FOAMGLAS® INSULATION SYSTEM SPECIFICATION

FOAMGLAS®
Pittsburgh Corning

General Guidelines for FOAMGLAS® Insulation

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1. General Notes

1.1 This specification offer application suggestions for the use of FOAMGLAS® insulation and accessory systems for temperature ranges from -268°C to +482°C (-450°F to +900°F). Other application options not listed in these guidelines may be appropriate. This specification may be applicable for indoor or outdoor installations. This specification is valid as for pre-insulation and on-site installation. Additional requirements for the insulation system, such as fire protection and/or acoustic insulation, will be covered by additional specifications or specification attachment.

1.2 Any deviation from this specification (i.e. alternative accessory materials, design etc.) must be authorized by written approval.

1.3 The product data sheets referenced in the text are listed at the end of the specification. Product data sheets for Pittsburgh Corning products may be accessed on line at: www.foamglas.com .

1.4 Technical drawings addressing most details are provided in Appendix A. Contact Pittsburgh Corning if additional details are needed.

1.5 SI and Metric unit conversions have been rounded to nearest English unit equivalent.

2. Codes and Standards

2.1 AISI American Iron and Steel Institute

2.2 ASTM International Standards

2.2.1 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation

2.2.2 ASTM C1639 Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation

2.2.3 ASTM C1729 Standard Specification for Aluminum Jacketing for Insulation

2.2.4 ASTM C1767 Standard Specification for Stainless Steel Jacketing for Insulation

2.3 EN Standards

2.3.1 EN 14305, Thermal insulation products for building equipment and industrial installations. Factory made cellular glass (CG) products. Specification

2.3.2 EN ISO 9229, Thermal insulation — Vocabulary (ISO 9229:2007)

2.4 International Organization for Standardization (ISO)

2.4.1 ISO 9001: Quality management systems — Requirements

2.4.2 ISO 9002: Quality systems. Modelled for quality assurance in production, installation, and servicing.

2.5 British Standards (BS)

2.5.1 BS 4370-1-4 Method of test for rigid cellular materials

2.6 Pittsburgh Corning Fabrication Guidelines (FI-322)

3. Preliminary Conditions

3.1 This specification is subject to revision without notice. Contact Pittsburgh Corning for current revision data before using. This specification is offered as a guide for the purpose described herein and should be employed at the discretion of the user. No warranty of procedures, either expressed or implied, is intended.

3.2 FOAMGLAS® pipe insulation and fabricated fittings must be transported and stored vertically. Packages must be handled with care and protected from the elements while in storage. FOAMGLAS® insulation packages and must not be allowed to come into direct contact with the ground in to prevent possible damage or contamination prior to application.

3.3 The surface to be insulated should be clean and free from all traces of grease, rust, dust and any foreign matter. Cleaning, such as sandblasting and priming of surfaces to be insulated, while recommended, is not part of this specification. If priming is specified, the primer must be thoroughly dry prior to the application of any insulation materials. The primer should also be compatible with any accessory materials.

3.3.1 The specifying engineer or owner shall, at their option, designate a rust inhibitor or corrosion resistant paint to be applied before the application of any insulation. The application of such paint or coating is not a requirement of this specification.

3.3.2 Any surface imperfection must be cleaned with a wire brush and then coated with a new layer of anti-corrosion paint or other suitable product. The surface must be moisture free before the insulation is applied and the product application must follow the anti-corrosion product manufacturer's guidelines.

3.3.3 When an adhesive is used, the compatibility between the anticorrosion paint and the adhesive must be verified before applying the insulation.

3.4 All insulation materials shall be stored in an area protected from the weather and kept dry before and during application.

3.5 The application of FOAMGLAS® insulation on pipes or equipment is to be done at ambient temperature.

3.6 The temperature limits of the accessory products must be respected during both storage and application.

3.7 Hydrostatic, radiographic and other tests must be completed before the insulation is applied in order to assure proper system performance.

3.8 When working on outdoor lines or equipment, no more insulation shall be applied than can be completely sealed by the end of each workday.

3.9 Any protrusions from piping and equipment such as vents, relief valves, thermocouple wells, etc., shall be considered as part of this specification and shall be insulated accordingly.

3.10 The general contractor, insulation contractor and owner shall provide sufficient inspection during the insulation and finish application. Continuous inspection of the application is not to be considered a requirement of Pittsburgh Corning.

3.11 Bore Coatings are typically specified if one or more of the following conditions exist:

3.11.1 The surface being insulated cycles, or swings through a given temperature range, more than once a week.

3.11.2 The surface being insulated experiences high vibration. Generally, this is associated with visible movement.

3.11.3 The FOAMGLAS® insulation is carrying the load of the pipe such as at a pipe hanger or support.

4. Design Requirements

4.1 On below ambient systems, the heat transfers should be limited to acceptable values with respect to both economic and functional aspects. Design thickness criteria will limit heat gain to between 25 to 37 W/m^2 (8 to 12 $Btu/hr•ft^2$). In some cases this may also limit condensation (recommendable). The insulation thickness shall be determined through calculations based on particular and unique environmental and operating conditions.

4.2 Insulation thickness can be selected to provide freeze protection for a predetermined time period under extreme ambient conditions, or, in conjunction with heat tracing systems, to maintain a design temperature value.

4.3 In addition, insulation thickness for a hot process may also be designed to provide a minimum heat loss for process control.

4.4 For hot service, insulation thickness will most frequently be designed to provide personnel protection [usually, surface temperatures below 60°C (140°F).

4.5 FOAMGLAS® insulation thickness can be designed to provide fire protection for piping and equipment for specified amounts of time under given fire conditions. Credit may be taken for the insulation in sizing pressure relief valves, protecting the steel from over stressing, or protecting the contents of the vessel from overheating.

4.6 The insulation thickness shall be calculated in accordance to ISO 12241, or ASTM C680, and based upon project requirements for heat loss, environmental conditions, etc. Contact the Pittsburgh Corning Technical Department for assistance in selecting an insulation thickness based on one or more of the above criteria.

4.7 Piping and equipment shall be insulated according to insulation class, operating temperature and insulation thickness defined in the specifications, P&ID, line designation table (list), piping isometrics, equipment drawings, general arrangement drawings, insulation thickness tables.

4.8 The entire system shall be fully insulated, including all piping components, instruments and tubing, drains to the extent specified.

4.9 All metal parts that protrude through the insulation shall be insulated, over an extent of 4 times the insulation thickness on below ambient systems, and/or two times the insulation thickness on above ambient systems.

4.10 The insulation at pipes and equipment shall end in such a distance to adjacent flanges, to allow removal of bolts without damage to the insulation.

4.11 Nameplates and tags shall be insulated; vessel vendor shall provide a duplicate, to be installed by insulation contractor on the outside surface of the insulation.

5. Materials Used

5.1 Insulation material - Insulation shall be FOAMGLAS® cellular glass insulation manufactured in accordance with ASTM C552, “Standard Specification for Cellular Glass Thermal Insulation”, by Pittsburgh Corning whose quality system for manufacturing, inspecting, and testing of FOAMGLAS® insulation is certified to meet the requirements of ISO 9001:2008.

5.1.1 FOAMGLAS® pipe insulation shall be fabricated according to the requirements of Pittsburgh Corning Fabrication Guidelines (FI-322) and ASTM C1639 “Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation”.

5.1.2 For pipes, FOAMGLAS® insulation shall be fabricated in half sections wherever possible. For large diameter piping where half sections are not practical, curved sidewall segments are preferred. See Appendix C: Table 1 for fabrication guidelines.

5.1.3 For large diameter piping, vessels, kettles, and other large radius curved surfaces; insulation should be fabricated in curved sidewall segments or dished head segments wherever possible. See Appendix C: Table 1 for fabrication guidelines.

5.1.4 For above ambient surfaces, the insulation may also consist of rectangular lags or segments, each having a trapezoidal cross section, adhered to a flexible facing, which allows the assembly to be formed into a cylindrical shape.

5.1.5 Dished head segments shall be used on all vessel heads that are 356 mm (14 in.) O.D. or larger. Heads smaller than 356 mm (14 in.) O.D. may be insulated with either dished head segments, or, by extending the insulation for the body of the vessel out over the end of the vessel and cutting round sections of FOAMGLAS® insulation out of flat block. These round sections are plugs that can be used to fill the opening formed by the extended insulation.

5.2 Anti-abrasive - This coating is only to be applied if the piping will be submitted to frequent and significant thermal movements or to vibrations. The anti-abrasive coating must be applied onto the inner side of the FOAMGLAS® elements which will be in contact with the metal pipe or equipment. Anti-abrasive coating shall be chosen from one of the following options depending upon the operating temperature of the system.

5.2.1 PC® HTAA supplied by Pittsburgh Corning for operating temperatures ≤ -183°C (-297°F) or ≥ 121°C (250°F).

5.2.2 PC® 80M Mortar available from Pittsburgh Corning. PC® 80M Mortar is a two-component in inorganic, non-combustible bore coating that is acceptable for use with stainless steel. PC® 80M Mortar is recommended for operating temperatures ≤ -183°C (-297°F) or ≥ 121°C (250°F).

5.2.3 Hydrocal® B 11 gypsum cement, manufactured by U.S. Gypsum Corporation for operating temperatures ≤ -183°C (-297°F) or ≥ 121°C (250°F).

5.2.4 PITTCOTE® 16 LTAA supplied by Pittsburgh Corning for operating temperatures ≥ -182°C (-296°F) or ≤ 120°C (248°F).

5.3 Joint sealant shall be one of the following:

5.3.1 PITTSEAL® 444Ns sealant or PITTSEAL® 444N sealant supplied by Pittsburgh Corning. PITTSEAL® 444N^{S} sealant and PITTSEAL® 444N sealant are specially formulated butyl sealant used for sealing joints in FOAMGLAS® insulation systems.

5.3.2 PC® RTV 450 Silicone Adhesive supplied by Pittsburgh Corning. A one part, neutral cure, silicone adhesive/sealant formulated for use with FOAMGLAS® insulation.

5.4 Fabrication Adhesive - See Appendix C: Table 2 for fabrication adhesive recommendations. May be:

5.4.1 Hydrocal® B-11 Powder, gypsum cement, as manufactured by U.S. Gypsum, Inc.

5.4.2 Hot asphalt, ASTM D 312, Type III

5.4.3 PC® 88 Adhesive as supplied by Pittsburgh Corning. PC® 88 Adhesive is a two-component urethane modified asphalt adhesive appropriate for temperatures from -56°C to 82 °C (-70°F to +180°F). For outdoor systems, PC® 88 adhesive can be used as a fabrication adhesive on systems with operating temperatures up to +482°C (900°F). For indoor systems the maximum operating temperature is limited to +82°C (+180°F). PC® 88 adhesive meets the requirements of ASTM C795 (ASTM C692, and ASTM C871) regarding stress corrosion of stainless steel.

5.4.4 PC® 99 adhesive as supplied by Pittsburgh Corning. PC® 99 adhesive is a moisture curing, polyether adhesive sealant appropriate as a fabrication adhesive for systems with operating temperatures from -73°C to +121°C (-100°F to +250°F). PC® 99 adhesive meets the requirements of ASTM C795 (ASTM C692, and ASTM C871) regarding stress corrosion of stainless steel.

5.5 Vapor Stop Sealant for below ambient systems shall be appropriate to the operating temperature of the system. Vapor stop sealant shall be one of the following:

5.5.1 Vapor Stop Sealant shall be PITTSTOP™ 196 Vapor Stop supplied by Pittsburgh Corning. PITTSTOP™ 196 Vapor Stop is a two component 1:1 mix ratio butyl rubber elastomer specially designed for use as a vapor stop sealant/coating/adhesive for cryogenic systems..

5.5.2 PITTSEAL® 444N^{S} sealant or PITTSEAL® 444N sealant supplied by Pittsburgh Corning. PITTSEAL® 444N^{S} sealant and PITTSEAL® 444N sealant are specially formulated butyl sealant used for sealing joints in FOAMGLAS® insulation systems.

5.5.3 PITTSEAL® CW sealant supplied by Pittsburgh Corning. A high performance, MS Polymer based sealant used for sealing joints in FOAMGLAS® insulation systems, on chilled water applications

5.6 Cryogenic adhesive shall be PC® 42 Cryogenic Adhesive supplied by Pittsburgh Corning. PC® 42 Cryogenic Adhesive is a three component, cryogenic adhesive formulated for use with FOAMGLAS® insulation.

5.7 Contraction joint filler/cushioning blankets, if necessary, shall be Type E needled glass fiber felt thermal insulation containing no organic binders,

manufactured in accordance with ASTM C1086, or light density (48 kg/m^3 or 3 lb./ft^3) fiberglass.[1]

5.8 Contraction joint vapor barrier/contraction joint barrier sheet shall be one of the following:[1]

5.8.1 Minimum 1.6 mm (0.062 in.) thick solid neoprene or butyl rubber

5.8.2 Minimum 0.94mm (0.037 in.) thick silicone impregnated glass fabric

5.9 Metal Bands shall be AISI type 304 (BSI 304 S16) stainless steel, 13 mm wide x 0.4 mm thick (0.5 in. x 0.016 in.), with matching seals or aluminum bands with matching seals, 13 x 0.5 mm (0.5 in. x 0.020 in.) for piping and equipment with O.D. up to 1219mm (48 in.), 19 x 0.5 mm (0.75 in. x 0.020 in.) for larger O.D.

5.10 Tape shall be 25 mm (1 in.) wide, high tensile strength fiber reinforced strapping tape. Tape is appropriate for providing temporary insulation securement for piping with insulation O.D.'s 457 mm (18 in.) or smaller as long as it is covered with metal jacket afterwards. Tape is not acceptable as primary means of securement.[2]

5.11 Reinforcing mesh fabric for the vapor retarder coating shall be one of the following:

5.11.1 Synthetic fabric, 6.5 x 6 meshes, PC® Fabric 79 as supplied by Pittsburgh Corning or approved equal.

5.11.2 Glass reinforcing mesh, PC® 150 glass reinforcing mesh as supplied by Pittsburgh Corning or approved equal.

5.12 Insulation Adhesive: For equipment operating up to +260°C (500°F) an adhered system, is possible. The proper adhesive shall be one of the following:

5.12.1 PC® 88 adhesive as supplied by Pittsburgh Corning. PC® 88 Adhesive is a two-component urethane modified asphalt adhesive appropriate for temperatures from -56°C to 82 °C (-70°F to +180°F). If low working stress is expected, PC® 88 adhesive can be used up to +120°C (248°F), otherwise the maximum operating temperature is limited to +82°C (+180°F). PC® 88 adhesive meets the requirements of ASTM C795 (ASTM C692, and ASTM C871) regarding stress corrosion of stainless steel.

5.12.2 PC® 99 adhesive as supplied by Pittsburgh Corning. PC® 99 adhesive is a moisture curing, polyether adhesive sealant appropriate for temperatures from -73°C to 60°C (-100°F to +140°F) continuous operation or up to +121°C (+250°F) intermittent. PC® 99 adhesive meets the requirements of ASTM C795 (ASTM C692, and ASTM C871) regarding stress corrosion of stainless steel.

5.12.3 PC® RTV 450 silicone adhesive supplied by Pittsburgh Corning. PC® RTV 450 silicone adhesive is a one part, neutral cure, silicone adhesive/sealant formulated for use at operating temperatures up to 204°C (400°F). PC® RTV 450 silicone adhesive meets the requirements of ASTM C795 (ASTM C692, and ASTM C871) regarding stress corrosion of stainless steel.

5.12.4 PC® HI-TEMP/RTV Silicone adhesive supplied by Pittsburgh Corning. PC® HI-TEMP/RTV Silicone adhesive is a one part, neutral cure, silicone

[1] Product manufacturer information available in Appendix B

[2] Product manufacturer information available in Appendix B

adhesive/sealant formulated for use at operating temperatures up to 260°C (500°F).

5.13 Protective coatings, membranes, or finishes are installed on below ambient systems to serve as a vapor retarder. This material will fill the surface cells of the FOAMGLAS® insulation to improve mechanical resistance of the system, improve freeze-thaw protection of the system, and to serve as an additional barrier to vapor and liquids. The protective coating, membrane, or finish shall be:

5.13.1 PITTWRAP® B100 jacketing supplied by Pittsburgh Corning, a 1.2 mm, (47 mil) thick Aluminum/butyl jacketing or equivalent.

PITTWRAP® IW30 Jacketing, a 0.76mm (30 mil) thick self-sealing, non-metallic sheet for protecting above ground FOAMGLAS® insulation systems chilled water and hot service pipelines under a metal jacket finish as supplied by Pittsburgh Corning. PITTWRAP® IW30 Jacketing is ideal for use where insulation has been roller coated with asphalt prior to jacketing.

5.13.1 PITTWRAP® IW50 Jacketing, a 1.27 mm (50 mil) thick self-sealing, modified bituminous membrane for protecting above ground FOAMGLAS® insulation systems under a metal or UV resistant jacket finish as supplied by Pittsburgh Corning. PITTWRAP® IW50 Jacketing is ideal for use where insulation has been roller coated with asphalt prior to jacketing.

5.13.2 Terostat PC® FR silicone polymer coating, as supplied by Pittsburgh Corning.

5.13.3 PITTCOTE® 300E coating supplied by Pittsburgh Corning. A moisture cure vapor retarder coating especially formulated for use with FOAMGLAS® insulation. PITTCOTE® 300E finish must be reinforced with a synthetic or glass fabric mesh, and must be covered with a metal jacket or UV resistant jacketing.

5.13.4 PITTCOTE® 300 finish supplied by Pittsburgh Corning. A vapor retarder asphalt coating especially formulated for use with FOAMGLAS® insulation. PITTCOTE® 300 finish must be reinforced with a synthetic or glass fabric mesh, and must be covered with a metal jacket, or UV resistant jacketing.

5.14 Optional mastic finish shall be PITTCOTE® 404 Coating supplied by Pittsburgh Corning. PITTCOTE® 404 is a flexible, acrylic latex coating used with FOAMGLAS® insulation. PITTCOTE® 404 coating is used with PC® Fabric 79. PITTCOTE® 404 coating is often used for an insulation finish over indoor fitting insulation when all-service-jacketing is used for the straight run insulation finish.

5.15 Insulation jacketing for indoor applications, shall be one of the following:

5.15.1 PITTWRAP® CF jacketing, a cellulose free fiberglass reinforced vapor retarder insulation jacketing used for protecting above ground indoor FOAMGLAS® insulation systems on chilled water and other moderate temperature service pipelines.

5.15.2 Any non-cellulose multi-ply laminated fiberglass-reinforced polypropylene, PVC, or vinyl faced/metalized film backed jacket. Jacket must not contain

known mold or mildew nutrients, and exhibit no mold growth when tested according to ASTM C1338 “Determining Fungi Resistance of Insulation Materials and Facings”.

5.15.3 PVC Jacketing 0.5 mm thick for visual and wash down applications.

5.15.4 Aluminum foil, 0.05 mm thick for non-visual applications

5.15.5 Aluminum foil, 0.2 mm thick for visual applications

5.16 Metal jacket finish for mechanical or fire protection shall be one of the following:

5.16.1 Use minimum 0.4mm (0.016 in.) aluminum jacket for insulation O.D.'s of 610mm (24 in.) or less. For larger O.D.'s use 0.6mm (0.024 in.) Aluminum jacket. Aluminum jacketing shall conform to ASTM C1729 Standard Specification for Aluminum Jacketing for Insulation.

5.16.2 Use minimum 0.4 mm (0.016 in.) smooth steel (i.e. stainless galvanized, aluminized, galvalume, etc.) where the FOAMGLAS® insulation system is also being used for fire protection. Stainless steel jacketing shall conform to ASTM C1767 Standard Specification for Stainless Steel jacketing for Insulation.

6. Application: -268°C (-450°F) to -179°C (-290°F)

6.1 Inner layer insulation shall be fabricated with Hydrocal® B 11 gypsum cement. The outer layer of FOAMGLAS® insulation shall be fabricated using hot asphalt as the fabrication adhesive. Fabrication shall be such that fabrication through-joints are minimized are minimized. Use insulation half-sections wherever possible and curved sidewall segments when half sections are not feasible.

6.2 It is necessary to install the insulation in two layers. The critical factor in determining the thickness of each layer is the interface temperature of the outer layer of insulation. This interface temperature must be within the service temperature range of the joint sealant.

6.3 In double layer applications, the first layer or layers of insulation shall be installed dry (using no joint sealants) with butt joints offset 305 mm (12 in.) laterally, and lap joints offset circumferentially between layers. The outer or final layer of insulation shall be installed with all joints tightly butted and the joints sealed full depth of the insulation thickness with PITTSEAL® 444N^{S} or 444N sealant. If the presence of organic materials is not acceptable (as in liquid oxygen systems) the outer layer sealant shall be PC® RTV 450 Silicone Adhesive or PC® HI-TEMP/RTV Silicone Adhesive. Any broken or poorly fitting insulation shall be replaced or re cut to fit.

6.4 The inner layers in multi-layer applications may be applied with glass fiber reinforced strapping tape, wrapping the tape 1½ times around the insulation such that the tape secures to itself. This procedure is acceptable as long as the O.D. of the insulation section being taped in place does not exceed 457 mm (18 in.).

6.4.1 For insulation with larger O.D.'s than 457 mm (18 in.), AISI type 304 (BSI 304 S16) stainless steel bands as specified shall be used.

6.4.2 Regardless of the O.D., the outermost layer of insulation shall be installed with metal bands in order to make certain that the sealed joints are drawn tight.

6.5 In asphalt bonded PC® 88 adhesive bonded, or PC® 99 adhesive bonded fabrication, with all joints of the outermost layer of FOAMGLAS® insulation completely sealed and drawn tight, the system is vapor sealed and no additional vapor barrier is required. As an engineer specified option, the insulation can be finished using one of the following three listed methods. Primarily these methods serve to protect the outer surface of the insulation material from physical or environmental damage.

Note: In Hydrocal® B-11 bonded fabrication, the joint zone is permeable to water vapor below ambient. The insulation should be finished using method 6.5.1 or 6.5.2.

6.5.1 Metal jacket finish with vapor retarder mastic - Prior to applying the metal jacket, cover the entire insulation surface with a tack coat of PITTCOTE® 300 finish at a coverage rate of approximately 0.8 to 1.2 liters/m^2 (2-3 gal./100 ft^2). PC® Fabric 79 reinforces the first layer of mastic. Apply a second coat at a rate of 1.6 to 2 liters/m^2 (4 to 5 gal. /100 ft^2). As an alternative, spray application can be made. See Pittsburgh Corning product data sheet for more detailed information. After the second coat has dried, cover the insulated surface with metal jacket. Apply metal jacket with all laps positioned to shed water and sealed with a manufacturer's recommended lap sealant. Firmly secure metal jacket in place with bands in accordance with manufacturer's recommendations. Do not use screws.

6.5.2 Metal jacket finish with combination protection wrap and vapor retarder mastic - Apply PITTWRAP® B100 jacketing or PITTWRAP® IW30 Jacketing as a protective jacket, to the insulation on straight runs. Then apply metal jacket in accordance with manufacturer's recommendations over the protective jacketing. Fittings, valves, and irregular shapes are finished with mastic and metal as described in section 6.5.1.

Note: The procedure for sealing the transition surface between jacketing and mastic is detailed in the product data sheet for the wrap being used.

7. Application: -178°C (-289°F) to -52°C (-61°F)

7.1 All insulation shall be applied in a double layer application as described in Section 6. Insulation shall be fabricated in half sections or curved sidewall segments with a minimum number of fabrication through-joints. For vessel head fabrication see Section 5.1.4.

7.2 FOAMGLAS® insulation shall be applied and finished as specified in Sections 6.2 through 6.5.

8. Application: -51°C (-60°F) to 2°C (35°F)

8.1 For surfaces with diameters up to approximately 0.9 m (3.0 ft.) O.D., the insulation shall be applied with all joints tightly butted and sealed with PITTSEAL® 444Ns or 444N sealant. For chilled water applications PITTSEAL® CW sealant may be used in place of PITTSEAL® 444Ns or 444N sealant.

8.2 Poorly fitting or broken insulation shall be replaced or re cut to form a completely vapor sealed insulation system. This insulation shall be banded in place as described above.

8.3 For piping, vessels, equipment, and tanks with diameters larger than 0.9 m (3.0 ft.), the insulation may be secured by using bands, pins, or adhesive. Contact Pittsburgh Corning for more details on these various systems.

8.4 In addition to the finishes listed in section 6.5 the following finish options are approved in this temperature range for indoor applications.

8.4.1 Acrylic mastic finish: Apply PITTCOTE® 404 coating as two coats at a coverage rate of 1.2 to 1.6 liters/m^2 (3-4 gal. /100 ft^2) for each coat. PC® Fabric 79 reinforces the first layer of mastic. See Pittsburgh Corning data sheet for more detailed information.

8.4.2 For indoor commercial piping, factory or field applied PITTWRAP® CF jacketing. Consult Pittsburgh Corning product data sheet for additional information.

9. Application: 2°C (36°F) to 82°C (180°F)

9.1 Insulation may be applied in a single layer application. Insulation should be fabricated in half sections or curved sidewall segments wherever possible. Beveled lags or flat block insulation may be acceptable for large diameter surfaces as shown in Table 1.

9.2 The use of joint sealant is recommended on all systems that operate below ambient temperature for any length of time, and is required on systems that operate at or below 2.2°C (36°F). In cases where the below ambient system is operating at a temperature higher than 2.2°C (36°F), and the outdoor relative humidity is not routinely expected to exceed 50%, the use of a joint sealant is at the discretion of the design engineer.

9.3 For piping and small diameter equipment, the insulation may be either taped or banded in place.

9.4 For piping, vessels, equipment, and tanks with diameters larger than 0.9 m (3.0 ft.), the insulation may be secured by using bands, pins, or adhesive. Contact Pittsburgh Corning for more details on these various systems.

9.5 Suggested finishes in this application temperature range are:

9.5.1 Weather barrier mastic finish: Apply PITTCOTE® 404 coating as two coats at a coverage rate of 1.2 to 1.6 liters/m^2 (3-4 gal. /100 ft^2) for each coat. PC® Fabric 79 reinforces the first layer of mastic. See Pittsburgh Corning data sheet for more detailed information.

9.5.2 Metal jacket finish with vapor retarder mastic - Prior to applying the metal jacket, cover the entire insulation surface with a tack coat of PITTCOTE® 300 finish at a coverage rate of approximately 0.8 to 1.2 liters/m^2 (2-3 gal./100 ft^2). PC® Fabric 79 reinforces the first layer of mastic, at a coverage rate of approximately 0.8 to 1.2 liters/m^2 (2-3 gal./100 ft^2). Apply a second coat at a rate of 1.6 to 2 liters/m^2 (4 to 5 gal. /100 ft^2). As an alternative, spray application can be made. See Pittsburgh Corning product data sheet for more detailed information. After the second coat has dried, cover the insulated surface with metal jacket. Apply metal jacket with all laps positioned to shed water and sealed with a manufacturer's recommended lap sealant. Firmly secure metal jacket in place with bands in accordance with manufacturer's recommendations. Do not use screws.

9.5.3 Metal jacket finish with combination protection wrap and vapor retarder mastic - Apply PITTWRAP® B100 jacketing or PITTWRAP® IW30 Jacketing as a protective jacket, to the insulation on straight runs. Then apply metal jacket in accordance with manufacturer's recommendations over the protective jacketing. Fittings, valves, and irregular shapes are finished with mastic and metal as described in section

9.5.4 On indoor commercial piping factory or field applied PITTWRAP® CF jacketing is preferred. Paperless ASJ, PVC jacketing or FRP jacketing are also acceptable options. Consult Pittsburgh Corning product data sheet for additional information.

Note: The procedure for sealing the transition surface between jacketing and mastic is detailed in the product data sheet for the wrap being used.

10. Application: 83°C (181°F) to 204°C (400°F)

10.1 Insulation may be applied in a single layer application. Insulation should be fabricated in half sections or curved sidewall segments wherever possible. Beveled lags or flat block insulation may be acceptable for large diameter surfaces as shown in Appendix C: Table 1.

10.2 For piping and small diameter equipment, the insulation may be either taped or banded in place.

10.3 For piping, vessels, equipment, and tanks with diameters larger than 0.9 m (3.0 ft.), the insulation may be secured using either bands, or pins. Contact Pittsburgh Corning for more details on these various systems.

10.4 Finish for this temperature range is usually metal jacket finish with no mastic, protection wrap, or lap sealant. Any of the finishes listed in section 9.5 may also be used. For this temperature range, check insulation surface temperature for ability to use a mastic finish or protection wrap product on exterior insulation surfaces.

10.4.1 Alternatives for this temperature range are:

10.4.2 FOAMGLAS® Insulation StrataFab® system. Consult Pittsburgh Corning for details.

10.4.1 FOAMGLAS® insulation PC® 700K system. Consult Pittsburgh Corning for details.

11. Application: 205°C (401°F) to 482°C (900°F)

11.1 Insulation should be fabricated in half sections or curved sidewall segments wherever possible. Beveled lags or flat block insulation may be acceptable for large diameter surfaces as shown in Appendix C: Table 1.

11.2 Pittsburgh Corning's primary recommendation for this temperature range is the FOAMGLAS® Insulation StrataFab® System. Contact Pittsburgh Corning for more information about the StrataFab® System.

11.3 As an alternative to the StrataFab® System, FOAMGLAS® insulation may be used in this temperature range in the following configurations:

11.3.1 Applied with the FOAMGLAS® insulation PC® 700K system. Consult Pittsburgh Corning for details

11.3.2 Applied in a double layer application. The first layer may be either taped or banded according to the recommendations above. The second layer should be banded in place.

11.3.3 Applied in a single layer with an external reinforcement of Hydrocal® B-11 gypsum cement and a 10x10 fiberglass scrim reinforcing fabric. This external reinforcement system is applied in the fabrication shop, not in the field.

11.3.4 Applied in a composite system using either a high density fibrous glass blanket or a mineral wool inner layer and FOAMGLAS® insulation outer layer. Not for use on systems containing combustible fluids.

Note: Pittsburgh Corning recommends that composite systems only be used on lines operating at 232°C (450°F) or higher. In addition, the system should be designed so that the FOAMGLAS® insulation/mineral wool interface is a minimum temperature of 121°C (250°F). Contact Pittsburgh Corning for further details.

11.4 For piping and small diameter equipment, the insulation should be banded in place. See Section 5.8. for guidelines in reference to securement.

11.5 For piping, vessels, equipment, and tanks with diameters larger than 0.9 m (3.0 ft.), the insulation may be secured using bands. Contact Pittsburgh Corning for more details on these systems.

11.6 See Section 10.4 for information regarding appropriate finish for this temperature range.

12. Inspection

12.1 The general contractor, insulation contractor and owner shall provide sufficient inspection during the insulation and finish application. Continuous inspection of the application is not to be considered a requirement of Pittsburgh Corning. Inspect all insulation and accessory materials to be certain they are applied in conformance with the specification recommendations. Joints should be tight, sealing and flashing should be thorough and water-tight, and finishes should be uniform and free of defects.

13. Quality Assurance

13.1 The insulation manufacturer's quality system, including its implementation, shall meet the requirements of ISO 9001:2008.

14. Certificates

14.1 The manufacturer will furnish evidence of compliance with the quality system requirements of ISO 9001:2008.

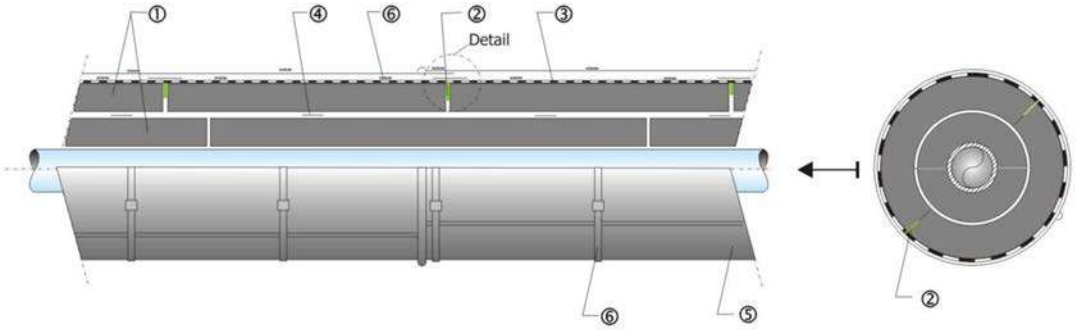
15. Product Data Sheets

15.1 Product data sheets for Pittsburgh Corning products may be accessed online at http://www.foamglas.com/ . The following are Pittsburgh Corning products referenced in this specification:

15.1.1	FOAMGLAS® ONE™ Insulation	FI-003
15.1.2	Hydrocal® B-11:	FI-169
15.1.3	PC® 80M Mortar	FI-289
15.1.4	PITTCOTE® 16 (LTAA) coating	FI-333
15.1.5	PC® 88 adhesive:	FI-125
15.1.6	PC® 99 adhesive/sealant	FI-284
15.1.7	PC® Fabric 79:	FI-159
15.1.8	PC® RTV 450 Silicone Adhesive	FI-244
15.1.9	PC® HI-TEMP/RTV Silicone Adhesive.	FI-232
15.1.1	PITTCOTE® 300E finish:	FI-120e
15.1.2	PITTCOTE® 300 finish:	FI-120
15.1.3	PITTCOTE® 404 coating:	FI-138
15.1.4	PITTSEAL® 444N^{s} sealant:	FI-164s
15.1.5	PITTSEAL® 444N sealant	FI164
15.1.6	PITTSTOP™ 196 Vapor Stop	FI-320
15.1.7	PC® 42 Cryogenic Adhesive	FI-319
15.1.8	PITTSEAL® CW sealant	FI-269
15.1.9	PITTWRAP® B100 jacketing	FI-281
15.1.10	PITTWRAP® IW30 jacketing	FI-235
15.1.11	PITTWRAP® CF jacketing	FI-288
15.1.12	StrataFab® Insulation System	FI-222
15.1.13	PC® 700K	

16. Appendix A Technical Drawings

16.1 Appendix A1: Pipe insulation



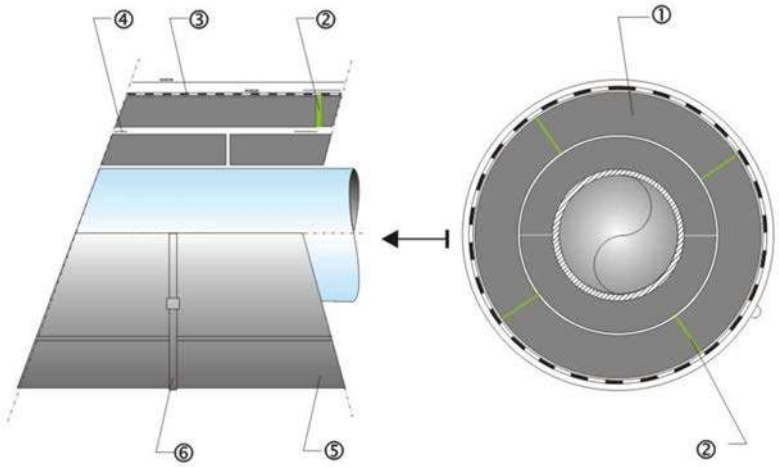
Detail: System A
Pre-Applied Alubutylfoil

Detail: System B
Site-Applied Alubutylfoil

Detail: System C
Terostat precoated

① Cellular Glass
② Sealer, Cryogenic Adhesive
③ Vapour Retarder
④ Tape
⑤ Metal Jacketing (when applicable)
⑥ Tension Strap

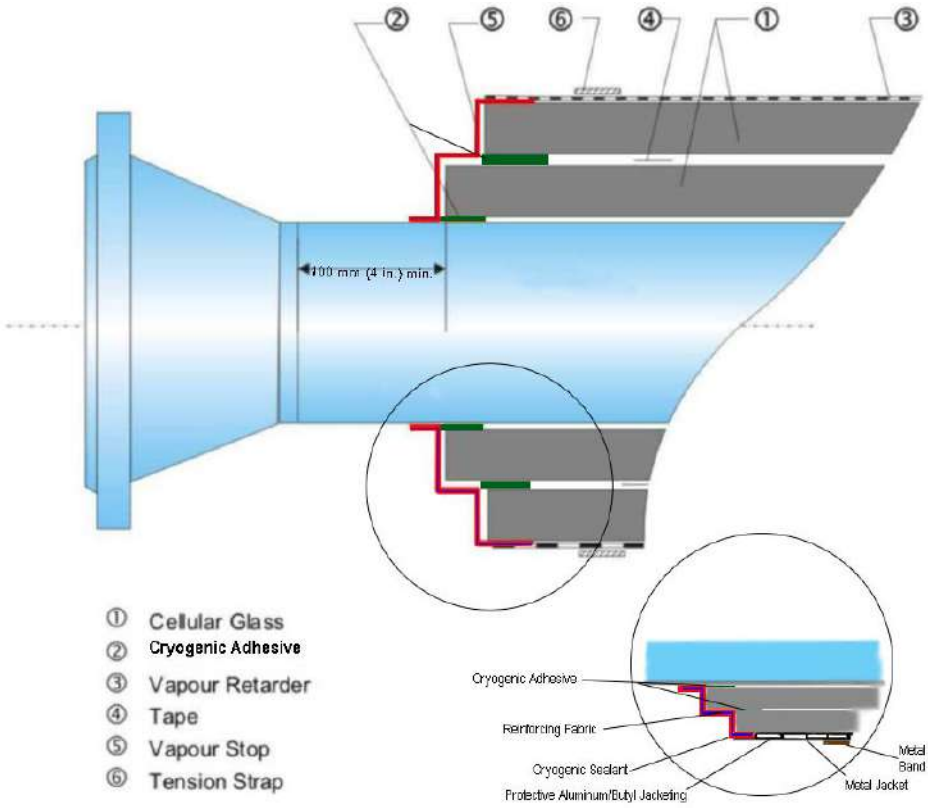
16.2 Appendix A2: Pipe Insulation: Quarter-Segments



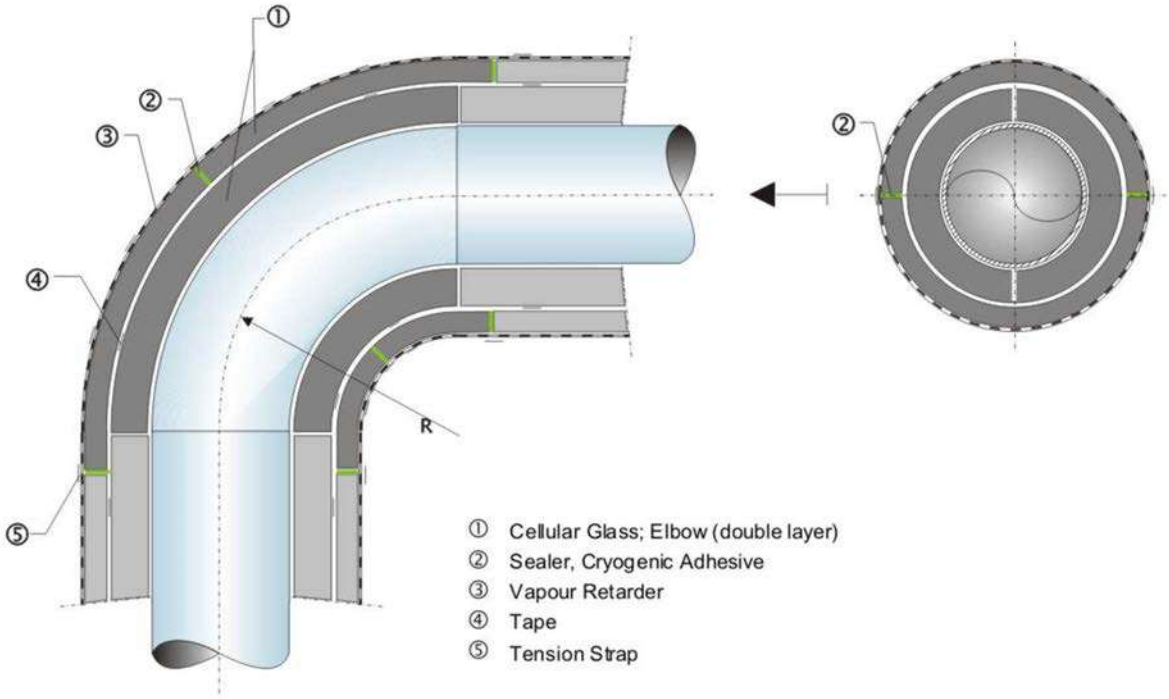
Staggered Joints

① Cellular Glass; Quarter Segments
② Sealer, Cryogenic Adhesive
③ Vapour Retarder
④ Tape
⑤ Metal Jacketing (when applicable)
⑥ Tension Strap

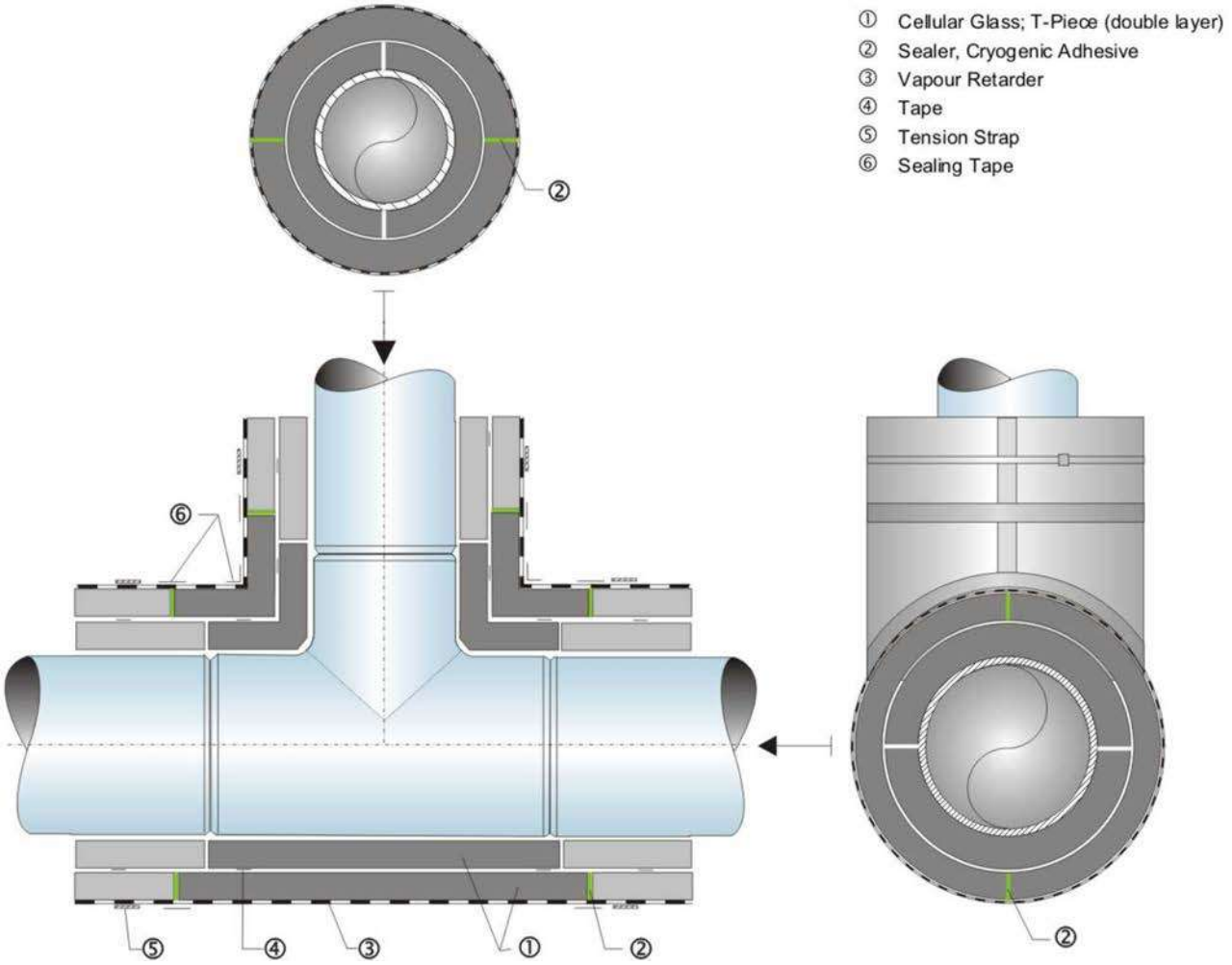
16.3 Appendix A3: Pipe Termination



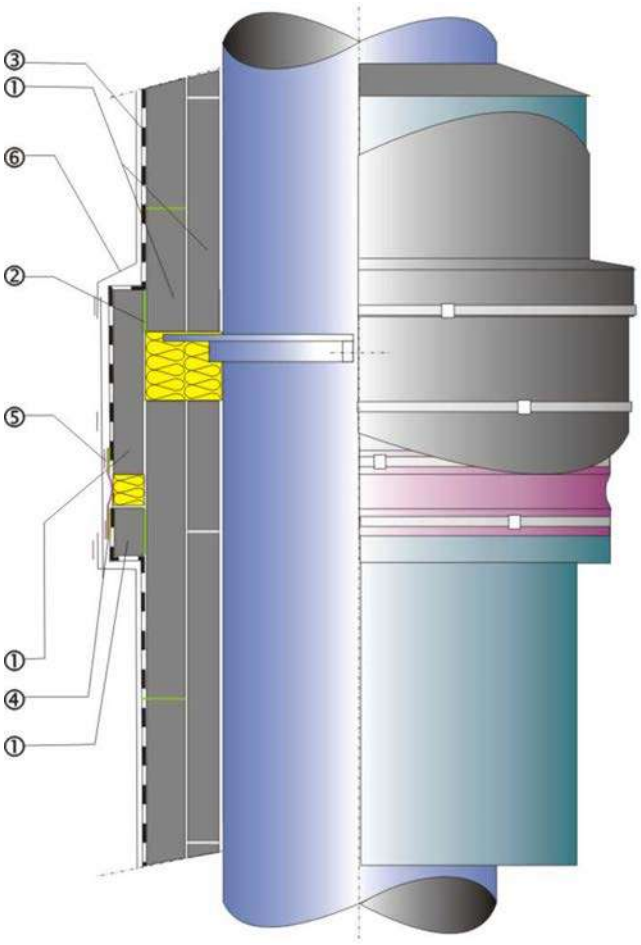
16.4 Appendix A4: Elbow Insulation



16.5 Appendix A5: Tee piece insulation

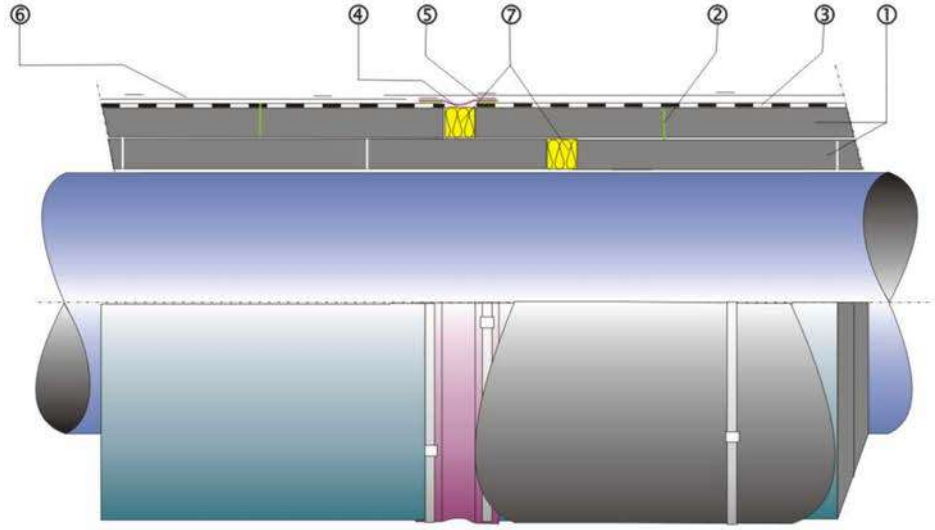


16.6 Appendix A6: Vertical Expansion / Contraction Joint



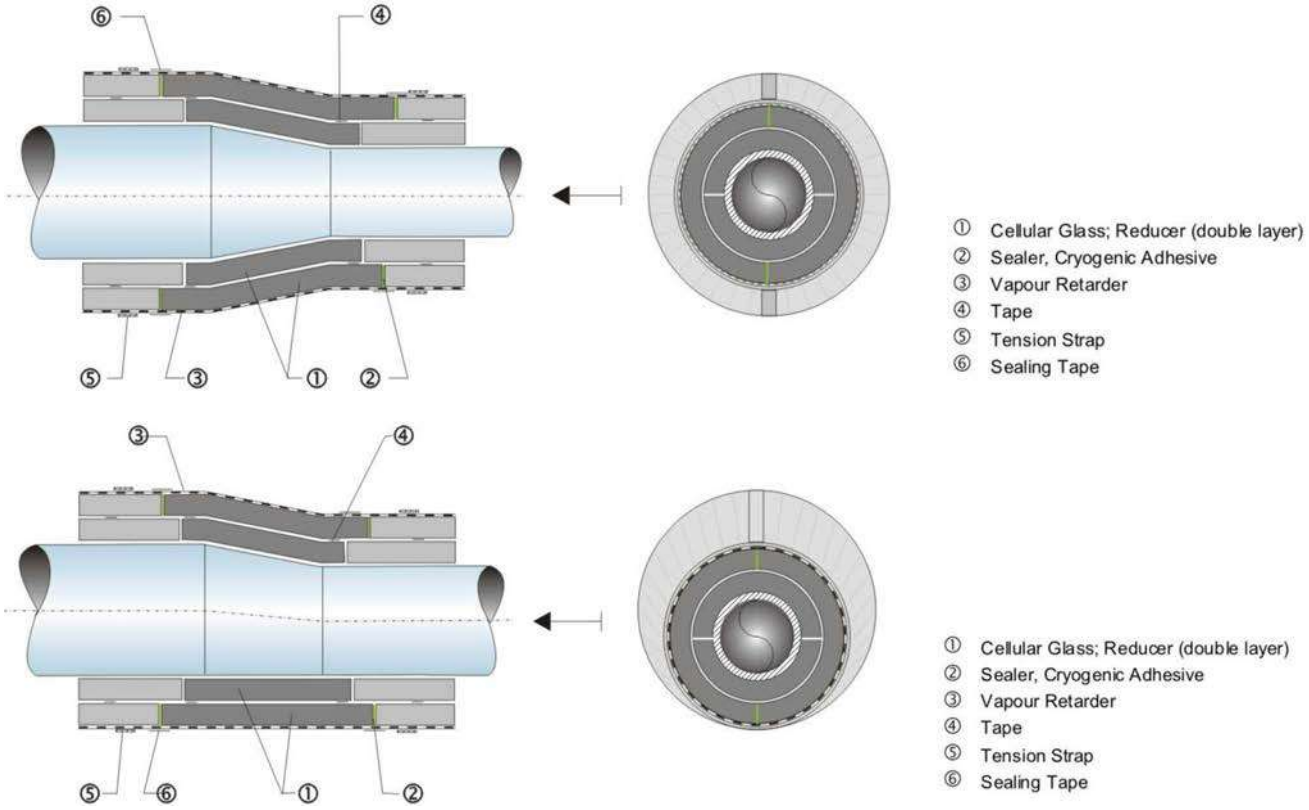
① Cellular Glass
② Sealer, Cryogenic Adhesive
③ Vapour Retarder
④ Rubber Vapour Barrier
⑤ Tension Strap
⑥ Metal Jacketing (when applicable)

16.7 Appendix A7: Horizontal Expansion / Contraction Joint

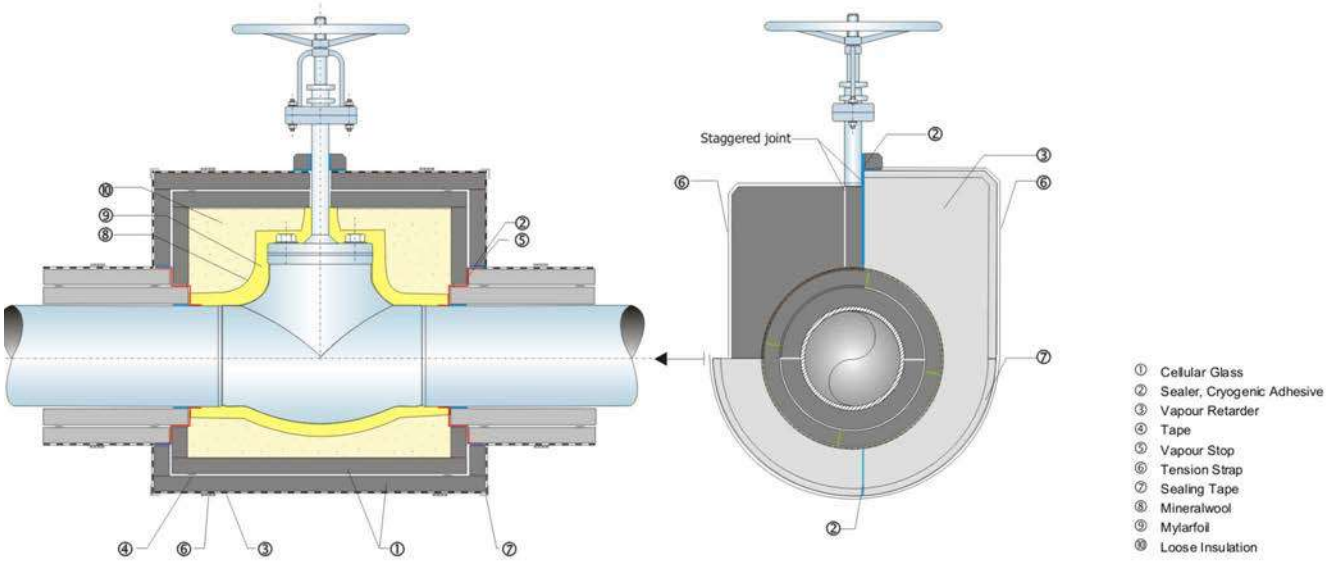


① Cellular Glass
② Sealer, Cryogenic Adhesive
③ Vapour Retarder
④ Rubber Vapour Barrier
⑤ Tension Strap
⑥ Metal Jacketing (when applicable)
⑦ Mineral Wool

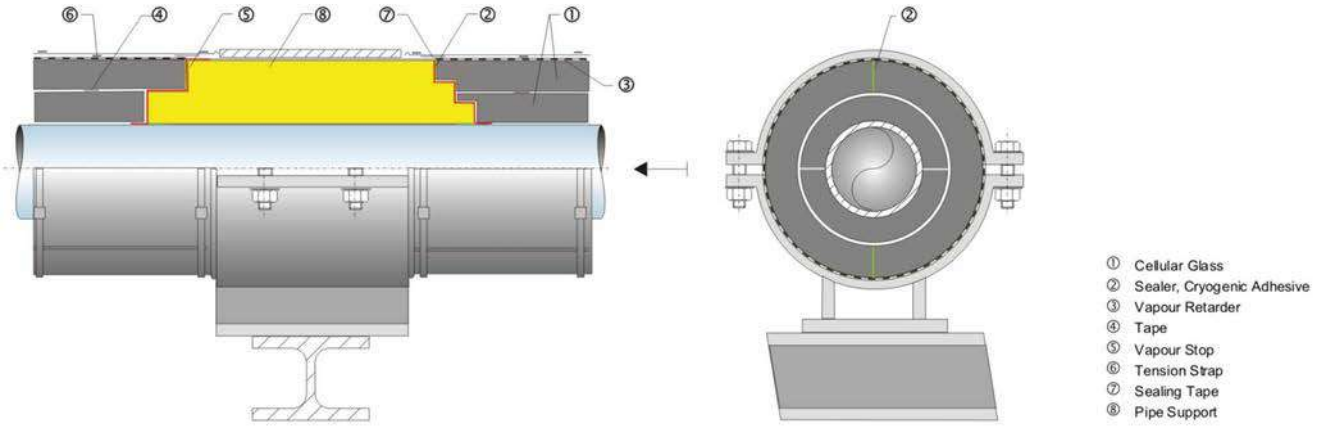
16.8 Appendix A8: Cone Insulation



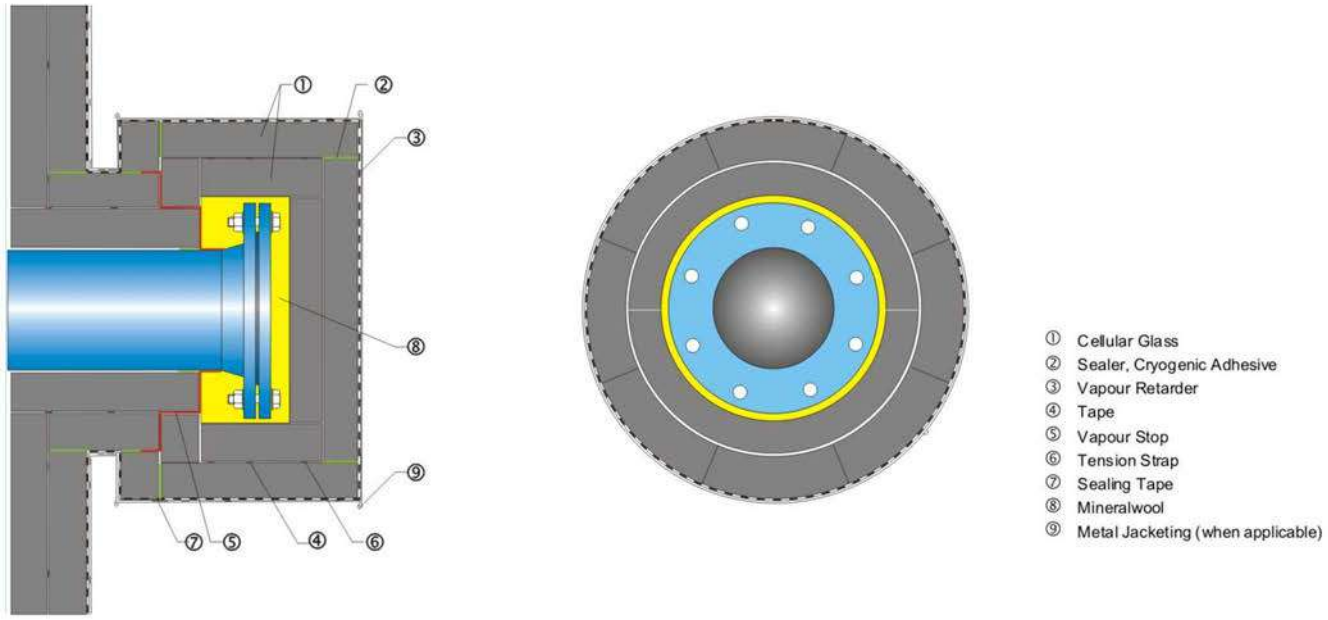
16.9 Appendix A9: Valve Insulation



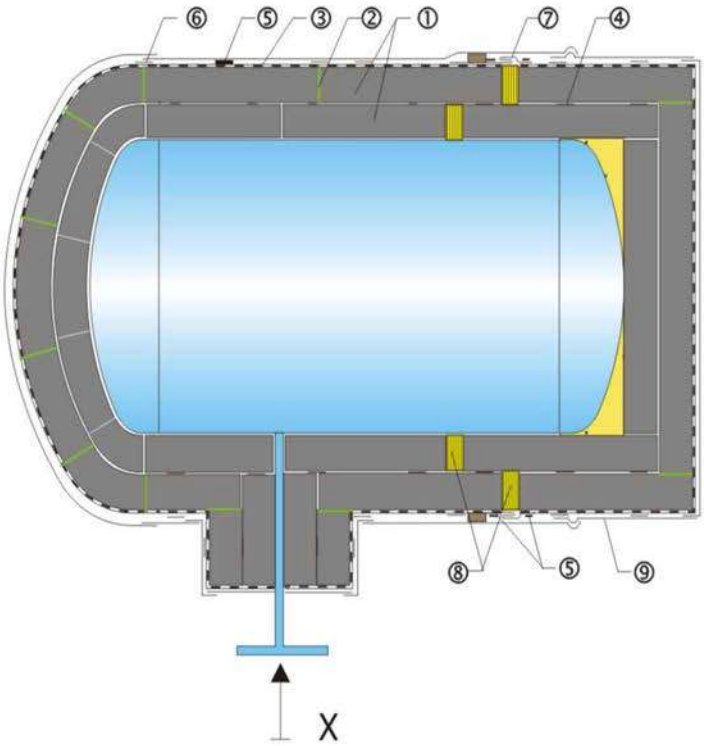
16.10 Appendix A10: Pipe Support Insulation



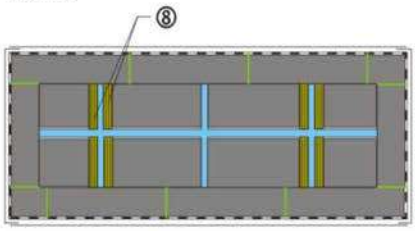
16.11 Appendix A12: Nozzle



16.12 Appendix A13: Vessel

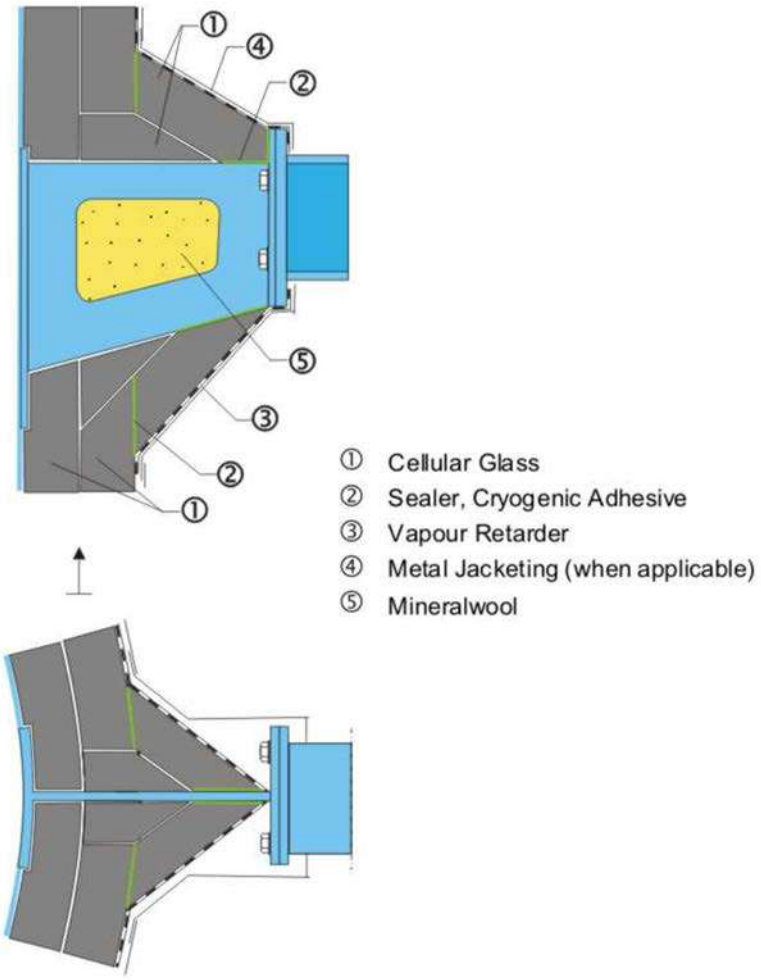


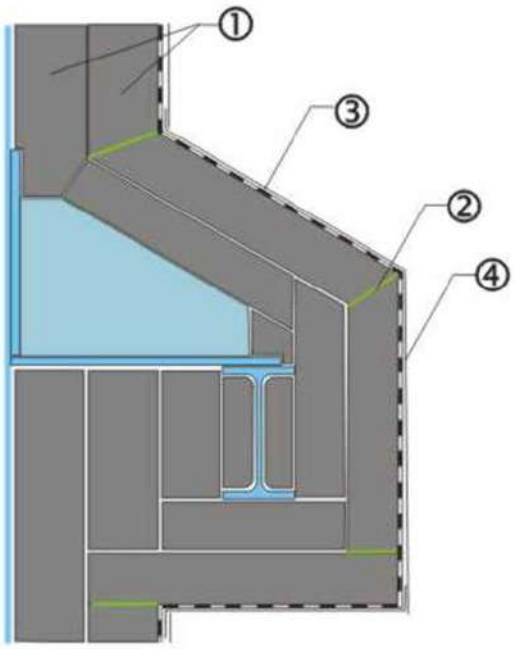
View: X



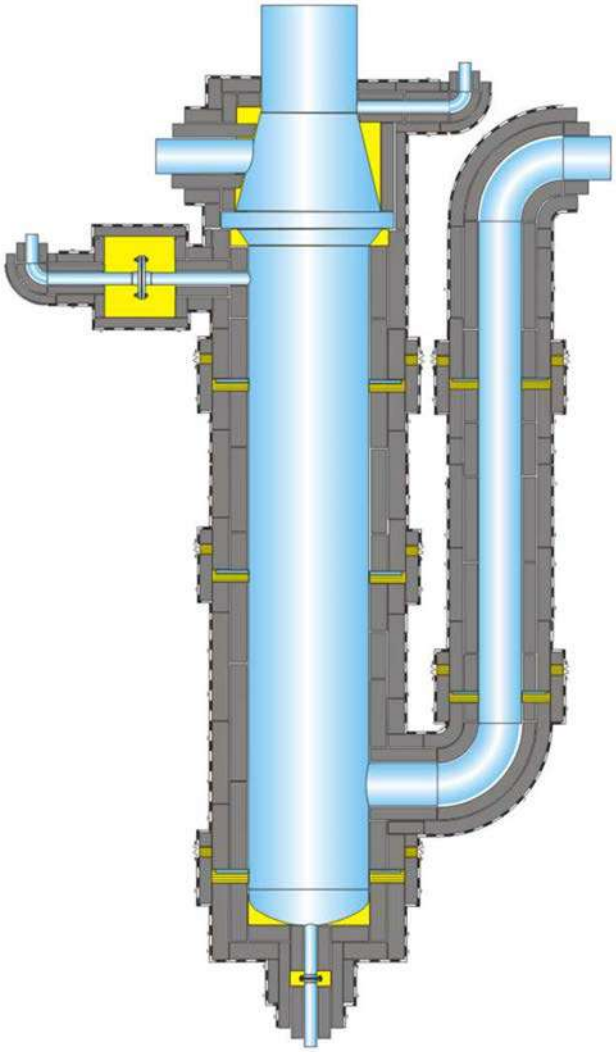
① Cellular Glass
② Sealer, Cryogenic Adhesive
③ Vapour Retarder
④ Tape
⑤ Tension Strap
⑥ Sealing Tape
⑦ Rubber Vapour Barrier
⑧ Mineralwool
⑨ Metal Jacketing (when applicable)

16.13 Appendix A14: Bracket





16.14 Appendix A15: pump



17. Appendix B: Other Product Manufacturers

TEMP-MAT® as supplied by Alpha Associates 2 Amboy Avenue Woodbridge, NJ 07095 Telephone: (732)634-5700 Fax: (732)634-1430 http://www.alphainc.com/site/ or equal.

AAA Acme Rubber Company 2003 E. Fifth St., Bldg. #1 Tempe, AZ 85281
Telephone: (480)966-9311 Fax: (480)966-2273
http://www.acmerubber.com/neosheet.htm or approved equal.

3M Scotch No. 880 tape, or equivalent

18. Appendix C: Tables

TABLE 1
RECOMMENDED FABRICATION CONFIGURATION

DIAMETER (O.D.)	HALF-SECTIONS (min. thickness)	CURVED SIDEWALL SEGMENTS	BEVELED LAGS	FLAT BLOCKS (max. size)
< 152 mm (< 6 in.)	25 mm (1 in.)			
152 to 305 mm (6 in. to 12 in.)	25 mm to 38 mm (1 in. to 1½ in.)			
305 to 508 mm (12 in. to 20 in.)	51 mm (2 in.)			
508 to 610 mm (20 in. to 24 in.)	51 mm to 64 mm (2 in. to 2½ in.)	X		
610 mm to 1.8 m (24 in. to 6 ft.)		X		
1.8 m to 4 m (6 ft. to 13 ft.)		X	X	152 mm (6 in.)
4.3 m to 7 m (14 ft. to 23 ft.)		X	X	229 mm (9 in.)
7.3 m to 16 m (24 ft. to 53 ft.)				305 mm (12 in.)
16.2 m to 45 m (54 ft. to 150 ft.)				457 mm (18 in.)
over 45 m (over 150 ft.)				457 mm (18 in.)

TABLE 2
FABRICATION ADHESIVE GUIDELINES

OPERATING TEMPERATURE °C (°F)	HOT ASPHALT	HYDROCAL® B-11	StrataFab® System
-268 to -179 (-450 to -290)		X [1]	
-178 to -74 (-289 to -101)	X	X	
-73 to 121 (-100 to 250)	X	X	
121 to 204 (250 to 400)	X [2]	X	X
205 to 260 (401 to 500)		X	X
261 to 482 (501 to 900)		X	X [3]

Notes: Table 1 and 2

[1.] Hydrocal® B 11 is an inorganic gypsum based cement product. For applications where the process temperature may result in the presence of liquid oxygen, inorganic materials are always preferred.
[2.] In this temperature range, only use asphalt if it is above ground and outdoors because of potential odor and melting concerns.
[3.] If the StrataFab® System is being used in a tunnel, vault or other confined air space, ventilation is recommended. Bonding adhesive may smoke in contact with hot surfaces above 52 °C (125°F). See Safety Data Sheet for safe handling and use.

19. Additional Information

Questions regarding this report should be directed to:
Pittsburgh Corning Corporation

Global Industry Headquarters
800 Presque Isle Drive
Pittsburgh, PA 15239 USA

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