Preparing Activity: NASA Superseding
UFGS-22 07 19.00 40 (August 2016)
UFGS-22 07 19 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 22 - PLUMBING

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PLUMBING PIPING INSULATION

02/23

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SECTION 22 07 19.00 40

PLUMBING PIPING INSULATION
02/23

****
NOTE: This guide specification covers the requirements for field-applied insulation for hot water, cold water, steam piping, exterior condensate piping including aboveground piping, piping on piers, piping under piers, piping in trenches on piers, piping in tunnels, and piping in manholes but does not cover cryogenic piping.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: If Section 22 00 00 PLUMBING, GENERAL PURPOSE is not included in the project specification, insert applicable requirements therefrom and delete the following paragraph.
****

Section 22 00 00 PLUMBING, GENERAL PURPOSE applies to work specified in this section.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C449	(2007; R 2013) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534/C534M	(2023) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation

ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C592	(2022a) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C755	(2019b) Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation
ASTM C795	(2008; R 2023) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1136	(2023) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D579/D579M	(2015) Standard Specification for Greige Woven Glass Fabrics
ASTM D5590	(2017; R 2021) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2022a; E 2023) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220	(2024) Standard on Types of Building Construction

NFPA 255	(2006; Errata 2006) Standard Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS 3779	(2016; Rev B) Tape Adhesive, Pressure Sensitive Thermal Radiation Resistant, Aluminum Foil/Glass Cloth
SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-PRF-19565	(1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed

item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G[, [____]]

SD-03 Product Data

Adhesives; G[, [____]]

Coatings; G[, [____]]

Insulating Cement; G[, [____]]

Insulation Materials; G[, [____]]

Jacketing; G[, [____]]

Tape; G[, [____]]

SD-08 Manufacturer's Instructions

Installation Manual; G[, [____]]

SD-11 Closeout Submittals

Record Drawings

Adhesives; S

Coatings; S

Insulation Materials; S

Recycled Materials; S

1.3 QUALITY CONTROL

1.3.1 Recycled Materials

Provide thermal insulation containing recycled materials to the extent practicable, provided that the material meets all other requirements of this section. The minimum recycled material content of the following insulation types are:

a. Rock Wool - 75 percent slag by weight

b. Fiberglass - 20-25 percent glass cullet by weight

c. Plastic Rigid Foam - 9 percent recovered material

d. Polyisocyanurate/Polyurethane - 9 percent recovered material

e. Rigid Foam - 9 percent recovered material

Submit recycled materials documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Performance Requirements

Provide noncombustible thermal-insulation system materials, as defined by NFPA 220. Provide adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, with a flame-spread classification (FSC) of [25 or less] [_____], and a smoke-developed classification (SDC) of [50 or less] [_____]. Determine these maximum values in accordance with [ASTM E84] [NFPA 255]. Provide coatings and sealants that are nonflammable in their wet state.

Provide adhesives, coatings, and sealants with published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

2.2 COMPONENTS

2.2.1 Insulation

****
NOTE: Select the applicable types of insulating materials used in the project and delete those which are not applicable.
****

[2.2.1.1 Mineral Fiber Insulation

Provide mineral fiber insulation conforming to [ASTM C592] [ASTM C553] [ASTM C547] and suitable for surface temperatures up to 188 degrees C 370 degrees F. Provide insulation with a density not less than [_____][64.1] kilograms per cubic meter [_____][4]-pound per cubic foot and with thermal conductivity not greater than [_____][0.037] watt per meter per degree Kelvin [_____][0.26] Btu-inch per hour per square foot per degree F at 66 degrees C 150 degrees F mean.

[For pipe sizes 250 mm 10-inches and larger, in lieu of fibrous glass pipe insulation, fiber pipe wrap insulation having an insulating efficiency not less than that of the specified thickness of fibrous glass pipe insulation may be provided.

]][2.2.1.2 Cellular Elastomer Insulation

Provide cellular elastomer insulation conforming to ASTM C534/C534M. Ensure the water vapor permeability does not exceed [_____][0.44] nanogram per second per square meter per pascal [_____][0.30] grain per foot per inch per hour per square foot mercury pressure difference for 25 millimeter 1-inch thickness of cellular elastomer.

][2.2.1.3 Cellular Glass Insulation

Conform to ASTM C552, Type II, Grade 2, pipe covering for Cellular Glass. Substitutions for this material are not permitted. Ensure minimum thickness is not less than 38 mm 1-1/2 inches.

][2.2.1.4 Calcium Silicate Insulation

Conform to ASTM C533. Ensure the apparent thermal conductivity does not exceed [_____][0.078] watt per meter per degree K [_____][0.54] Btu-inch per hour per square foot per degree F at [_____] 93 degrees C 200 degrees F mean.

][2.2.1.5 Fiberglass Insulation

Conform to ASTM C547. Ensure the apparent thermal conductivity does not exceed [_____][0.078] watt per meter per degree K [_____][0.54] Btu-inch per hour per square foot per degree F at 93 degrees C 200 degrees F mean.

Fiber glass pipe insulation having an insulating efficiency not less than that of the specified thickness of mineral fiber pipe insulation may be provided in lieu of mineral fiber pipe insulation for aboveground piping.

][2.2.1.6 Polyisocyanurate Pipe Insulation

Conform to ASTM C591 for polyisocyanurate, minimum density of 27.20 kilograms per cubic meter (kg/cu m) 1.7 pounds per cubic foot.

][2.2.1.7 Pipe Barrel

For temperatures up to and including 650 degrees C 1200 degrees F, use pipe barrel insulation Type II, Molded, Grade A or Type III, Precision V-Groove, Grade A.

][2.2.1.8 Pipe Fittings

Provide molded pipe fitting insulation covering for use at temperatures up to and including 650 degrees C 1200 degrees F.

]2.2.1.9 Flexible Blankets

Provide flexible blankets and felts for use at temperatures up to and including 177 degrees C 350 degrees F with a density of 16 kilogram per cubic meter 1 pound per cubic foot. Ensure thermal conductivity is no greater than [_____][0.038] watt per meter per degree K [_____][0.26] Btu per hour per square foot per degree F at 24 degrees C 75 degrees F mean.

2.2.2 Adhesives

2.2.2.1 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. [To resist mold/mildew, ensure lagging adhesive conforms to ASTM D5590 with 0 growth rating.]Provide nonflammable and fire-resistant lagging adhesives with a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Adhesive are MIL-A-3316, Class 1, pigmented

[white] [red] and suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Apply lagging adhesives in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

2.2.2.2 Vapor-Barrier Material Adhesives

Ensure adhesives conform to the requirements of ASTM C916, Type I, when attaching fibrous-glass insulation to metal surfaces or attaching insulation to itself, to metal, and to various other substrates.

2.2.2.3 Cellular Elastomer Insulation Adhesive

For cellular elastomer insulation adhesive, provide a solvent cutback chloroprene elastomer conforming to ASTM C916, Type I, and is approved by the manufacturer of the cellular elastomer for the intended use.

2.2.3 Insulating Cement

2.2.3.1 General Purpose Insulating Cement

Provide general purpose insulating cement, [diatomaceous silica] [mineral fiber], conforming to ASTM C195. Ensure composite is rated for 982 degrees C 1800 degrees F service, with a thermal-conductivity maximum of [_____][.123] watt per (meter degree Kelvin) [_____][0.85] Btu per inch per hour per square foot for each degree F temperature differential at 93 degrees C 200 degrees F mean temperature for a 25 millimeter 1-inch thickness.

2.2.3.2 Finishing Insulating Cement

Provide finishing insulating cement of a mineral-fiber, hydraulic-setting type conforming to ASTM C449.

2.2.4 Caulk

Provide elastomeric joint sealant in accordance with ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.5 Corner Angles

Provide a nominal 0.41 millimeter 0.016 inch thick aluminum 25 by 25 millimeter 1 by 1 inch corner angle piping insulation with factory applied kraft backing. Ensure aluminum conforms to ASTM B209/B209M, Alloy [3003] [3105] [5005].

2.2.6 Jacketing

****

NOTE: Select the following aluminum jackets for all weather exposed piping insulation, except system T-3. Consider stainless steel jackets for corrosive atmospheres. Specify aluminum or PVC for mechanical equipment rooms.

****

[2.2.6.1 Aluminum Jacket

****
NOTE: Use bracketed sentence for Naval Base Norfolk.
****

Provide aluminum jackets conforming ASTM B209/B209M, Temper H14, minimum thickness of 0.41 mm 0.016 inch, with factory-applied polyethylene and kraft paper moisture barrier on the inside surface. Provide smooth surface jackets for jacket outside diameters less than 200 mm 8 inches. Provide corrugated surface jackets for jacket outside diameters 200 mm 8 inches and larger. Provide stainless steel bands, minimum width of 13 mm 0.5 inch. Provide factory prefabricated aluminum covers for insulation on fittings, valves, and flanges.[Provide aboveground jackets and bands with factory-applied baked-on semi-gloss brown color conforming to Federal Standard SAE AMS-STD-595A, "Colors," color chip number 20062.]

][2.2.6.2 Asphalt-Saturated Felt

Provide asphalt-saturated felt conforming to ASTM D226/D226M, without perforations, minimum weight of 0.49 kilograms per square meter 10 pounds per 100 square feet.

][2.2.6.3 Stainless Steel Jacket

Provide stainless steel jackets conforming to ASTM A240/A240M; Type 304, minimum thickness of 0.25 mm 0.010 inch, smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 13 mm 0.5 inch. Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges.

][2.2.6.4 Glass Cloth Jacket

Provide plain-weave glass cloth conforming to ASTM D579/D579M, Style 141, weighing not less than 0.25 kilogram/square meter [_____][7.23] ounces per square yard before sizing. Factory apply cloth wherever possible.

Provide leno weave glass reinforcing cloth, 26-end and 12-pick thread conservation, with a warp and fill tensile strength of 7.9 and 5.3 kilonewton per meter 45 and 30 pounds per inch of width, respectively, and a weight of not less than [_____] 0.51 kilogram per square meter [_____] [1.5] ounces per square yard. [At the Contractor's option, Style 191 leno-weave glass cloth conforming to ASTM D579/D579M may be provided.]

][2.2.6.5 PVC Jacket

Provide 0.25 millimeter 0.010 inch thick, factory-premolded polyvinylchloride, [one-piece fitting] [pipe-barrel sheeting vapor-barrier jacketing] that is self-extinguishing, with high-impact strength and moderate chemical resistance. Ensure jacket has a permeability rating of 0.574 nanogram per pascal per second per square meter 0.01 grain per hour per square foot per inch of mercury pressure difference, determined in accordance with ASTM E96/E96M. Provide manufacturer's standard solvent-weld type vapor-barrier joint adhesive.

Ensure conformance to ASTM C1136 for, Type I, low-vapor transmission, high-puncture resistance vapor barriers.

]2.2.7 Coatings

[2.2.7.1 Outdoor Vapor-Barrier Finishing

Provide a nonasphaltic, hydrocarbon polymer, mastic coating. Ensure the coating conforms to the requirements of ASTM C1136.

][2.2.7.2 Indoor Vapor-Barrier Finishing

Provide a pigmented resin and solvent compound coatings conforming to ASTM C1136, Type II.

][2.2.7.3 Outdoor and Indoor Nonvapor-Barrier Finishing (NBF)

Provide a pigmented polymer-emulsion as recommended by the insulation material manufacturer for the surface to be coated.

]2.2.7.4 Vapor Retarder

The vapor retarder coating be fire and water resistant and appropriately selected for either outdoor or indoor service. Color white. The water vapor permeance of the compound in accordance with ASTM C755. Use nonflammable, fire resistant type coating. [To resist mold/mildew, coating in accordance with ASTM D5590 with 0 growth rating.][For Indoor service, coating in accordance with MIL-PRF-19565 Type II and be Qualified Products Database listed.]All other application and service properties in accordance with ASTM C647.

2.2.7.5 Cellular-Elastomer Finishing

Provide a polyvinylchloride lacquer coating recommended by the manufacturer of the cellular elastomer finish.

2.2.7.6 Coating Color

[Provide white][Conform to the color code specified][Blend with background of surrounding area][Provide as specified by the Contracting Officer] for the coating color.

2.2.8 Tape

Provide a knitted elastic cloth glass lagging specifically suitable for continuous spiral wrapping of insulated pipe bends and fittings that produces a smooth, tight, wrinkle-free surface. Conform to requirements of SAE AMS 3779 and ASTM D579/D579M for tape, weighing not less than [_____][0.339] kilogram per square meter [_____][10] ounces per square yard.

2.3 MATERIALS

Submit manufacturer's catalog data for the following items:

a. Adhesives

b. Coatings

c. Insulating Cement

d. Insulation Materials

e. Jacketing

f. Tape

Provide compatible materials that do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state. Meet ASTM C795 requirements for materials to be used on stainless steel surfaces. Provide materials that are asbestos free.

PART 3 EXECUTION

Apply insulation only to the system or component surfaces that have previously been tested and approved by the Contracting Officer.

3.1 PREPARATION

Submit installation drawings for pipe insulation, conforming with the adhesive manufacturer's written instructions for installation. Submit installation manual clearly stating the manufacturer's instructions for insulation materials.

Clean surfaces to remove oil and grease before insulation adhesives or mastics are applied. Provide solvent cleaning required to bring metal surfaces to such condition.

3.2 INSTALLATION OF INSULATION SYSTEMS

Apply materials in conformance with the recommendations of the manufacturer.

Install smooth and continuous contours on exposed work. Smoothly and securely paste down cemented laps, flaps, bands, and tapes. Apply adhesives on a full-coverage basis.

Install insulation lengths tightly butted against each other at joints. Where lengths are cut, provide smooth and square and without breakage of end surfaces. Where insulation terminates, neatly taper and effectively seal ends, or finish as specified. Direct longitudinal seams of exposed insulation away from normal view.

Use insulation meeting maximum value conductance as tested at any point, do not use an average. Meet or exceed the specified maximum conductance by adding additional insulation thickness.

[3.2.1 Dual-Temperature (Hot- and Chilled-) Water Piping

Install a [mineral fiber with vapor barrier jacket, Type T-1] [cellular class with vapor barrier jacket, Type T-4] insulation, with a thickness of not less than [_____]. Insulate aboveground pipes, valve bodies, fittings, unions, and flanges.

][3.2.2 Hot-Water, Steam, and Condensate-Return Piping

Install a mineral fiber insulation with glass cloth jacket, Type T-2, with a thickness of not less than [_____]. Insulate aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces.

][3.2.3 Cold-Water and Condensate-Drain Piping

Insulate aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces.

[Provide 10 millimeter 3/8 inch mineral fiber insulation with glass cloth jacket, Type T-2, with a thickness of not less than [_____].

][Install a cellular-elastomer insulation conforming to ASTM C534/C534M, with a water-vapor permeability not exceeding 5.74 nanograms per pascal per second per square meter 0.1 grain per square foot per hour per inch mercury pressure-differential for 25 millimeter 1 inch thickness.

][Provide flexible cellular-elastomeric thermal insulation for cold water piping, Type T-3, with a thickness of [10][15] millimeter [3/8][1/2] inch. Use expanded, closed-cell pipe insulation only aboveground, not for underground piping.

]][3.2.4 Refrigerant Suction Piping

Install a cellular-elastomer insulation, Type T-3, with a nominal thickness of 20 millimeter 3/4-inch. Insulate surfaces, including valve, fittings, unions, and flanges.

][3.2.5 Cooling-Tower Circulating Water Piping

****
NOTE: Normally, cooling-tower circulating water piping does not require insulation.
****

Install a cellular-elastomer insulation, Type T-3, with a thickness of not less than [_____]. Insulate aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces.

****
NOTE: Type T-6 is normally specified for exterior use.
****

Install a mineral fiber insulation with aluminum jacket, Type T-6, with a thickness of not less than [_____]. Insulate aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces.

][3.2.6 Steam and Condensate Piping, 2.4 Megapascal 350 Psig

Install a calcium silicate insulation with glass cloth jacket, Type T-5. Ensure a thickness of not less than [_____], based on an 27 degrees C 80 degrees F ambient temperature in still air with an insulation "K" factor of 0.37 at 93 degrees C 200 degrees F mean temperature:

][3.2.7 Hot Water Heating Converter

Install a calcium silicate insulation with glass cloth jacket, Type T-7, with a thickness of 40 millimeter 1-1/2 inches.

][3.2.8 Chilled-Water and Dual-Temperature Pumps

Install a cellular elastomer insulation, Type T-9, with a thickness of 25

millimeter 1-inch. Cover surfaces subject to condensation and provide a vapor-barrier coating.

][3.2.9 Low-Pressure Steam and Condensate, Weather-Exposed

Install a calcium silicate insulation with weatherproof jacket, Type T-17, with a thickness of not less than [_____]. Insulate all surfaces.

][3.2.10 Steam and Condensate, Weather-Exposed, 861 Kilopascal 125 Psig

Install a calcium silicate insulation with weatherproof jacket, Type T-17, with a thickness not less than [_____]. Insulate all system surfaces.

][3.2.11 Steam and Condensate, Weather-Exposed, 2.4 Megapascal 350 Psig

Install a calcium silicate insulation with weatherproof jacket, Type T-17, with a thickness not less than [_____]. Insulate all system surfaces.

]3.3 APPLICATION

[3.3.1 Type T-1, Mineral Fiber with Vapor-Barrier Jacket

Apply factory and field attached vapor barrier jacket to piping insulated with mineral fiber. Maintain vapor seal. Securely cement jackets, jacket laps, flaps, and bands in place with vapor-barrier adhesive. Provide jacket overlaps not less than [_____][40] millimeter [_____][1-1/2] inches and jacketing bands for butt joints 75 millimeter 3-inches in width.

Insulate exposed-to-view fittings and valve bodies with preformed mineral-fiber of the same thickness as the pipe-barrel insulation. Temporarily secure fitting insulation in place with light cord ties. Apply a 1.52 millimeter 60-mil coating of white indoor vapor-barrier coating and, while still wet, wrap with glass lagging tape with 50 percent overlap, and smoothly blend into the adjacent jacketing. Apply additional coating as needed with rubber-gloved hands to smooth fillets or contour coating. Allow to fully cure before the finish coating is applied. Field fabricate and install insulation for concealed fittings and special configurations. Build up insulation from mineral fiber and a special mastic consisting of a mixture of insulating cement and lagging adhesive diluted with 3 parts water. Where standard vapor-barrier jacketing cannot be used, make the surfaces vapor tight by using coating and glass lagging cloth or tape as previously specified.

In lieu of materials and methods previously specified, fittings may be wrapped with a twine-secured, mineral-wool blanket to the required thickness and covered with premolded polyvinylchloride jackets. Make seams vapor tight with a double bead of manufacturer's standard vapor-barrier adhesive applied in accordance with the manufacturer's instructions. Hold all jacket ends in place with AISI 300 series corrosion-resistant steel straps, [_____][0.381] millimeter [_____][15]-mils thick by [_____][15] millimeter [_____][1/2]-inch wide.

Set pipe insulation into an outdoor vapor-barrier coating applied intermittently over a minimum length of [_____][150] millimeter [_____][6] inches at maximum [_____][3500]-millimeter [_____][12] feet spacing. Seal the ends of the insulation to the jacketing with the same coating material to provide an effective vapor-barrier stop.

Do not use staples as a means to apply insulation. Install continuous

vapor-barrier materials over all surfaces, including areas inside pipe sleeves, hangers, and other concealment.

Provide piping insulation at hangers consisting of 208 kilogram per cubic meter 13-pounds per cubic foot density; fibrous-glass inserts or expanded, rigid, closed-cell, polyvinylchloride. Where required, seal junctions with vapor-barrier jacket, glass-cloth mesh tape, and vapor-barrier coating.

Expose white-bleached kraft paper side of the jacketing to view.

Finish exposed-to-view insulation with not less than a [0.152]-millimeter [6]-mil dry-film thickness of nonvapor-barrier coating suitable for painting.

][3.3.2 Type T-2, Mineral Fiber with Glass Cloth Jacket

Apply factory attached presized, white, glass cloth jacket to piping insulated with mineral fiber. Securely cement jackets, jacket laps, flaps, and bands in place with vapor-barrier adhesive. Provide jacket overlaps not less than 40 millimeter 1-1/2 inches and jacketing bands for butt joints 75 millimeter 3 inches wide.

Insulate exposed-to-view fittings with preformed mineral-fiber of the same thickness as the pipe insulation. Temporarily secure in place with light cord ties. Install impregnated glass lagging tape with indoor vapor-barrier on 50 percent overlap basis. Blend tape smoothly into the adjacent jacketing. Apply additional coating as needed, using rubber gloved hands to a smooth fillets or contour coatings. Tape ends of insulation to the pipe at valves 50 mm 2 inches and smaller. Field fabricate and install insulation for concealed fittings and special configurations. Build up insulation from mineral fiber and a mixture of insulating cement and lagging adhesive, diluted with 3 parts water. Finish surfaces with glass cloth or tape lagging.

[Cover all valves 65 millimeter 2-1/2 inches and larger and all flanges with preformed insulation of the same thickness as the adjacent insulation.

][Finish exposed-to-view insulation with a minimum [_____][0.152]-millimeter [_____][6]-mil dry-film thickness of nonvapor-barrier coating suitable for painting.

][In lieu of materials and methods specified above, fittings may be wrapped with a twine-secured, mineral-wool blanket to the required thickness and covered with premolded polyvinylchloride jackets. Hold all jacket ends in place with AISI 300 series corrosion-resistant steel straps, [_____][0.381] millimeter [_____][15] mils thick by 15 millimeter [_____][1/2]-inch [_____] wide. Provide fitting insulation, thermally equivalent to pipe-barrel insulation to preclude surface temperatures detrimental to polyvinylchloride.

]][3.3.3 Type T-3, Cellular Elastomer

Cover piping-system surfaces with flexible cellular-elastomer sheet or preformed insulation. Maintain vapor seal. Cement insulation into continuous material using a solvent cutback chloroprene adhesive recommended by the manufacturer for the specific purpose. Apply adhesive to both of the contact surfaces on a 100-percent coverage basis to a minimum thickness of 0.254 millimeter 10-mils wet or approximately 4

square meter per liter 150 square feet per gallon of undiluted adhesive.

Set cold water piping insulation into an outdoor vapor-barrier coating applied intermittently over a minimum length of 150 millimeter [6] inches at maximum intervals of 3500 millimeter 12 feet. At piping supports, ensure insulation is continuous by using outside-carrying type clevis hangers with insulation shield. Install [Cork] [Wood dowel] load-bearing inserts between the pipe and insulation shields to prevent insulation compression.

Insulate hot-water, cold-water, and condensate drain pipes to the extent shown with nominal [10][15] millimeter [3/8][1/2]-inch thick, fire retardant (FR), cellular elastomer, preformed pipe insulation. Seal joints with adhesive.

At pipe hangers or supports where the insulation rests on the pipe hanger strap, cut the insulation with a brass cork borer and insert a [No. 3] superior grade cork. Seal seams with approved adhesive. Insulate sweat fitting with miter-cut pieces of cellular elastomer insulation of the same nominal pipe size and thickness as the insulation on the adjacent piping or tubing. Join miter-cut pieces with approved adhesive. Slit and snap covers over the fitting, and seal joints with approved adhesive.

Insulate screwed fittings with sleeve-type covers formed from miter-cut pieces of cellular elastomer thermal insulation having an inside diameter large enough to overlap adjacent pipe insulation. Lap pipe insulation against fittings, and overlap not less than [_____][25] millimeter [_____][1] inch. Use adhesive to join cover pieces and cement the cover to the pipe insulation.

Finish surfaces exposed to view or ultraviolet light with not less than a [_____][0.051] millimeter [_____][2] mil minimum dry-film thickness application of a polyvinylchloride lacquer recommended by the manufacturer. Apply in not less than [two] [_____] coats.

][3.3.4 Type T-4, Cellular Glass with Vapor-Barrier Jacket

Apply factory and field attached vapor barrier jacket to piping insulated with cellular glass. Maintain vapor seal. Securely cement jackets, jacket laps, flaps, and bands in place with vapor-barrier adhesive. Provide jacket overlaps not less than [40][_____] millimeter [1-1/2][_____] inches. Provide jacket bands for butt joints of not less than [_____][75] millimeter [3][_____] inches width. Provide insulation continuous through hangers. Bed insulation in an outdoor vapor-barrier coating applied to all piping surfaces.

Insulate flanges, unions, valves, anchors, and fittings with factory premolded or prefabricated or field fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation. When segments of insulation are used, provide elbows with not less than three segments. For other fittings and valves, cut segments to the required curvature or nesting size.

Secure segments of the insulation in place with twine or copper wire. After the insulation segments are firmly in place, apply a vapor-barrier coating over the insulation in two coats with glass tape imbedded between coats. Vary the tint of the first coat from the expected white color of the second coat to ensure the complete application of the two coats. Apply coatings to a total dry-film thickness of 1.6 millimeter 1/16 inch

minimum. Overlap glass tape seams not less than [_____][25] millimeter [1][_____]inch and tape ends not less than [_____][100] millimeter [4][_____]inches.

In lieu of materials and methods specified above, fittings may be wrapped with 10 millimeter 3/8-inch thick, vapor-barrier, adhesive-coated strips of cellular elastomer insulation. Install insulation under tension, compressed to 25 percent of original thickness, and wrapped until overall thickness is equal to adjacent insulation. Secure cellular elastomer in place with twine and sealed with vapor-barrier coating applied to produce not less than [_____][1.6] millimeter [_____][1/16]-inch dry-film thickness. Cover fittings with premolded polyvinylchloride jackets. Make seams vapor-tight with a double bead of manufacturer's standard vapor-barrier adhesive applied in accordance with the manufacturer's instructions. Hold jacket ends in place with AISI 300 series corrosion-resistant steel straps, [_____][0.381] millimeter [_____][15]-mils thick by [_____][15] millimeter [_____][1/2]-inch wide.

To prevent condensation, insulate anchors secured directly to piping for not less than [_____][150] millimeter [_____][6] inches from the surface of the pipe insulation.

Install white-bleached kraft paper side of jacket exposed to view.

Finish exposed-to-view insulation with not less than a [_____][0.152] millimeter [_____][6]-mil dry-film thickness of nonvapor-barrier coating suitable for painting.

][3.3.5 Type T-5, Calcium Silicate with Glass Cloth Jacket (Piping)

Apply factory attached presized, white glass cloth jacket to piping insulated with calcium silicate. Field apply jackets when required. Securely cement jackets, jacket laps, flaps, and bands in place with vapor-barrier adhesive. Ensure jacket overlap is not less than [_____][40] millimeter [_____][1-1/2] inches and jacketing bands for butt joints are100 millimeter 4 inches wide. Fabricate fittings from segmented pipe barrel sections bedded in general purpose insulating cement and wired in place. Fill voids with a general purpose insulating cement with not less than [_____][6] millimeter [_____][1/4] inch thick, final coating. Apply glass lagging tape with a minimum overlap of 50 percent glass lagging tape with lagging adhesive, blended smoothly into adjacent jacketing. Apply additional adhesive as needed using rubber-gloved hands to smooth filets and contour coatings.

][3.3.6 Type T-6, Mineral Fiber with Aluminum Jacket

Apply factory or field attached aluminum jacket to piping insulated with mineral fiber.

Insulate fittings and valve bodies with preformed mineral-fiber of the same thickness as the pipe-barrel insulation. Temporarily secure fitting insulation in place with light cord ties. Apply a 1.52 millimeter 60-mil coating of vapor-barrier mastic, and while still tacky, wrap with glass lagging tape.

Apply additional mastic as needed using rubber-gloved hands to smooth fillets or contour coatings. Field fabricate and install insulation for special configurations. Build up insulation from mineral fiber and a mixture of insulating cement and lagging adhesive diluted with 3 parts

water. Only where standard aluminum jacketing cannot be used, make the surfaces vapor-tight by using mastic and glass lagging cloth or tape as specified above with an added finish coat of mastic.

Set pipe insulation into outdoor vapor-barrier coating applied intermittently over a minimum length of [_____][150] millimeter [_____][6]-inches with a maximum coating application of [_____][3500] millimeter [_____][12]-foot. Seal ends of the insulation to the jacketing with the same coating material to provide effective vapor barrier stops.

Install continuous vapor barrier over all surfaces, including areas inside pipe sleeves, hangers, and other concealment.

Apply piping insulation to both sides of pipe hangers. Insulate junctions with a special mastic mixture, glass cloth mesh tape, and mastic as previously specified.

Securely cement jacket laps, flaps, and bands in place with aluminum jacket sealant. Provide 150 millimeter 6-inch wide minimum jacketing bands for butt joints.

Wherever possible, lap joints against the weather so that the water runs off the lower edge and in accordance with the pipe drainage pitch. Locate longitudinal laps on horizontal lines 45 degrees below the horizontal centerline and alternately staggered 25 millimeter 1-inch. Lap jacketing material a minimum of [_____][50] millimeter [_____][2] inches, circumferentially sealed with mastic, and strapped to provide a waterproof covering throughout. Locate straps 200 millimeter eight inches on center and pull up tight to hold jacketing securely in place. Use screws in addition to straps when necessary to obtain a waterproof covering. Place extra straps on each side of supporting devices and at openings. Where flanging access occurs, strap a chamfer sheet to the pipe at jacketing.

Stiffen exposed longitudinal edges of aluminum jacketing by bending a 25 millimeter 1 inch hem on one edge.

Provide expansion joints for maximum and minimum dimensional fluctuations.

To prevent corrosion, do not allow the aluminum jacketing to come in direct contact with other types of metal.

At openings in jacket, apply an outdoor vapor-barrier coating for [_____][50] millimeter [_____][two] inches in all directions. Apply jacketing while waterproofing is tacky.

Use screws at each corner of each sheet, at fitting jackets, and as necessary for the service. Place Number 7, 10 millimeter 3/8 inch long, binding-head aluminum sheet metal screws through the mastic seal.

][3.3.7 Type T-7, Calcium Silicate with Glass Cloth Jacket (Surfaces)

Cover surfaces with insulation block bedded in an insulating cement and covered with glass cloth jacketing.

Clean surfaces with a chlorinated solvent. Mix general purpose insulating cement with 3 parts water to 1 part nonvapor-barrier adhesive to bring to application consistency. Set block into bedding and joints and fill spaces with a bedding mix and wrap with galvanized chicken wire mesh well laced into an envelope. Trowel a 10 millimeter 3/8 inch thick coating of

bedding mix jacket on the nonvapor-barrier adhesive and glass cloth. Finish surfaces with not less than a [_____][0.152] millimeter [_____][6]-mil dry-film thickness of nonvapor-barrier coating.

[Aluminum sheet jacketing may be used in lieu of glass cloth.

]][3.3.8 Type T-9, Cellular Elastomer

Clean pump surfaces with solvent. Apply not less than 25 millimeter [_____][1]-inch of general purpose insulating cement, mixed with nonvapor-barrier adhesive diluted with 3 parts water, to achieve smooth surface and configuration contours. After all water has been removed, cover surfaces with 13 millimeter 1/2 inch thick cellular elastomer insulation, attached and joined into a continuous sheet with an outdoor vapor-barrier coating recommended by the insulation manufacturer for the specific purpose. Apply coating to both of the contact surfaces on a 100-percent coverage basis with a minimum thickness of [_____][0.254] millimeter [_____][10] mils wet. Blend coating into the adjacent flange insulation. Cover joint with a band of cellular elastomer equal to the flange assembly width. Use same coating to seal insulation to the casing at penetrations and terminations. Insulate pumps in a manner that permits insulation to be removed to repair or replace pumps.

Finish insulation with a [_____][0.051] millimeter [_____][2] mil minimum dry-film application of a polyvinylchloride lacquer coating recommended by the manufacturer and applied in not less than [two] [_____] coats.

][3.3.9 Type T-10, Mineral-Fiber Fill

Pack voids surrounding pipe with mineral-fiber fill.

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NOTE: Insulation system Type T-17 may be used as is written for drained shallow trenches or by modification to eliminate all thermoplastic references and requiring only standard aluminum jackets.

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][3.3.10 Type T-17, Calcium Silicate Weatherproof Jacket

Cover piping system surfaces with calcium silicate insulation. Cover fittings and valve bodies with preformed insulation of the same material and thickness as the adjoining pipe insulation.

]3.4 CLOSEOUT ACTIVITIES

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NOTE: Following a minimum of 90 calendar days operation (or installation), but no later than one year, the Systems Engineer/Condition Monitoring Office/Predictive Testing Group should inspect the installation using Infrared Imaging. This technology can identify insulation voids, insulation settling, and areas of insufficient insulation. Identification of insulation materials and locations is required to effectively identify these types of problems. The Systems Engineer/Condition Monitoring Office/Predictive Testing Group needs to know the

warranty expiration date, if there is a warranty, in order to perform the inspections within the prescribed time frame.
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Final acceptance of the performed work is dependent upon providing Record Drawings details to the Contracting Officer. Include construction details, by building area, the insulation material type, amount, and installation method. An illustration or map of the pipe routing locations may serve this purpose.

Provide a cover letter/sheet clearly marked with the system name, date, and the words "Record Drawings Insulation/Material" for the data. Forward to the [Systems Engineer][Condition Monitoring Office][Predictive Testing Group][_____] for inclusion in the Maintenance Database."

-- End of Section --