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27.0 INSULATION

27.1 INTRODUCTION

The pipeline will normally be uninsulated and the gas flow temperature will be controlled, to the extent possible, so as to avoid or mitigate the effects of frost heave and thaw settlement. Pipeline insulation and boardstock insulation will be considered at those locations outlined under other sections of this Technical Information Supplement (see Sections 9, 11, 13, 16 and 28.)

This section contains the design criteria and design procedures for the pipe insulation system and boardstock insulation. Boardstock insulation may be used to maintain the thermal integrity of the soils within the construction zone as well as special off-right-of-way facilities where synthetic insulation material is required in conjunction with gravel pads.

Historical data as well as industry standards will be utilized in developing the specifications for final design and construction. Where this information is insufficient to ensure integrity for the proposed applications, laboratory tests will be conducted on the physical properties of the proposed insulation and/or insulation system.

Available information indicates that polyurethane and expanded bead polystyrene may meet the design criteria for pipe insulation and has been used on arctic projects. The pipe insulation jacketing materials being considered are elastomeric urethane products, polyethylene and fabric reinforced composites. The thermal resistance requirements for insulated embankments and the pipe insulation thickness and thermal insulating properties are established by the geothermal analyses described in Section 21.

27.2 CODES AND CRITERIA

27.2.1 Codes

No codes relate directly to insulation and insulation system design for the proposed applications. Industry standards that apply to material quality and performance testing will be utilized in developing the material specifications.

27.2.2 Criteria

27.2.2.1 Pipe Insulation

- Where specified, insulation system for buried service will provide thermal resistance to limit freezing of frost susceptible soils surrounding the gas pipeline.
- Where specified, insulation system for above ground service will provide thermal resistance to maintain the temperature of the insulated pipe within the design operating temperature limits.

- Insulation system will be suitable for a minimum service life of 50 years.
- Insulation system will have sufficient compressive strength to withstand handling and overburden loads.
- Insulation and jacket system will demonstrate low permeability to water.
- Insulation jacket system will be a non-metallic material with moisture barriers at the end of each pipe joint.
- Insulation jacket system will have high resistance to tearing, impact and abrasion.
- Components of the insulation system on buried pipe will be bonded together as an integral system to resist thermal movement and soil resistance loadings.
- Insulation system must be compatible so stresses caused by differences in coefficient of thermal expansion will not cause disbondment between the components of the system.
- Insulation system must be adequate to withstand additional stresses imposed by concrete weights, and/or concrete coatings that may be applied for buoyancy control at some stream crossings.
- Insulation system in aboveground berms (See Section 28) must be adequate to prevent excessive cooling during a shutdown of TAPS.
- Insulated pipe may be used at some stream crossings.
- Insulation system for field weld joints will be compatible with the insulating system of adjoining pipe joints.
- For buried service, insulation system materials will have physical characteristics to withstand exposure to frozen soils as well as water saturated soil subject to annual freeze/thaw cycles.
- For aboveground service, insulation system will have physical characteristics to withstand ambient temperatures ranging from -70°F to +100°F during the operating life of the pipeline.
- Insulation system will be compatible with the pipeline gas operating temperatures.
- A barrier system will be provided to prevent longitudinal moisture migration if insulation properties are adversely affected by moisture.

27.2.2.2 Boardstock Insulation

- Boardstock insulation will provide thermal resistance to prevent or minimize the thawing of frozen soils.
- Boardstock insulation will be suitable for a minimum service life of 50 years.
- Mechanical strength and thickness must be such that, in conjunction with the overlaid gravel traffic surface, the system will support the shear and compression forces of the project design axle load.

- Boardstock thickness will allow for mechanical damage due to workpad gradation and wheel loads. These allowances will be based on the gradation limits given in the specification.
- Placement of boardstock insulation will address retardation of water infiltration.
- The boardstock insulation system will be designed to control excessive heat flow through the joints.
- Thermal workpad design will be developed in accordance with Section 9.

27.3 DESIGN PROCEDURES

27.3.1 Pipe Insulation

- Optimum physical properties of the insulation system will be developed from the results of the review of available testing and performance standards, performance history and/or project laboratory and field tests. Physical properties will be defined in accordance with current industry standards supplemented as required by project specific standards.
- Long-term performance of the pipe insulation system will be ensured to withstand the moisture and temperature conditions surrounding the buried pipeline. Qualification requirements will provide moisture penetration data through insulation and jacketing materials and values for predicting the subsequent degradation of the thermal resistance properties of the insulation.
- The required thickness and thermal insulating properties of the insulation system will be established by the geothermal analyses described in Section 21.
- Material and construction specifications will be developed for detection and repair of detrimental flaws in the insulation system.
- Aboveground pipe insulation system may be protected by a metallic cladding.

27.3.2 Boardstock Insulation

- Thermal resistance required for the embankment (including boardstock insulation) will be as established by geothermal analysis. (See Sections 9 and 21).
- Long-term performance predictions will be based on historical data supplemented as required by results from laboratory freeze/thaw moisture absorption tests.
- Mechanical strength values and required thickness will be based on traffic load analysis and historical data.
- Thermal workpad design will be in accordance with Section 9.
- Design application of boardstock insulation is outlined in Sections 9, 11, 13, 16, and 28. Typical situations for application of boardstock insulation may include, but are not limited to, the following:

- Over the gas pipeline in thaw unstable soils to limit thaw settlement during the dormant period. (See Section 13.)
- Under the workpad where adjacent to Dalton Highway in thaw unstable soil.
- Under the workpad and over the TAPS fuel gas pipeline in thaw unstable soil segments to limit thaw settlement of the fuel gas pipeline.
- Under the workpad, over the pipeline and possibly over the full width of the construction zone to reduce the thaw plug instability potential on steeper slopes in ice-rich frozen soil segments.
- Under the workpad and/or over the pipeline in areas where high liquefaction potential would result if the soils were allowed to thaw and where adjacent structures cannot tolerate large displacements.
- Under solid waste disposal site embankments to limit thaw into ice-rich subgrade soils.
- On cut slope faces in ice-rich soil to maintain slope stability and limit thaw degradation.
- Under valve, pig launcher and receiver foundations in thaw unstable soils to limit thaw settlement.
- At low water crossings and culvert locations to limit thaw settlement.
- Over the ground surface around piles in frozen ground supporting the gas pipeline at stream crossings or other special elevated locations to reduce pile embedment depth requirements by limiting thaw degradation/downdrag loads.
- Under the berm at TAPS buried crossings to prevent the operating gas pipeline adversely chilling the TAPS oil pipeline during normal operations or a TAPS shutdown situation.
- Over side bends in the gas pipeline in thaw unstable soils to prevent loss of soil strength by thawing during the dormant period.
- Within the construction zone at TAPS aboveground crossings to preserve frozen soil conditions for TAPS structure.
- Under the workpad North of Atigun Pass to limit thaw penetration in thaw unstable soils and in site specific areas to reduce gravel requirements.

27.4 BIBLIOGRAPHY

ANNGTC Project Report* "Insulated 48-Inch Pipe Bend Test Program", September 1982.

ANNGTC Project Report* "Bending of Coated, Insulated and Jacketed 48" Pipe," May 1981.

*This document is stamped, marked or otherwise identified as confidential and/or proprietary or otherwise protected. The ANNGTC continues to claim confidential treatment for this document, and it should be withheld from disclosure.

ANNGTC Project Report* "Insulated 42-Inch Pipe Bend Test Program", December 1981.

ANNGTC Project Report* "The Degradation in Thermal Performance Due to Moisture Absorption and Freeze - Thaw Cycling of Two Polyurethane Foam Insulation Materials With and Without Vapor Barriers" Parts I and II, December 1982.

*This document is stamped, marked or otherwise identified as confidential and/or proprietary or otherwise protected. The ANNGTC continues to claim confidential treatment for this document, and it should be withheld from disclosure.