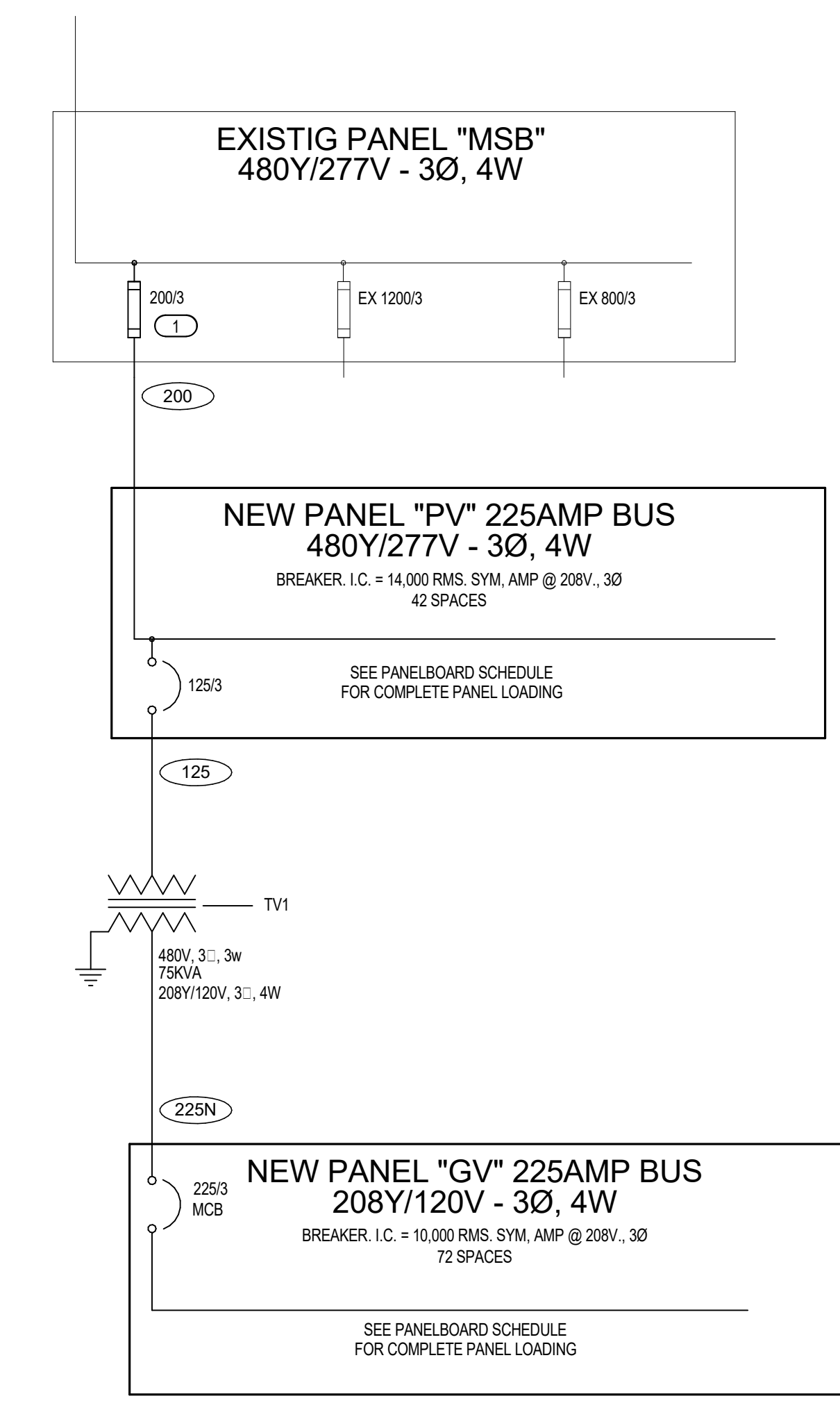
- KEYED NOTES**
- REPLACE EXISTING 800A SPARE FUSE IN EXTERIOR PANEL "MSB" WITH NEW 200A FUSE TO FEED NEW PANEL "PV". SEE 2E101. VERIFY EXISTING SPARE FUSE PRIOR TO INSTALLATION.
 - NEW CONDUIT PATH FROM EXISTING PANEL "MSB" TO NEW PANEL "PV" SHALL ENTER THE NEW ADDITION ABOVE ACCESSIBLE CEILING. EC SHALL KEEP ROOF CLEAR OF ELECTRICAL FOR FUTURE ADDITION.
 - EXISTING UNDERGROUND ELECTRICAL LINE. EC SHALL INTERCEPT AND REROUTE AS REQUIRED FOR THE CONSTRUCTION OF NEW BUILDING. THE NEW ROUTE MAY RUN THROUGH THE NEW BASEMENT TIGHT TO STRUCTURE. EC SHALL PROVIDE A TEMPORARY REROUTE DURING CONSTRUCTION.

FEEDER SCHEDULE

AMPS	CONDUIT SIZE	PHASE CONDUCTORS	EQUIPMENT GROUND CONDUCTOR
125	2"	#1	#6
200	2"	#30	#6
225	2 1/2"	#40	#4

NOTES:

- FEEDER SIZES ARE ON THE PLAN WHERE 60 REFERS TO A 60A FEEDER WITHOUT NEUTRAL AND 60N REFERS TO A 60A FEEDER WITH NEUTRAL.
- SOME FEEDER SIZES DO NOT MATCH BREAKER SIZE DUE TO UP-SIZING OF THE FEEDER FOR VOLTAGE DROP.
- CONDUITS ARE SIZED PER NEC TABLES FOR THINWALL AND MAY BE UPSIZED FOR EASE OF PULLING OR DOWNSIZED AS ALLOWED PER NEC FOR CONDUIT TYPES BEING INSTALLED.
- ALL CONDUCTORS 100A AND LESS ARE SIZED PER 60 DEGREE LUGS. EC MAY SIZE CONDUCTORS FOR ACTUAL RATING OF LUGS PER NEC.



1 ELECTRICAL SITE PLAN
1/8" = 1'-0"



2 ELECTRICAL ONE-LINE DIAGRAM
NOT TO SCALE

WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION
 Project Location: 1019 SOUTH KNOWLES AVENUE
 NEW RICHMOND, WISCONSIN 54017
 Sheet Title: **ELECTRICAL SITE PLAN**

HSR Project Number: **18043-6**
 Project Date: **JULY, 2019**
 Drawn By: **JCN**

Key Plan:

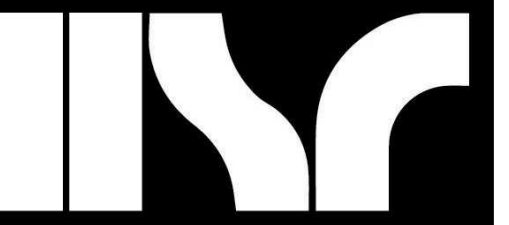
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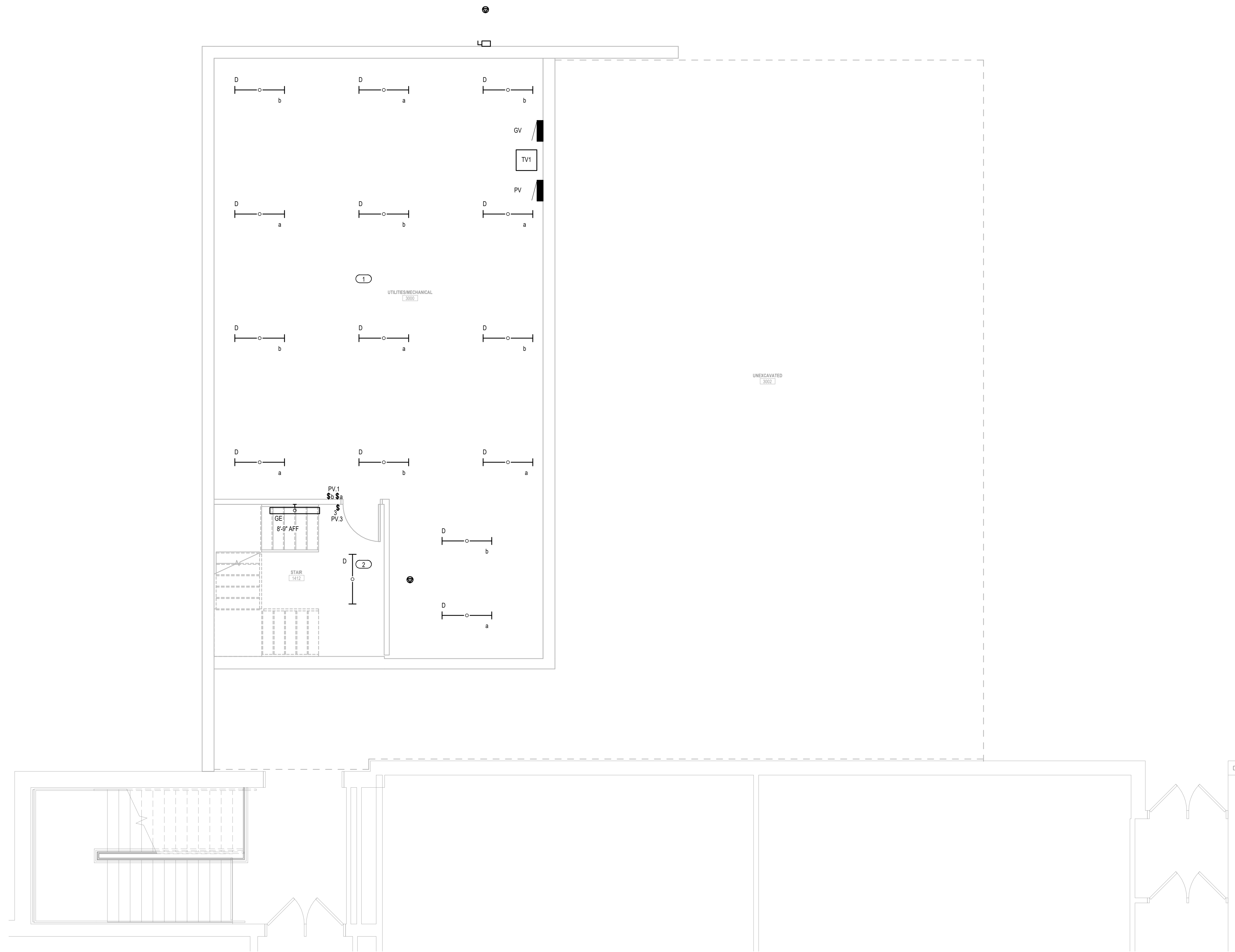
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KEYED NOTES	
1	EC SHALL ADJUST LOCATIONS AND HEIGHT OF AREA LIGHT FIXTURES AS REQUIRED FOR MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL CONTRACTOR.
2	TYPE "D" FIXTURE SHALL BE SURFACE MOUNTED TO THE UNDERSIDE OF LANDING ABOVE.



1 LOWER LEVEL LIGHTING PLAN

1/4" = 1'-0"



Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **ELECTRICAL LOWER LEVEL LIGHTING PLAN**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **JCN**

Key Plan:

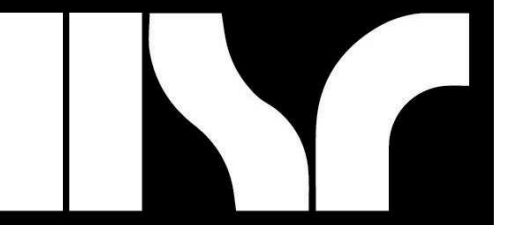
**CONSTRUCTION
DOCUMENTS**

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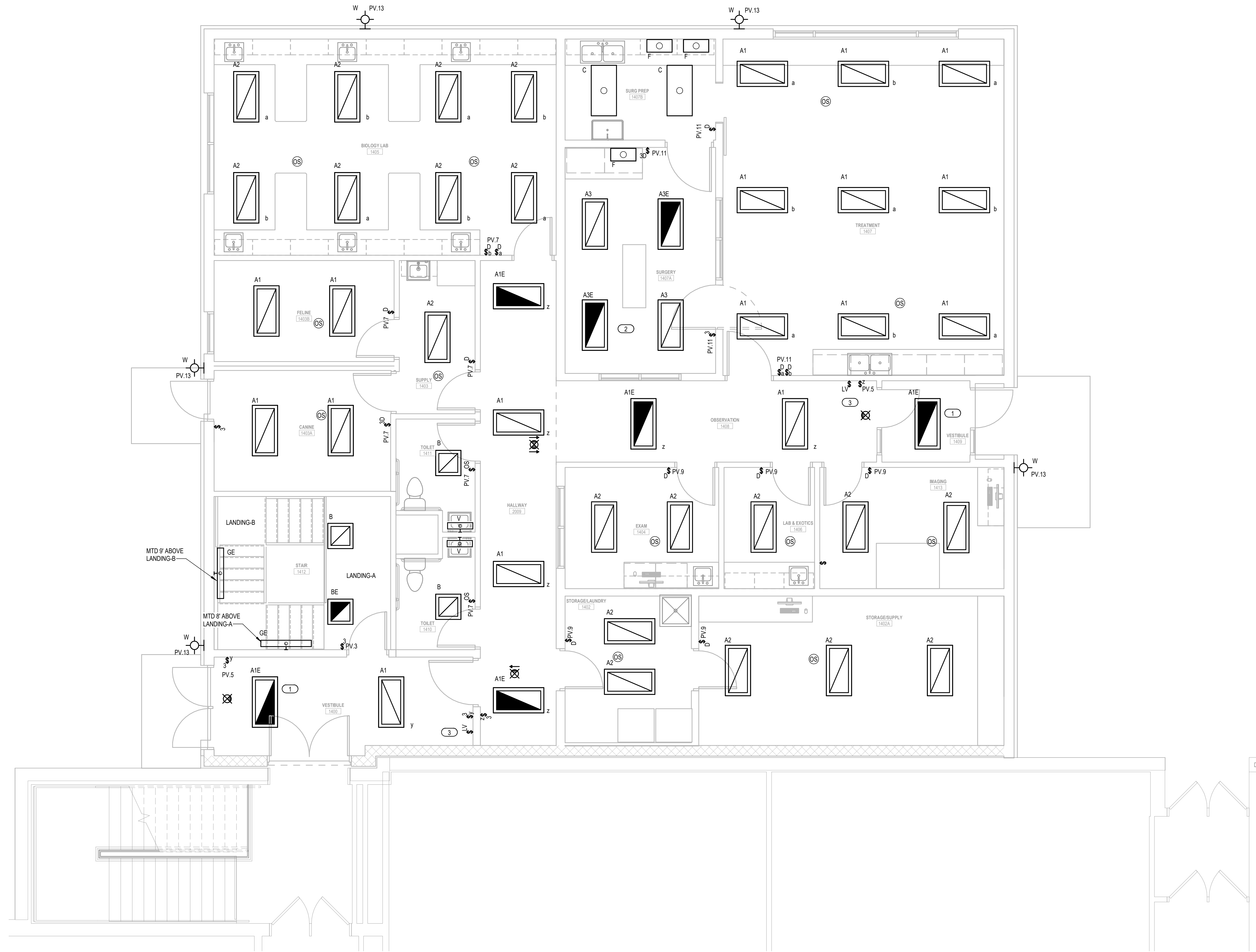
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MEP PROJECT NO.: H08.19.02

GENERAL NOTES

1. PROVIDE REMOTE BATTERY BACKUP AND PHOTOCELL FOR TYPE "W" FIXTURES.
2. TIE NEW LIGHTING INTO EXISTING BUILDING AUTOMATION SYSTEM.

KEYED NOTES

1. EMERGENCY FIXTURE TO REMAIN ON 24 HOURS
2. AREA FIXTURES SHALL BE RECESS MOUNTED IN HARD CEILING. COORDINATE WITH GENERAL AND MECHANICAL CONTRACTORS.
3. LOW VOLTAGE OVERRIDE SWITCH TO TIE INTO EXISTING CONTROL PANEL TO SERVE NEW CORRIDORS. SWITCH SHALL OVERRIDE LIGHTING CONTROL SYSTEM FOR 2 HOUR PERIOD.



1 FIRST FLOOR LIGHTING PLAN
1/4" = 1'-0"



Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: **1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017**
Sheet Title: **ELECTRICAL FIRST FLOOR LIGHTING PLAN**

Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **JCN**

Key Plan:

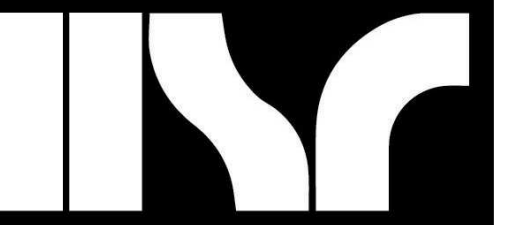
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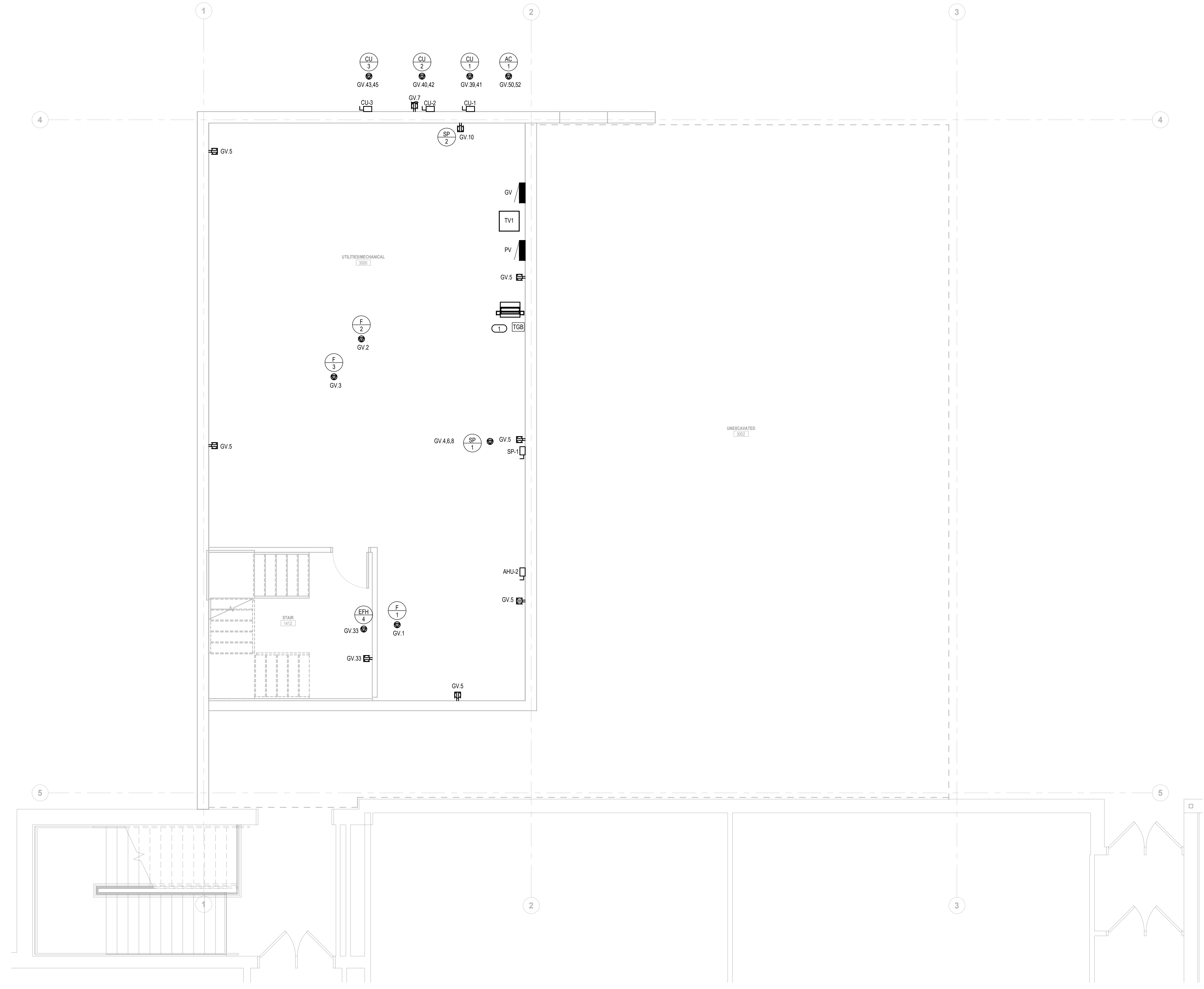
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KEYED NOTES	
1	OWNER TO FURNISH NEW DATA RACK, EC TO INSTALL. EC TO PROVIDE PATCH PANELS. COORDINATE EXACT LOCATION OF DATA RACK WITH OWNER. COORDINATE TGB LOCATION WITH RACK LOCATION. LOCATE ON NEAREST WALL.

1 LOWER LEVEL POWER & SYSTEMS PLAN
1/4" = 1'-0"



Project Title: **WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION**
Project Location: 1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
Sheet Title: **ELECTRICAL LOWER LEVEL POWER & SYSTEMS PLAN**

HSR Project Number: **18043-6**

Project Date: **JULY, 2019**

Drawn By: **JCN**

Key Plan:

**CONSTRUCTION
DOCUMENTS**

No.	Description	Date

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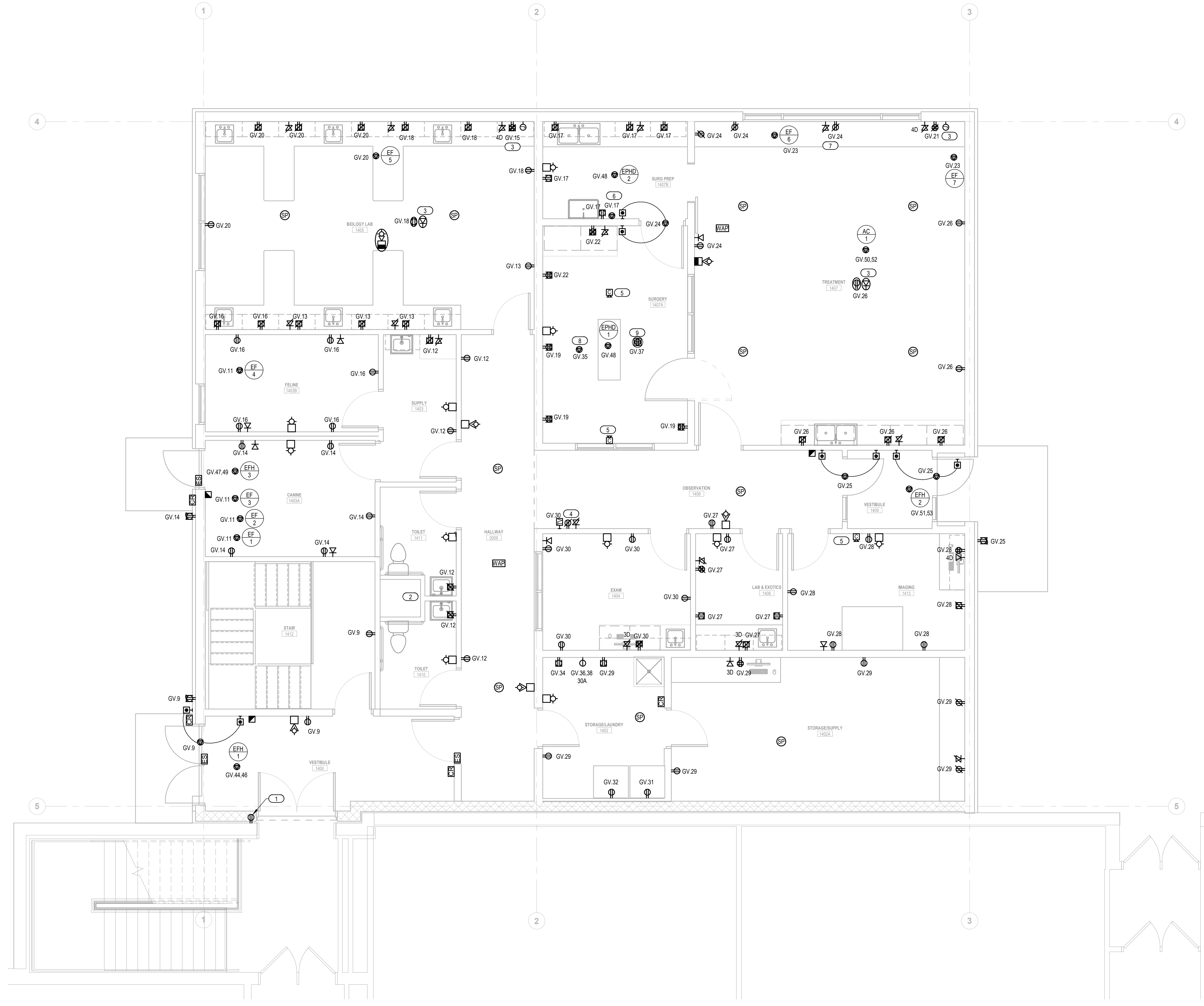
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- GENERAL NOTES**
- PROVIDE (1) DATA DROP TO EACH OUTLET UNLESS OTHERWISE NOTED.
 - CAMERA LOCATION SHOWN SHALL BE ROUGH IN ONLY.
 - CARD READERS SHALL BE "HD PROXIMITY ProPro 5355" OR EQUAL PROXIMITY READERS.
- KEYED NOTES**
- EXISTING EXTERIOR RECEPTACLE TO BE REMOVED IN DEMOLITION PHASE.
 - PROVIDE 4" CONDUIT DOWN TO THE BASEMENT FOR DATA RUNS. COORDINATE WITH MECHANICAL AND PLUMBING CONTRACTORS.
 - PROVIDE 2" CONDUIT TO ABOVE ACCESSIBLE CEILING FOR HDMI CABLING FROM TEACHERS STATION TO PROJECTOR. VERIFY EXACT LOCATION OF TEACHERS STATION AND PROJECTOR WITH OWNER PRIOR TO INSTALLATION.
 - PROVIDE POWER AND DATA AT 8" AFF FOR WALL MONITOR. COORDINATE EXACT HEIGHT AND LOCATION WITH OWNER PRIOR TO INSTALLATION.
 - VERIFY CAMERA MOUNTING HEIGHT AND LOCATION WITH OWNER PRIOR TO INSTALLATION.
 - PROVIDE 120V1 HARDWIRED CONNECTION TO WASTE GAS SCAVENGER SYSTEM CONTROLLER. COORDINATE WITH PLUMBING CONTRACTOR.
 - POWER AND DATA SHALL BE MOUNTED HORIZONTALLY BELOW WINDOW. VERIFY WITH OWNER PRIOR TO INSTALLATION.
 - SURGICAL BOOM LIGHT FURNISHED BY OWNER AND INSTALLED BY EC. PROVIDE 20" GFCI BREAKER WITH DEDICATED CIRCUIT TO JUNCTION BOX ABOVE CEILING. INSTALL PER MANUFACTURER'S SPECIFICATIONS. COORDINATE WITH EQUIPMENT SUPPLIER. VERIFY EXACT LOCATION WITH OWNER PRIOR TO INSTALLATION.
 - PROVIDE CEILING MOUNTED QUAD RECEPTACLE WITH GFCI BREAKER AND DEDICATED CIRCUIT.

1 FIRST FLOOR POWER & SYSTEMS FLOOR
1/4" = 1'-0"



WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION
 Project Location: 1019 SOUTH KNOWLES AVENUE
 NEW RICHMOND, WISCONSIN 54017
 Sheet Title: **ELECTRICAL FIRST FLOOR POWER & SYSTEMS PLAN**

Project Title: **WITC - NEW RICHMOND CAMPUS VETERINARY TECHNICIAN ADDITION**
 HSR Project Number: **18043-6**
 Project Date: **JULY, 2019**
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Key Plan:

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WITC - NEW RICHMOND CAMPUS
VETERINARY TECHNICIAN ADDITION
1019 SOUTH KNOWLES AVENUE
NEW RICHMOND, WISCONSIN 54017
ELECTRICAL SCHEDULES

Project Title: WITC - NEW RICHMOND CAMPUS VETERINARY TECHNICIAN ADDITION
Project Location: 1019 SOUTH KNOWLES AVENUE, NEW RICHMOND, WISCONSIN 54017

HSR Project Number: 18043-6

Project Date: JULY, 2019

Drawn By: JCN

Key Plan:

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PANELBOARD: PV BUS AMPACITY: 225A Volts: 480/277 Wye A.I.C. Rating: 10k Supply From: MSB Phases: 3 Mains: 200 A Mounting: SURFACE Wires: 4 Top/Bottom Feed												
CKT	Circuit Description	Trip	Poles	A	B	C	Poles	Trip	Circuit Description	CKT		
PV.1	Lighting Space 3000	20 A	1	0.6						PV.2		
PV.3	Lighting Room 1412	20 A	1		0.2					PV.4		
PV.5	Lighting VESTIBULE 1400	20 A	1			0.4				PV.6		
PV.7	Lighting Room 1411, 1410	20 A	1	0.6						PV.8		
PV.9	Lighting Room 1413, 1406, 1404, 1402, ...	20 A	1		0.3					PV.10		
PV.11	Lighting Room 1407, 1407A, 1407B	20 A	1			0.8				PV.12		
PV.13	Exterior Lighting	20 A	1	0.4						PV.14		
PV.15										PV.16		
PV.17										PV.18		
PV.19										PV.20		
PV.21										PV.22		
PV.23										PV.24		
PV.25										PV.26		
PV.27										PV.28		
PV.29										PV.30		
PV.31	Spare	20 A	1	0.0	0.0			1	20 A	Spare	PV.32	
PV.33	Spare	20 A	1		0.0	0.0			1	20 A	Spare	PV.34
PV.35	Spare	20 A	1				0.0	0.0	1	20 A	Spare	PV.36
PV.37	Spare	125 A	3	0.0	19.9				3	125 A	TV1	PV.38
PV.39	--	--	--		0.0	22.8			--	--	--	PV.40
PV.41	--	--	--				0.0	17.4	--	--	--	PV.42
Total Load:				21.4 kVA	23.3 kVA	18.6 kVA						
Total Amps:				79 A	86 A	67 A						
Load Classification												
HVAC Blowers	780 VA	100.00%	780 VA	Total Conn. Load: 63104 VA								
HVAC Cooling	18280 VA	100.00%	18280 VA	Total Est. Demand: 57462 VA								
HVAC Heating	14590 VA	100.00%	14590 VA	Total Conn. Current: 716 A								
Lighting	3189 VA	125.00%	3986 VA	Total Est. Demand Current: 68 A								
Miscellaneous	3744 VA	100.00%	3744 VA	Non-Coincident... 18 A								
Motor	200 VA	112.50%	225 VA	Total Est. Demand - NC: 52 A								
Receptacle	23452 VA	71.32%	16726 VA									
Power	315 VA	100.00%	315 VA									
Notes:												

Branch Panel: GV Location: Space 1401 Volts: 120/208 Wye A.I.C. Rating: 10k Supply From: TV1 Phases: 3 Mains: 225 A Mounting: SURFACE Wires: 4 MCB Rating: 225 A Top/Bottom Feed											
CKT	Circuit Description	Trip	Poles	A	B	C	Poles	Trip	Circuit Description	CKT	
GV.1	F-1	15 A	1	1330...	1330...			1	15 A	F-2	GV.2
GV.3	F-3	15 A	1		1330...	1248...		3	25 A	SP-1	GV.4
GV.5	Receptacle Room 1415, 1401	20 A	1			1080...	1248...	--	--	--	GV.6
GV.7	Receptacle Exterior	20 A	1	180...	1248...			--	--	--	GV.8
GV.9	Receptacle Room 1412, 1400	20 A	1		540...	180...		1	20 A	Receptacle Space 1401	GV.10
GV.11	EF-1, EF-2, EF-3, EF-4	20 A	1			400...	1080...	1	20 A	Receptacle Room 2009, 1410, 1411, 1403	GV.12
GV.13	Receptacle BIOLOGY LAB 1405	20 A	1	720...	1080...			1	20 A	Receptacle CANINE 1403A	GV.14
GV.15	Receptacle BIOLOGY LAB 1405	20 A	1		360...	1260...		1	20 A	Receptacle Room 1405, 1403B	GV.16
GV.17	Waste Gas Controller SURG PREP 1407B	20 A	1			900...	540...	1	20 A	BIOLOGY LAB 1405, Projector	GV.18
GV.19	Receptacle SURGERY 1407A	20 A	1	1080...	720...			1	20 A	BIOLOGY LAB 1405, EF-5	GV.20
GV.21	Receptacle TREATMENT 1407	20 A	1		360...	720...		1	20 A	Receptacle SURGERY 1407A	GV.22
GV.23	EF-5, EF-6 TREATMENT 1407	20 A	1			200...	720...	1	20 A	Room 1407, 1407A	GV.24
GV.25	Door Operators Room 1409	20 A	1	370...	900...			1	20 A	TREATMENT 1407	GV.26
GV.27	Receptacle Room 1406, 1408	20 A	1		1260...	1260...		1	20 A	Receptacle IMAGING 1413	GV.28
GV.29	Receptacle Room 1402, 1402A	20 A	1			1440...	1260...	1	20 A	Receptacle Room 1404, 1408	GV.30
GV.31	Freezer Receptacle STORAGE/LAUNDR...	20 A	1	180...	180...			1	20 A	Freezer Receptacle STORAGE/LAUNDR...	GV.32
GV.33	EFH-4, Receptacle 1415	20 A	1		1964...	180...		1	20 A	Washer Receptacle STORAGE/LAUNDR...	GV.34
GV.35	Surgery Light SURGERY 1407A	20 A	1			115...	2294...	2	30 A	Dryer Receptacle STORAGE/LAUNDRY...	GV.36
GV.37	Receptacle SURGERY 1407A	20 A	1	360...	2294...			--	--	--	GV.38
GV.39	CU-1	30 A	2		2080...	2080...		2	30 A	CU-2	GV.40
GV.41	--	--	--			2080...	2080...	--	--	--	GV.42
GV.43	CU-3	45 A	2	3740...	2400...			2	30 A	EFH-1	GV.44
GV.45	--	--	--		3740...	2400...		--	--	--	GV.46
GV.47	EFH-3	20 A	2		1000...	380...		1	15 A	EPHD-2, EPHD 2	GV.48
GV.49	--	--	--	1000...	1240...			2	15 A	AC-1	GV.50
GV.51	EFH-2	20 A	2		1000...	1240...		--	--	--	GV.52
GV.53	--	--	--			1000...					GV.54
GV.55											GV.56
GV.57	Spare	20 A	1		0 VA	0 VA		1	20 A	Spare	GV.58
GV.59	Spare	20 A	1		0 VA	0 VA		1	20 A	Spare	GV.60
GV.61	Spare	20 A	1	0 VA	0 VA			1	20 A	Spare	GV.62
GV.63	Spare	20 A	1		0 VA	0 VA		1	20 A	Spare	GV.64
GV.65	Spare	20 A	1			0 VA	0 VA	1	20 A	Spare	GV.66
GV.67	Spare	20 A	1	0 VA	0 VA			1	20 A	Spare	GV.68
GV.69	Spare	20 A	1		0 VA	0 VA		1	20 A	Spare	GV.70
GV.71	Spare	20 A	1		0 VA	0 VA		1	20 A	Spare	GV.72
Total Load:				19882 VA	22754 VA	17366 VA					
Total Amps:				169 A	193 A	145 A					
Legend:											
Load Classification											
HVAC Blowers	780 VA	100.00%	780 VA	Total Conn. Load: 59937 VA							
Motor	200 VA	112.50%	225 VA	Total Est. Demand: 53521 VA							
HVAC Cooling	18280 VA	100.00%	18280 VA	Total Conn. Current: 196 A							
HVAC Heating	14590 VA	100.00%	14590 VA	Total Est. Demand Current: 149 A							
Miscellaneous	3744 VA	100.00%	3744 VA	Non-Coincident... 40 A							
Power	315 VA	100.00%	315 VA	Total Est. Demand - NC: 108 A							
Notes:											