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SECTION 232213.1 STEAM AND CONDENSATE PIPING SYSTEMS BELOW GRADE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnish and install all Underground, fittings, and piping and accessories to make complete and operations systems.
- B. All systems shall be installed in accordance with local.
- C. Provide stress calculations and forces at all anchors, guides and supports
- D. Secure all permits and local/state approvals for the installation of all components included under this Section.

1.02 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.03 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. ASME: American Society of Mechanical Engineers
- C. ANSI: American National Standards Institute
 - 1. A13.1: Scheme for Identification of Piping Systems
 - 2. B16.5: Pipe Flanges and Flanged Fittings
 - 3. B16.9: Factory Made Wrought Steel Butt Weld Fittings
 - 4. B31.1: Power Piping
 - 5. B36.10: Welded and Seamless Wrought Steel Pipe
 - 6. Z49.1: Safety in Welding and Cutting
- D. ASTM: American Society for Testing and Materials
 - 1. A 53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - 2. A 105/A105M: Forgings, Carbon Steel, for Piping Components
 - 3. A 106: Seamless Carbon Steel Pipe for High-Temperature Service
 - 4. A 135: Electric-Resistance-Welded Steel Pipe
 - 5. A193: Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
 - 6. A 234/A234M: Pipe Fittings of Wrought Carbon Steel and Alloy / Rev A: Steel for Moderate and Elevated Temperature
 - 7. A 307: Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength
 - 8. A 568: Steel, Sheet Carbon and High-Strength Low-Alloy / Rev A: Hot-Rolled and Cold-Rolled, General Requirements
 - 9. D-3350: Polyethylene Plastic Pipe and Fittings Materials

E. Use in conjunction with the following University of Delaware Standards:

1. Common Work for HVAC Systems 23 05 00
2. Common Requirements for HVAC Systems 23 05 01
3. Identification of HVAC Piping and Equipment 23 05 53
4. HVAC Insulation 23 07 00
5. Steam & Condensate Valves 23 05 23
6. Steam and Condensate Piping Systems Above Grade 23 22 13
7. Steam and Condensate Specialties 23 22 14

1.04 SUBMITTALS

- A. Product Data: Include data on pipe materials, pipe fittings and accessories. Provide Manufacturers catalogue information and mill certificates.
- B. Welders Certificate: Include welder's certification of compliance with ASME (BPV IX).
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Project Record Documents: Record actual locations of all piping, valves, traps and valve tag numbers.
- E. Pipe Flexibility Analysis: The conduit manufacturer shall provide stress calculations for all underground piping for the design conditions indicated below. The calculations shall indicate stresses, displacement and forces on anchors and shall check for compliance with ASME B31.1, Power Piping. No loops, elbows or offsets shown on the drawings may be deleted from the design without Manufacturer's prior approval. Should the calculations indicate additional expansion loops are required than shown on the drawings, the conduit manufacturer shall include these in his proposal. Each system layout shall be designed and computer analyzed in strict conformance with ANSI B31.1 by the piping system manufacturer to determine stresses and movements of the service pipe.
- F. The conduit manufacturer shall furnish submittal drawings and data and shall provide onsite technical instruction and inspections as specified herein.

1.06 QUALITY ASSURANCE

- A. Installer: Company specializing in performing work of the type specified in this section, with documented experience.
- B. Welders: Certify in accordance with ASME (BPV IX).

1.07 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.1 code for installation of steam and condensate piping systems including specialties.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor

regulations.

- C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.01 UNDERGROUND STEAM AND CONDENSATE PIPING (0-50 PSIG)

A. Manufacturer

- 1. Prefabricate Conduit Piping System - The prefabricated piping system shall be as furnished by Rovanco Piping Systems, Inc. INSUL-800. No substitutes.

B. Description of Piping

- 1. System pressure and temperature

	Steam	Condensate
Operating Pressure	50 psig	50 psig
Design Pressure	100 psig	50 psig
Design Temperature	338 deg. F.	300 deg. F.
Test Pressure	150 psig	100 psig

- 2. Piping system shall be a class "A" drainable, dryable and testable conduit for high temperature below ground applications. The piping system will be provided with all accessories such as joint insulation, polyethylene shrink sleeves, and link seals at manholes. The steam and condensate conduit system shall be the product of a single manufacturer regularly engaged in providing such systems.
- 4. Outer casing closures, complete with insulation, shall be furnished by the piping system manufacturer at a ratio of one closure for each fabricated item or length. Separate casings shall be furnished for the steam and condensate pipes.
- 5. The outer casing shall be 10 gauge spiral wall steel insulated with minimum 1.5" thick high temperature foam having a density of 2 pcf, K factor of 0.165, 90% closed cell and compressive strength of 35 psi. The insulation shall be capable of continuous service at a temperature of 300° F. The insulation shall be enclosed within an outer jacket of seamless high-density polyethylene (HDPE) per ASTM D1248 and D3350 with a minimum thickness of 175 mils. Alternative insulation system will not be accepted.

6. The underground system, including all straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions. The system shall be designed to minimize the number of field welds and shall be in strict conformance with ANSI B31.1.
- C. Steam Pipe and Fittings (Carrier pipe)
1. Pipe
 - a. Pipe sizes 2" through 10", Schedule 40 steel, ERW to SW2F (NPS 2-4) or ERW to ASTM A53, Grade, Grade B; or ERW to ASTM A135, Grade B; or ERW to ASTM A139, Grade B; or ERW to API5L, Grade B.
 - b. Pipe sizes 12" through 24", Standard Weight steel, ERW to SW2F (NPS 2-4) or ERW to ASTM A53, Grade, Grade B; or ERW to ASTM A135, Grade B; or ERW to ASTM A139, Grade B; or ERW to API5L, Grade B.
Note: Seamless to ASTM A106, ASTM A53, OR API 5L, Grade B may be substituted in all sizes
 2. Fittings
 - a. Pipe sizes 2" through 24", schedule 40, butt-welding, carbon steel, ASTM A234, Grade WPB or WPBW, ANSI B16.9.
- D. Condensate Pipe and Fittings (Carrier pipe)
1. Pipe:
 - a. Pipe sizes 2" through 10" shall be Schedule 160 steel, seamless to ASTM A106, Grade B.
 2. Fittings
 - a. Pipe sizes 2" through 10", schedule 160, butt-welding carbon steel, ASTM A234, Grade WPB or Grade WPBW, ANSI B16.9.
- E. Joints - Runs shall be butt-welded.
- F. Insulation
1. The pipe insulation shall be high temperature foam with a K factor of 0.145, a density of 2 pcf, 90% closed cell content and compressive strength of 35 psi. The insulation shall be capable of continuous service at 400°F with capability of intermittent temperatures up to 450° F for one hour.
 2. The steam pipes shall have nominal 2" thick insulation (minimum 1.75"). Condensate pipes to be bare.
 3. The 10-gauge steel casing enclosing the pipes shall be insulated with high temperature foam having a density of 2 pcf, K factor of 0.165, 90% closed cell and compressive strength of 35 psi. The insulation shall be capable of continuous service at a temperature of 300° F.
 4. The outer jacket enclosing the insulation shall be seamless high-density polyethylene (HDPE) with a minimum thickness of 0.175. The jacket at all fittings shall be butt fusion welded so as to be positively watertight.

G. End Seals

1. Terminal ends of underground casings, inside building walls or manholes, shall be fitted with end seals consisting of a steel plate welded to the pipe and the conduit. End seals shall be fitted with drain and vent openings located diametrically opposite on the vertical centerline of the end plate and shall be shipped to the jobsite with plugs in place. Wall sleeves and link seals are required on conduit entries above floor level and in manholes. The above ground system terminal ends shall be sealed water-tight by the factory.

H. Anchors

1. Prefabricated anchors shall be furnished where shown on plans and shall consist of a steel plate welded to pipe and conduit and sealed at the HDPE juncture. The steel plate shall be ½" thick for conduits to 22 inches diameter and ¾" thick for conduits 24 inches diameter and larger.
2. A concrete block shall be cast at the anchor plate and shall be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. The concrete block shall be at least 30 inches in length and shall extend a minimum of 12 inches beyond the top, bottom and sides of the anchor plate. The installing contractor will install the concrete for the anchor.
3. Flow able fill shall be poured around the anchor to provide high compressive strength bedding.

I. Guides

1. Piping shall be suitably spaced and supported within the casing by full round insulating support guides that permit the pipe to expand and contract freely without stress or wear on the pipe or insulation. The pipe supports for the underground system shall provide for free drainage and air circulation within the casing.
2. Support guides shall be provided in the conduit to support and hold the pipe properly in place.

J. Fittings

1. Fittings shall be factory prefabricated, delivered to the site with the pipe, insulation and conduit pre-assembled. Systems that require field fabrication of joints are not acceptable.

K. Wall sleeves and Link Seals

1. Piping vendor shall provide wall sleeves and link seals for the steam manholes, building entries where indicated on plans. See miscellaneous material for listing.

L. Miscellaneous Material

M. The following items shall be provided by the Piping Vendor:

1. Manhole Lids
(2) Fibrelite manhole lid removal tools. One of the tools may be used by the installing contractor and the other tools shall be turned over to UD O&M at the beginning of the project. At the end of the project, turn over the other tool used by the installing contractor to UD O&M.
2. Wall Apertures

Steam Manhole or Building (Name):

(X) Link seals for X" steam, X" condensate Insul 800

(X) x" long wall sleeves for X" steam, X" condensate Insul 800

(X) X" dia. x X" long wall sleeves for 8" ductile iron manhole vents

(X) 36" dia. Fibrelite steam manhole lids with rims and skirts

PART 3 EXECUTION

3.01 PIPING INSTALLATION

A. General

1. Provide all piping systems as shown on the drawings and otherwise required to make a complete, workable and neat job, installing all valves, appurtenances, unions and gaskets. The Contractor shall use care arranging all piping as shown on the drawings and shall carefully examine the arrangements where offsets are indicated and shall follow details as shown.
 2. All piping shall be run to true alignment parallel to building walls, and with uniform grades and spacing so as to present a neat and workmanlike appearance.
 3. The drawings shall indicate the sizes of piping, piece number, connections. If this information is omitted or unclear, obtain additional information from the field service technician before proceeding.
 4. Ends of all pipes shall be reamed clean and all pipes shall be straightened before erection and measures shall be taken to preserve this cleanliness after erection.
 5. Provide proper provision for expansion and contraction in all portions of pipe work, to prevent undue strains on piping or apparatus connected.
 6. Steam and condensate mains shall be pitch, as indicated on the drawings, 1" in 20'-0" (minimum), 1" in 10'-0" (preferred minimum) down in direction of flow.
- B. Piping vendor shall meet with contractor to determine the exact location of field joints prior to manufacturing the piping. All straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions, and designed to minimize the number of field welds.
- C. Due to the unknown extent of underground interferences, sketching and fabrication shall be based on actual site conditions, which may be different from the drawings. Piping vendor shall provide field assistance on an as needed basis to resolve interferences with existing conditions.
- D. Pipe routing shall follow that shown on the drawings, unless interferences prevent such. The contractor must review deviations with Owner prior to fabrication and installation.

3.02 FIELD QUALITY CONTROL

- A. Installation shall be in strict accordance with the manufacturers printed instructions. The services of a factory trained field service instructor (F.S.I.), a full time employee of the manufacturer, shall be required. The F.S.I. shall have a minimum of 10 years of field service experience. A resume detailing training and experience of the F.S.I. must be furnished with the system supplier's proposal.
- B. The F.S.I. shall be present during critical stages of installation and tests including, but not

limited to, unloading and handling of pipe, placing of pipe in trench, hydrostatic and air testing, and placement of anchors and backfill. If the F.S.I. is unavailable at critical times or quality of the support determined to be unacceptable, the Owner will back-charge the piping vendor against retainage at a rate of \$2,000 per day

- C. The field service instructor shall submit a report to the owner's representative at each visit to the jobsite certifying that the piping system is being installed in accordance with the manufacturer's requirements and shall report to the University's representative, immediately, any deviation from accepted installation procedures. The instructor shall have no authority to stop any work in progress!
- D. At completion of installation the contractor shall furnish to the University's representative, certification from the manufacturer that the system was installed in accordance with the manufacturer's requirements.

3.03 FIELD WELDING

- A. All welding done under this Contract shall be performed by experienced welders in a neat and workmanlike manner. All welding done shall be in accordance with ASME B31.1 Power Piping Code (latest Edition and Addenda). The Contractor shall furnish to the Owner for approval and record the following:
 - 1. Welding Procedure Specifications (WPS) for each procedure to be used
 - 2. Procedure Qualification Record (PQR)
 - 3. Welding Operator Qualification Tests (WPQ) for each welder to be employed.
- B. Documents shall be on forms similar to the forms referenced in the ASME Boiler & Pressure Vessel Code, Section IX, latest edition. These records shall be furnished to the Owner for this project not less than (2) weeks, prior to any welding. All welders to be employed by the Contractor on this work shall be certified in accordance with the above. The Mechanical Contractor shall test welders to these procedures within (3) months of the work beginning to certify them for this work. The above forms shall be clearly marked specifically for the Contractor's use and certified by the appropriate personnel. Documents prepared for other's use are not allowed. Failure to provide these forms to the satisfaction of the Owner, or his representative, will result in the replacement of the Mechanical Contractor with one who can meet these requirements, at no additional cost to the Owner. No delays or cost increases to the overall project schedule will be accepted due to non-compliance with the above by the Mechanical Contractor.
- C. Mitered elbows are not permitted. Odd angle elbows shall be cut from long radius elbows.
- D. The weld reinforcement shall be not less than 1/16" or more than 1/8" above the normal surface of the joined sections. The reinforcement shall be crowned at the center and shall taper on each side to the surface being joined. The exposed surface of the weld shall present a workmanlike appearance and shall be free of depressions below the surface of the joined members.
- E. No welding of any kind shall be done when the temperature of the base metal is lower than 50°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Temperature of metal shall be "warm to the hand", or approximately 60°F.
- F. Welds will be inspected visually by supervisory representatives of the Engineer and the Contractor. Any weld judged defective by the Engineer from a visual inspection shall be cut out

and tested in the presence of the Owner or his representative. In the event any welder consistently produces a high percentage of unsatisfactory production welds, he shall be discharged at the request of the Owner, even though he is able to produce satisfactory welds when especially tested. Removal and replacement of test coupons and samplings shall be done at the expense of the Contractor.

- G. Store all 7018 electrodes in rod oven once original container is opened.

3.04 RADIOGRAPHIC TESTING OR MAGNETIC PARTICLE TESTING

- A. Welds on all underground steam and condensate shall be radiographically tested to full depth penetrations.
- B. The welds shall meet the X-ray requirements in ANSI B31.1.
- C. The independent inspection services shall be provided by the Owner but must be coordinated with the mechanical contractor.

3.05 CLEANING AND FLUSHING

- A. The equipment and piping installed under this Section shall be blown out under pressure and cleaned of foreign matter, through temporary connections where necessary, before the system is placed in service. Water through a minimum 2" fire hose shall be utilized. The water shall discharge through a dirtbag to a grass area. A detail description of the flushing shall be including in the contraction drawings. Alternatively high pressure steam may be used to blown out following ASME procedures. Precautions shall be used to prevent foreign matter from getting into equipment and piping during construction. All materials and labor including hoses, dirtbag, etc. shall be provided by the Contractor.

3.06 INSPECTIONS AND NON-DESTRUCTIVE TESTS

- A. Visual inspection shall include examination of joint details prior to welding, inspection for defects during welding, and for defects, undercut, overlay, and reinforcement details after welding.
- B. Records of non-destructive examination shall be thoroughly examined by the contractor's qualified Q.A. engineer and the Owner. The records shall be kept in permanent file and forwarded to the Owner at the end of the job.
- D. Tests performed shall not relieve the Contractor of his responsibility for leaks which may develop after the tests are made.
- E. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of the tests herein specified. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.
- F. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to the Owner.
- G. All equipment and piping installed under this Contract shall be tested and found tight. Insulated or otherwise concealed piping shall be tested before being closed in. All leaking joints shall be corrected, retested and found tight. Such tests shall conform to the requirements of Local Codes but shall not be less than the equivalent of the tests called for herein. Threaded joints that leak shall not be seal-welded to correct leakage.

- H. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.
- I. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.

3.07 CONDUIT AIR TEST

- A. All field welds at underground casing closures shall be tested for leaks before applying insulation and jacket. During test, all field welds shall be checked with soapsuds, and re-welded, as necessary.
- B. Following acceptance of the air test the conduit closures shall be insulated using pour foam and molds and sealed with a high temperature shrink sleeve. The system manufacturer shall furnish all materials for field joints.
- C. At the completion of the run of pipe, the run of pipe from end-seal to end-seal shall be tested at 5 psi for one hour with no pressure loss. The test shall be witness and signed off by UD steam shop personnel.

3.08 HYDROSTATIC TESTING

- A. Hydrostatic testing will be witnessed a designated University of Delaware representative.
- B. Hydrostatic test shall be performed at the pressure indicated on the table 2.01B for one hour with no pressure loss. The test shall be witness and signed off by the designated University of Delaware representative.

3.09 BACKFILL

- A. Flowable fill - The steam and condensate pipes shall be backfilled with flowable fill along the entire trench from 6 inches below to 6" above the top of the insulated piping system. See civil specification for backfill requirements.
- B. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable soil per the civil specification.

3.10 CONDUIT DRYING

- A. The pipe insulation must remain dry. If at any time the insulation becomes wet, the contractor shall dry the piping using compressed air following the manufacturers written instructions.
- B. The owner reserves the right to direct the contractor to prove that the underground piping is dry at no cost. The contractor shall provide all temporary hookups including, air compressors, regulators, hoses, etc. to complete this task.

END OF SECTION