Direct Bury District Heat System

Design and Construction Standard

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SECTION 1 - SCOPE

This Standard pertains to all direct bury district heat (DH) distribution mains and service lines owned, operated and maintained by Doyon Utilities (DU), including service connections to the DH system up to the demarcation point, same. (The "demarcation point" is defined elsewhere in this document.)

DH distribution mains and service lines consist of a steam supply line and a condensate return line. Condensate return lines may be pumped (pressurized) or gravity drained.

DH distribution mains and service lines, up to the demarcation point, will be designed, constructed and repaired by DU at DU expense.

SECTION 2 - GENERAL INFORMATION AND REQUIREMENTS

2.1 SYSTEM OPERATING PARAMETERS

2.1.1. Fort Wainwright Alaska (FWA): The FWA CHPP provides steam to the FWA DH system at approximately 85 PSIG and superheated at up to 450°F. Steam pressure and temperature decreases with distance from the CHPP. Consult with DU regarding approximate steam pressure and temperature at a given location within the system. Condensate is normally returned at 10-to-25 PSIG and approximately 170°F, though under certain conditions condensate temperature can be up to 270°F.

2.1.2. Fort Greely Alaska (FGA): The FGA CHP provides steam to the FGA DH system at a nominal temperature and pressure of 60 PSIG and 300°F. Steam pressures and temperatures drop away with distance from the CHPP. Consult with DU for regarding approximate steam pressure and temperature at a given location within the system. Condensate is returned at 10-to-14 PSIG and approximately 160°F.

2.2 SYSTEM DESIGN PARAMETERS

All new DH system piping will be tested to 150 PSIG. The minimum design pressure and temperature of all new DH system piping shall be 300 PSIG and 500°F.

2.3 SERVICE LINE SIZE

The sizes of the DH steam supply and condensate return service lines depends on a variety of factors, including the quantity of energy needed and the intended purpose. The Customer or the Customer's Designer shall be responsible to determine the quantity of energy needed, in terms of both peak and total annual energy demand. DU will determine the service line size required based on

energy demand information provided by the Customer or the Customer's Designer.

2.4 SYSTEM CONTAMINATION

The DU DH systems at FWA and FGA are closed systems that operate on the principal that no material leaves or enters the distribution mains or service lines. The sole product is the energy that is delivered to the Customer. Cross connections to wells, building heating systems, tanks where mixtures of chemicals are stored, or any connections which can allow entry of untreated or contaminated water, or any other fluid, into the DU DH system, are strictly prohibited. Design or construction errors that allow foreign substances to be introduced into the DH distribution mains or service lines can contaminate the entire system. Losses of thousands of dollars per hour can result from contamination because of the costs incurred in replacing ruined system fluid. DU reserves the right to (a) seek compensation from Designers or Contractors responsible for design or construction errors that cause system contamination, and (b) refuse DH service to Customers or facilities that cause contamination and require repairs or corrections prior to resuming service.

2.5 METER INSTALLATION

Unless specific arrangements have been made, DU or DU Contractor personnel will install the DH meter and automatic meter reading (AMR) equipment.

SECTION 3 - SPECIFIC REQUIREMENTS

3.1 DIRECT BURY DISTRICT HEAT SYSTEM PIPING

3.1.1. Piping System: A pre-engineered, pre-insulated, welded, Class A, Drainable-Dryable-Testable (DDT) piping system shall be used for all new direct-bury DH distribution mains and service lines. The system supplier shall have at least five years experience fabricating systems of the composition defined herein. All straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions. Each system layout shall be computer analyzed by the piping system manufacturer, to determine stresses and movement of the service pipe. The system design shall be in strict conformance with ANSI B31.1, latest edition, and stamped by a Registered Professional Engineer. Factory trained field technical assistance shall be provided for the critical periods of the installation; i.e., unloading, field joint instruction and testing.

Acceptable systems include, but are not necessarily limited to:

A Multi-Therm 500, by Perma-Pipe Inc. (http://www.permapipe.com)

B Insul 800, by Rovanco Piping Systems (http://www.rovanco.com/)

Other manufacturer's systems must be reviewed and approved by DU.

Follow the piping system manufacturer's design and installation requirements, guidelines and recommendations, unless superseded by the requirements of this Standard.

3.1.2. Internal Pipe Material: The internal (also called "service" or "carrier") pipe material shall be standard weight carbon steel, except for condensate piping which shall be Schedule 80. Pipe shall be butt welded for sizes 2-½" and larger and socket welded for 2" and below. Where possible, straight sections shall be supplied in 40' random lengths with 6" of piping exposed at each end for field joint fabrication.

3.1.3. Outer Conduit Pipe Material: The outer conduit pipe material shall be smooth wall, welded steel conduit. Minimum thicknesses shall be as follows:

Outer Conduit Diameter	Conduit Thickness
6" – 26"	10 Gauge
28" - 36"	6 Gauge
38" - 42"	4 Gauge

Changes in outer conduit size, as required at oversized conduit to allow for carrier pipe expansion, shall be accomplished by eccentric and/or concentric fittings and shall provide for continuous drainage.

3.1.4. Internal Pipe Supports: All pipes within the outer conduit shall be supported at intervals not exceeding 10'. These supports shall be designed to allow for continuous airflow and drainage of the outer conduit in place. The straight supports shall be designed to occupy not more than 10% of the annular air space. Supports shall be of the type where insulation thermally isolates the internal pipe from the outer conduit.

3.1.5. Internal Pipe Insulation Material: Internal pipe insulation shall be mineral wool. Split insulation shall be held in place by stainless steel bands installed not more than 18 inches apart. The insulation shall have passed the boiling test requirements specified in the Federal Agency Guidelines.

3.1.6. Outer Conduit Insulation Material: All outer conduit welds, including elbows, anchors, tees and end seals, shall be air tested at 5 PSIG to

assure conduit tightness prior to insulating. Air test records shall be submitted to DU for review and approval.

Outer conduit insulation shall be spray applied polyurethane foam or polyisocyanurate foam rated for 300°F service, having a nominal 2 lb/ft^3 density for all straight lengths and fittings. The insulation thickness shall be 1-½" minimum. Insulation must completely fill the annular space between the outer conduit and the outer jacket.

Quality assurance procedures for the insulation shall include either a visual check prior to jacketing, an infrared inspection or an x-ray inspection of the entire length to insure there are no insulation voids. The foam shall have the minimum characteristics of 0.16 K-factor, density of 2 lb/ft^3, closed cell content of 90-to-95% and compression strength of 40 PSI.

The piping system supplier shall provide written temperature performance certification from the insulation manufacturer and an Independent Testing Agency Report and Certification that the insulation meets the referenced performance standards. All test samples will be taken from production material, identified, tagged and tested in accordance with the table below. Test reports showing results will be furnished to DU for review and approval.

Attribute	ASTM STD	Sample Frequency	Requirement
Insulation Density	D 1622	Once per shift	$\geq$ 2 lb/ft^3
Insulation Compression Strength	D 1621	Once per shift	$\geq$ 40 psi
Insulation Closed Cell Content	D 2856	Once per shift	$\geq$ 90%
Insulation Thermal Conductivity	C 518	Once per shift	< 0.16 Btu-in/hr/ft^2/°F

3.1.7. Insulation Thickness: The piping system shall be insulated as necessary to limit heat loss to a maximum of 60 BTUs per hour per linear foot of pipe (BTU/Hr/Ft) on the hottest pipe, based on a 5' burial depth, and an average soil temperature of +20°F.

3.1.8. Outer Jacket: The outer jacket shall be:

A minimum 0.175 mil thick fiberglass (FRP) applied directly onto the outer conduit foam insulation; OR

B heavyweight, seamless, minimum 0.175 mil thickness, high impact, polyethylene conforming to ASTM D1248 & D3350.

PVC jacket material is prohibited.

All straights and fittings shall be factory jacketed.

3.1.9. Field Joints: All field joints shall be constructed per the system supplier's recommendations. The air space between the internal pipe insulation and the outer conduit pipe shall remain continuous.

3.1.10. Subassemblies: End seals, gland seals and anchors shall be designed and factory prefabricated to prevent the ingress of moisture into the system. All subassemblies shall be designed to allow for complete draining and drying of the outer conduit system.

3.1.11. Valves: All valves shall be located in utilidors, manholes, vaults or buildings. Refer to the DU Utilidor District Heat System Design and Construction Standard for requirements. Direct bury valves are not permitted.

Designers shall consult with DU to determine if a new isolation valve will be required on an existing distribution main at the connection points of a new DH service (to enhance DH system isolation capabilities).

3.1.12. Pipe Anchors: Anchors and installation method for anchors shall be designed and stamped by a Registered Professional Engineer. The design and installation method for anchors shall accept the loads imposed on them by expansion loops, alignment guides and any static thrust due to the internal pressure in the piping system(s), inclusive of all new and existing piping systems.

The areas of outer jacket within 3' of the anchor must be insulated with internal pipe insulation material (mineral wool) capable of withstanding the internal pipe operating temperature plus 25°F continuously. Pipe anchors on direct buried piping with expansion loops should be installed in undisturbed soil.

3.1.13. Expansion Compensation: Expansion compensation for steam and condensate piping shall be provided for the thermal expansion from the ambient installation temperature to the final operating temperature. Expansion compensation shall be provided through the use of expansion loops and other piping offsets. There shall be no offsets in piping that will impose non-axial loads on existing expansion joints. Design of new service line connections to existing distribution mains shall consider the effect of the new service lines on the expansion of the existing distribution mains and the effect of the expansion of the existing distribution mains on the new service lines. New anchors, expansion joints, alignment guides, drip legs and associated appurtenances shall be provided as necessary on existing distribution mains. Anchors and alignment guides shall be located with respect to expansion joints per manufacturer's installation requirements. Direct bury expansion joints are not permitted. If it is necessary to add a a new expansion joint to an existing distribution main, it must be located in a utilidor, manhole, vault or building.

3.1.14. Drains and Vents: Drains and vents shall be provided at the ends of the system to allow draining of groundwater or condensate that may leak into the piping system annular space if there is a failure in the casing or the carrier pipe. Vents shall allow water vapor to escape and provide an indication of leakage.

Steam and condensate air vents shall be installed at all high points in the piping system and at piping offsets where air can collect. Air vents shall be piped to discharge to a safe location. A manual isolation valve shall be installed just before the air vent. When possible, slope steam piping up to the building. Where condensate must counter-flow against steam flow that pipe shall be oversized to facilitate condensate drainage.

All drains and vents shall be located in utilidors, manholes, vaults or buildings. Refer to the DU Utilidor District Heat System Design and Construction Standard for requirements.

3.1.15. Drip Legs and Steam Traps: A drip leg with a steam trap assembly shall be provided on steam distribution mains at a maximum interval of 300' apart, at the low points of any isolatable section of piping, and on both sides of all steam distribution main isolation valves. For steam main sizes up to and including 10" in diameter, drip leg diameter shall be the same as the steam main. For steam main sizes 12" in diameter and larger, drip leg diameter shall be half the diameter of the steam main. All drip leg and steam trap assemblies shall be located in utilidors, manholes, vaults or buildings. Refer to the DU Utilidor District Heat System Design and Construction Standard for requirements. Steam and condensate piping shall be anchored at each drip leg location.

Each section of steam distribution main must have more than one blow-down to avoid vapor lock that could prevent free drainage of condensate. Steam service lines shall slope back to the distribution main, not to the building, to allow blow-down of a service line from the utilidor, manhole or vault.

3.1.16. Manholes / Vaults: Manholes or vaults shall be used for all connection laterals, main line valves, drip legs, trap stations, and at every change in direction, regardless of distance. Manholes or vaults shall also be installed at a minimum separation of 300' on straight runs of direct bury district heat distribution mains.

3.2 INSTALLATION REQUIREMENTS

3.2.1. The installing contractor shall handle the pre-engineered piping system in accordance with the directions furnished by the manufacturer. In addition, all underground DH system piping shall be:

A suitably supported during installation, providing adequate support to prevent sags and to maintain proper grade;

B installed with sufficient provision for expansion and contraction so that the system will not be subjected to excessive stress during startup and shutdown;

C suitably anchored to restrict movement of the system during startup and shutdown to that allowed by expansion loops.

3.2.2. Bury Depth: Underground (direct bury) DH system piping shall be installed with a minimum of 4' of soil cover. If 4' of soil cover cannot be provided, DU may authorize less cover provided that 1" of additional insulation is furnished for all piping not located below pavement (i.e., street, alley, parking lot, etc.). All DH piping located below pavement shall have a minimum of 4' of soil cover.

3.2.3. Separation: Unless recommended otherwise by a specific pre-engineered piping system manufacturer, maintain a minimum horizontal separation distance of 2', center-to-center, between underground DH system distribution mains (steam and condensate) throughout their entire length.

Maintain a minimum horizontal separation distance of 4', center-to-center, between an underground DH system distribution main (steam or condensate) and all or other utilities.

Maintain a minimum vertical separation distance of 12" between the bottom and top of the insulation jacket on a DH system distribution main (steam or condensate) and any crossing wastewater main or service line, or storm drain line.

3.2.4. Trench Bedding and Pipe Cover: A 4" layer of sand or fine gravel shall be placed and tamped in the bottom of the trench, to provide uniform bedding for the system. The entire trench shall be evenly backfilled with the same material in 6" compacted lifts to a minimum height of 6" above the top of the piping system. The remainder of the trench shall be backfilled as directed elsewhere in this Standard.

3.2.5. Utilize appropriate and sufficient sealant and waterproofing at utilidor, manhole, vault and building wall penetrations to prevent water from entering into the piping system insulation jacket or into the premises.

3.3 INSPECTION REQUIREMENTS

3.3.1. Welding Inspection: In general, all welding inspection shall be conducted in accordance with the current edition of ASME/ANSI B31.1 Power Piping Code. This code specifies necessary inspection and examination requirements, and references the necessary AWS qualifications for inspection and examination.

3.3.2. Insulation Inspection: DU personnel must inspect all underground pipe insulation prior to backfill. The insulation outer coating shall be smooth and even, with no recesses that can hold or trap water.

3.3.3. Pressure Testing: See 3.1.6 Outer Conduit Insulation and 3.4 COMMISIONING.

3.3.4. Inspection after Connection: All DH services are subject to periodic inspection and review after connection. DU may take samples for identification of sources of condensate contamination. Based on the results of the investigation, DU may require the Customer to take corrective measures.

3.4 COMMISSIONING

3.4.1. Pressure Testing: Prior to connection to existing the DH system, all new DH system piping and equipment shall be pressure tested. The outer conduit shall be tested with air at 15 PSIG. The internal pipe shall be tested with water at 150 PSIG. The test pressures shall be held for a minimum duration of 2 hours. Install caps, blind flanges, or plugs as necessary at the ends of each test section. Testing against closed valves is not recommended. If no perceptible pressure loss is recorded during the test interval, and no visual evidence of leakage exists, the pressure test will be considered acceptable.

3.4.2. Flushing: After successfully pressure testing the system, the internal pipe system shall be filled with a 5% solution of trisodium phosphate,

allowed to stand for 2 hours, and then flushed clear using potable water. Following the potable water flush, the system shall be slowly filled with steam and continuously drained to remove residual contamination.

3.4.3. Conductivity Test: Immediately after any new DH system piping is energized, a sample of condensate will be withdrawn and tested for contamination. The sample must not contain more than 10 μΩ (micro-ohms) of conductivity, or 0.02 PPM of iron. If contamination is detected the new DH piping must be flushed from inside the Customer's facility until the contamination is reduced to below the referenced limits.