1. GENERAL NOTES

1.1. This specification covers the application of FOAMGLAS® insulation on liquid natural gas piping and equipment (LNG), operating at or near −160°C (−260°F) for control of heat gain. This specification may be applicable for indoor or outdoor installations.

1.2. 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. The final application procedure is the responsibility of the project designer and/or owner.

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: http://www.foamglas.com/industry/en/

1.4. English unit conversions have been rounded to nearest SI unit equivalent.

2. PRELIMINARY CONDITIONS

2.1. FOAMGLAS® pipe insulation and fabricated fittings should be transported and stored vertically. Handle the packages with care. FOAMGLAS® insulation packages should be protected from the elements while in storage and should not be allowed to come into direct contact with the ground.

2.2. The surface to be insulated should be clean and free from all traces of grease, rust, dust and any foreign matter. The design engineer should decide whether a coat of anticorrosion paint is necessary, and the type of paint compatible with the service temperature and the adhesive used (if any). If he decides to specify a paint, the following rules should be observed:

2.2.1. 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.

2.2.2. Any surface imperfection should be wire brushed and then coated with a new layer of anticorrosion paint. The surface should be perfectly dry before the insulation is applied.

2.2.3. When an adhesive is used, the compatibility between the anticorrosion paint and the adhesive should be verified before applying the insulation.
2.3. The surface and the materials used should be dry before and during application, and should remain dry until start up.

2.4. The application of FOAMGLAS® insulation on pipes or equipment should be done at ambient temperature (no application when piping or equipment is in service).

2.5. The temperature limits of the accessory products should be respected during both storage and application.

2.6. Hydrostatic, radiographic and other tests should be completed before the insulation is applied.

3. DETERMINATION OF REQUIRED INSULATION THICKNESS

3.1. 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/m² (8 to 12 Btu/ft²). 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. Thickness calculations are available from Pittsburgh Corning.

4. MATERIALS USED

4.1. Insulation material

FOAMGLAS® pipe insulation shall be fabricated according to the requirements of ASTM C1639 “Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation”.

4.2. Anti-abrasive
This coating is only to be applied if the piping should be submitted to frequent and significant thermal movements or to strong vibrations. The anti-abrasive coating should be applied onto the inner side of the FOAMGLAS® elements which will be in contact with the metal pipe or equipment.

4.2.1 PC® LTAA
4.2.2 Hydrocal® B-11 gypsum cement (see Data Sheet FI-169) or,
4.2.3 PC® 136 adhesive, used for stainless steel piping (see Data Sheet FI-252)

4.3. Joint sealant
PITTSEAL® 444N sealant, a one-component, permanent non-hardening butyl based sealant or equivalent.

4.4. Contraction joint filler/cushioning blankets if necessary, shall be 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, or Type E needle glass fiber felt thermal insulation containing no organic binders, manufactured in accordance with ASTM C1086. or light density (48 kg/m³ or 3 lb/ft³) fibreglass

4.5. 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 1219 mm (48 in.), 19 x 0.5 mm (0.75 in. x 0.020 in.) for larger O.D.

4.6 Tape shall be Scotch No. 898 tape, a high tensile strength, fiber reinforced tape available from 3M Corporation, or equivalent

4.7. Contraction Joint vapour barrier
Contraction Joint Barrier Sheet shall be minimum 1.6 mm (0.062 in.) thick solid neoprene or butyl rubber as supplied by 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.

4.8 Reinforcing Mesh Fabric for the weather barrier coating shall be synthetic fabric, 6.5 x 6 mesh, PC® Fabric 79 as supplied by Pittsburgh Corning.
Or approved equal

4.9. Protective Coatings or Membranes and Finishes
A vapour retarder has to be installed. This material will fill the cells, improves mechanical resistance of the system, and is an additional barrier to vapour and liquids.

4.9.1 Vapour Retarder Mastic – PITTCOTE® 300 coating, an asphalt mastic, as supplied by Pittsburgh Corning. PITTCOTE® 300 coating must be covered with metal jacket.

4.9.2 TEROSTAT PCFR monomer coating, as supplied by PC.

4.9.3 Hypalon® based coating (type Monolar® or similar), to be reinforced with synthetic fabric, as PC® Fabric 79 or similar.

4.9.4. Alu-butyl sheet

4.9.5 Metal Jacket
Use minimum 0.4 mm (0.016 in.) metal jacket for insulation. Use minimum 0.4 mm (0.016 in.) smooth stainless steel jacket for caustic service or where the FOAMGLAS® insulation is being used for fire protection applications.

5. APPLICATION OF PIPE INSULATION

5.1. Before application of the insulation:
5.1.1. apply vapour stop system to cryogenic supports (when required)
5.1.2. mark location of insulation terminations (at flanges, valves, …) and contraction/expansion joint location (when required) on the object
5.2. Application of insulation

5.2.1 It is necessary to install the insulation in multiple layers. Two layers will normally suffice, when respective thickness are commercially available.

5.2.2. The insulation of straight piping, bends, T-pieces, equipment heads,…, will be fully fabricated to fit; number of pieces
as few as possible, and defined by transport conditions

5.2.3 it is strongly recommended to start application with fittings; straight pipes to be cut on site to fit between fittings/marks

5.2.4 The first layer of FOAMGLAS® insulation shall be installed dry (using no joint sealant). The first layer shall be secured with fiber reinforced tape applied on 300 mm (12 in.) centers, with a 50% overlap of the tape per wrap, or with metal bands

5.2.5 Intermediate layers of FOAMGLAS® insulation shall be applied with all joints staggered from those of the preceding layer. Securement of each layer shall be with fiber reinforced tape using two (2) wraps per section or with metal bands

5.2.6 The final layer of insulation shall be applied with all joints staggered from those of the preceding layer and sealed with joint sealer. A continuous seal must be provided for the full length of all joints; care is to be taken sealant in longitudinal and circumferential joints meet, in order to avoid gaps. poor fitting. It is recommended to apply the sealant by extrusion (gun or cartridges).

5.2.7 The outer layer of FOAMGLAS® insulation shall be secured with 13 wide x 0.4 mm thick (1/2 in. x .015 in.) stainless steel bands at the rate of two (2) bands, equally spaced, per section of insulation. Bands are to be well secured, closing tightly the longitudinal joints

5.2.8 Care must be taken that the outer layer of FOAMGLAS® insulation is not cracked when secured with the stainless steel bands. Cracked or broken FOAMGLAS® insulation shall be replaced.

5.3 EXPANSION/CONTRACTION JOINTS

Physical contraction of the object, when cooled down to cryogenic temperatures may affect insulation system, as differences in temperature and expansion coefficient will result in the creation of gaps in the insulation and finishing, or undue stress, causing cracks.

FOAMGLAS® insulation is thermally stable, having an expansion coefficient lower than and closer to steel than other insulation materials. This creates the situation that when an object is cooled, joints in the insulation will have a tendency to close; no gaps will be created.

Providing that during application some considerations are followed, and a fully flexible vapour retarder is used, the solution described in 5.3.1 is more adequate than a classic exp/contr joint described in 5.3.2, as contraction joints remain a weak point in the system (fibrous, application, closing of the vapour barrier foil, ...)

5.3.1 NO EXPANSION/CONTRACTION JOINTS

This system will only function using vapour barriers that are appropriate for this system:
- Terostat (as extremely flexible)
- Alu/butyl foil, providing an appropriate tape is used on the joints

Every circumferential joint will allow movement.

- insulation of the inner layers will be applied so as to leave a circumferential joint width of 1mm (0.04 in.) (no sealant)
- circumferential joints in the outer layer will be 3 to 5 mm wide (0.12 in. to 0.20 in.); sealant is applied in beads of sufficient
thickness to close the joint at installation; it is recommended to apply two beads in the circumferential joint (note that complete filling of joint will result in too much material when closed at service).

It is a good practice to use a wedge at application, in order to ensure joint width.

This system is NOT applicable on vertical piping, as insulation weight will close joints.

5.3.2 EXPANSION/CONTRACTION JOINTS
The physical contraction/expansion of the piping and equipment shall be determined by the design engineer so that contraction/expansion joints in the insulation can be positioned or located to eliminate any undue stress on the insulation.

Application is recommended between two fixed points (supports, insulation terminations at valve and flange locations, fittings), maximum spacing to be 6 m (20 ft), providing maximum contraction of 25mm (1 in.) can be met.

Contraction joint to be applied in all layers, minimum 150 mm (6 in.) offset, width to be 50mm (2 in.), and filled with resilient low density glass fibre (fibre direction perpendicular on the pipe)
The rubber vapour barrier sheet is wrapped around the joint, completely sealed with joint sealer, and banded with stainless steel bands.

On vertical piping, expansion/contraction joints will be installed at
- Under insulation support ring
- Under pipe support
- Under top elbow

5.4. valve and flange insulation
Valves and flanges to be insulated applying the same thickness and layering as the adjacent piping.
The adjacent straight piping is provided a step-type juncture in order to allow insulation to be installed with staggered joints.
Vapour stop mastic (if required) is applied to juncture in time to allow complete drying before box installation.

It is recommended to insulate valves and flanges with prefabricated boxes (fitting covers) made to fit.
All voids (if applicable) between object and boxes to be filled with loose wool.

5.5 MISCELLANEOUS
5.5.1 Vertical insulation should be supported in an appropriate manner; the self-supporting height of the insulation is determined by taking the mechanical resistance of FOAMGLAS® insulation into account, as well as the movement during contraction. For the purpose of dead load in a vertical support, the insulation will support its own weight on the face of the butt end of the insulation segment for a distance of 15 m (50 ft). The thermal contraction requirements of the pipe metal with respect to the insulation system, however, would ultimately govern the number of supports and their location.
Angle iron or metal plates should be welded onto the vessel or piping to support the insulation. The width of the support should be chosen so as to support the inner layer(s). To prevent a thermal break, the outer layer of insulation should be applied with the mid-point of the insulation section covering the insulation support ring.
Should the ring be wider, a supplementary layer may have to be installed at the insulation support location. Should there be varying thicknesses of insulation on a vessel, a support should be placed at the point where the different thicknesses meet.

5.5.2. Supports, cradles, skirts and legs welded directly onto the equipment should be insulated with the same thickness of insulating material as the equipment itself, in order to avoid thermal bridges. This insulation should extend over a distance equal to four times the insulation thickness and should never be less than 30 cm (12 in.). The cradle shall be designed to provide a sufficient bearing area to limit the compressive force on the insulation to 1.4 kg/cm² (20 psi) maximum at any point.

5.5.3 The insulation of the bottom heads, manholes and other individual items should also be fixed in place with stainless steel straps.

5.5.4 Hollow spaces between object and insulation should be filled with insulating materials to prevent "pumping" of enclosed air, in case of extreme temperature changes. Hollow spaces may be filled with small FOAMGLAS® parts (made of chopped up cuttings).

6. INSULATION FINISH

6.1. Mastic & metal finish
6.1.1 Over the completed insulation installation apply a coat of vapour retarder mastic as specified in 4.9.1., at the rate of 0.8 to 1.2 liter/m² (2 - 3 gal./100 ft²).

6.1.2 Metal jacketing shall be applied over the mastic coating with the joints positioned to shed water. Follow standard practice of engineers specifications for jacket application.

6.1.3 As it may be impossible to avoid moisture under the cladding due to water penetration or condensation, care needs to be taken to evacuate this as efficiently as possible (no wicking space materials, drain holes, ...)

6.2 TEROSTAT coating
TEROSTAT-PCFR is a sprayable and gunable one component polymer. It will be factory applied on all outer layer FOAMGLAS® elements; jointing of these elements or treatment of minor surfaces can be done on site, using adequate tooling. For this purpose, TEROSTAT-PCFR shall be delivered in suitable containers and cartridges.

Apply a bead of TEROSTAT-PCFR on top of all joints, by cartridge, trowel, or gun. The TEROSTAT-PCFR bead will be smoothed flush with the factory applied TEROSTAT-PCFR surface, on such way that the coverage will be at least as thick as the pre-applied coat, and that there will be a complete closure of the coating system. Use an adequate tool like a flexible spatula (Teflon), covered with a soapy water solution, in order to achieve a smooth finish with no drag marks.

Due to its elasticity, this coating is suited to be installed on systems requiring no EXPANSION/CONTRACTION joints.

6.3 Alu/butyl foil
6.3.1 When applied at site, wrap this sheet over the insulation, avoiding wrinkles and holidays. It is good practice to work with sheets on straight piping, and tapes or cut-to-fit sheets on the fittings. Sufficient pressure should be given at the overlapping seams, to create a firm bond between foils at the butyl material level.
It is recommended to heat the material at colder application temperatures.

6.3.2 When the material is pre-applied on the outer insulation layer, it has a perfect fit with inner layer insulation. Sealing on site is done by covering the joints by means of Alu-butyl tape, recommended width to be 4” (100mm). Sufficient pressure will ensure sufficient bond between pre-applied foil and tape at butyl level.

This pre-applied foil application is suited to be installed on systems, requiring no expansion/contraction joints, providing a specific tape is used over the circumferential joints (tape with a non-adhering section in the middle, allowing joint movements).

6.4. Metal jacketing (optional)
Metal jacketing applied as per good practice. Reference can be made to existing manuals (CINI, PIP, …) As it may be impossible to avoid moisture in the cladding due to condensation, care needs to be taken to evacuate this as efficient as possible (drain holes, no wicking spacer materials, …)

7. INSPECTION/QUALITY ASSURANCE

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.

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

8. CERTIFICATES

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

Product Data Sheets

1. PITTSEAL® 444N Sealant: FI-164
2. PITTCOTE® 300: FI-120.
3. TEROSTAT-PCFR: FI-260
5. PC® Fabric 79: FI-159

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