



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 772

Thermal insulation (cold service)

04	10/08	Updated for service temperatures from ambient down -200°C
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Rev.	Date	Notes

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1. Scope

This standard specification defines the technical requirements concerning cold insulating materials and for the thermal insulation of equipment and piping for onshore and offshore installations operating between ambient temperature and -200°C.

This standard gives only general guide lines particularly for systems operating in the range minus 40°C to minus 200°C. Specific insulation requirements have to be specified based on information provided by the insulation systems SUPPLIERS.

The following are excluded:

- Equipment and piping:
 - For hot service
 - For cyclic service
 - Buried
 - Subject to acoustic protection
- Instruments.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
ASTM A 653	Steel sheet, Zinc coated (Galvanized) or Zinc-Iron alloy coated (Galvannealed) by the hot dip process
ASTM A 792	Steel sheet 55% Aluminium-Zinc alloy coated by the hot dip process
ASTM B 209	Aluminium and Aluminium alloy sheet and plate
ASTM C 165	Compressing properties, practice for measuring
ASTM C 168	Standard terminology relating to thermal insulating materials
ASTM C 177	Standard test method for steady-state heat flux measurement and thermal transmission properties by means of the guarded-hot-plate apparatus
ASTM C 203	Breaking load and flexural properties of block type thermal insulation
ASTM C 240	Standard test methods of testing cellular glass insulation block
ASTM C 303	Standard test method for density of pre-formed block type thermal insulation

Reference	Title
ASTM C 450	Prefabrication and field fabrication of thermal insulating fitting covers for NPS piping, vessel laggings and dished head segments
ASTM C 461	Standard test method for mastics and coatings used with thermal insulation
ASTM C 516	Vermiculate loose fill for nominal sizes of pipe/tubing, NBS system, practise
ASTM C 518	Standard test method for steady state thermal transmission properties by means of the heat flowmeter apparatus
ASTM C 549	Perlite loose fill for nominal sizes of pipe/tubing, NBS system, practise
ASTM C 552	Standard specification for cellular glass thermal insulation
ASTM C 585	Inner/outer diameters of rigid thermal insulation for nominal sizes of pipe/tubing, NBS system, practise
ASTM C 591	Specification for unfaced preformed rigid cellular polyurethane - Thermal insulation
ASTM C 755	Selection of vapour retarders for thermal insulation
ASTM C 647	Properties/test of mastics/coatings of thermal insulation, guide
ASTM C 687	Standard Practice for Determination of Thermal Resistance of Loose-Fill Building Insulation
ASTM C 795	Standard specification for thermal insulation for use in contact with austenitic stainless steel
ASTM C 871	Standard test methods for chemical analysis of thermal insulation. Materials of leachable chloride, fluoride, silicate, and sodium ions
ASTM C 921	Packaging material properties/testing
ASTM C 929	Standard practice for handling, transporting, shipping, storage, receiving and application of thermal insulation material for use in contact with austenitic stainless steel
ASTM C 945	Practice for design consideration and spray application of a rigid cellular polyurethane insulation system on outdoor service vessels
ASTM C 950	Repair of rigid cellular polyurethane roof insulation
ASTM C 1033	Pipe insulation installed vertically, test
ASTM C 1046	In situ measurement of heat flux measurement of heat flux and temperature on building envelope component, practise
ASTM C 1104/1104M	Standard test method for determining the water vapour sorption of unfaced mineral fibre insulation
ASTM D 696	Coefficient of linear thermal expansion of plastics between -30°C and +30°C with a vitreous silica dilatometer

Reference	Title
ASTM D 1621	Standard test method for compressive properties of rigid cellular plastics
ASTM D 1622	Standard test method for apparent density of rigid cellular plastics
ASTM D 2126	Standard test method for response of rigid cellular plastics to thermal and humid aging
ASTM D 2842	Standard test method for water absorption of rigid cellular plastics
ASTM D 6226	Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E 84	Standard test method for surface burning characteristics of building materials
ASTM E 96	Standard test method for water vapour transmission of material
ASTM E 228	Standard Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer
BS 476 – Part 6	Fire tests on building materials and structures – Method of test for fire propagation for products
BS 476 – Part 7	Fire tests on building materials and structures – Method of test to determine classification of the surface spread of flame products
EN 826	Determination of compression behaviour
EN 1604	Thermal insulating products for building applications. Determination of dimensional stability under specified temperature and humidity conditions.
NF EN 1609	Thermal insulating products for building applications. Determination of short term water absorption by partial immersion.
EN 10456	Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values
EN 12086	Thermal insulating products for building applications - Determination of water vapour transmission properties
EN12087	Thermal insulating products for building applications - Determination of long term water absorption by immersion
EN 12667	Determination of thermal resistance by means of guarded hot plate and heat flow meter methods. Products of high and medium thermal resistance
EN 12939	Determination of thermal resistance by means of guarded hot plate and heat flow meter methods. Thick products of high and medium thermal resistance
EN 13501-1	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests

Reference	Title
prEN 14305	Thermal insulation products for building equipment and industrial installations – Factory made cellular glass products – Specification
NF EN 13471	Thermal insulating products for building equipment and industrial installations - Determination of the coefficient of thermal expansion
ISO 844	Testing of rigid cellular plastics; compression test
ISO 845	Cellular plastics and rubbers; Determination of Apparent Density
ISO 1209	Rigid cellular plastics – Determination of flexural strengths and apparent flexural modulus of elasticity
ISO 2219	Expanded pure agglomerated cork for thermal insulation - Characteristics, sampling and packaging second edition
ISO 2528	Determination of water vapour transmission rate – gravimetric dish method
ISO 2811	Paints and varnishes – determination of density
ISO 2896	Rigid cellular plastics - Determination of water absorption
ISO 8301	Thermal insulation. Determination of steady-state thermal resistance and related properties. Heat flow meter apparatus.
ISO 12944 – 2	Paints and varnishes-Corrosion protection of steel structures by paint systems. Part 2: Classifications of environments

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
IMO Res. MSC61 (67) – Annex 1 Part 2	International maritime Organisation Resolution - Fire test procedures – Smoke and toxicity test
IMO Res. MSC61 (67) – Annex 1 Part 5	International maritime Organisation Resolution - Fire test procedures – Test for surface flammability

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP ECI 002	Drawings and Symbols – Principles of presentation at project identification phase
GS EP COR 350	External protection of off-shore and coastal structures and equipment by painting
GS EP PVV 211	Design and fabrication of pressure vessels according to ASME VIII
GS EP PVV 212	Design and fabrication of pressure vessels according to PD 5500

3. Insulation systems

3.1 Design of systems

The thermal insulation systems are defined in the tables in the Appendices.

For special cases not covered by the Appendices, the CONTRACTOR shall submit any variant to the COMPANY for approval before use.

3.2 Use of the systems

The following parameters and criteria provide a quick guide for selecting the most appropriate system or systems for each situation:

3.2.1 Equipment configuration

- Horizontal and vertical vessels
- Piping.

3.3 Definition of atmosphere or environment

The insulation systems can be divided into industrial, marine and offshore with increasing level of environmental severity as follows ([ISO 12944](#) part 2 definitions are referred):

Rural atmosphere: the atmosphere prevailing in rural areas and small towns, without significant contamination by corrosive agents such as sulphur dioxide and/or chlorides.

Urban atmosphere: the contaminated atmosphere prevailing in densely populated areas without significant industry. It has moderate concentrations of pollutants such as sulphur dioxide and/or chlorides.

Industrial atmosphere: the atmosphere contaminated by corrosive pollutants from local and regional industry (mainly sulphur dioxide)

Marine atmosphere: atmosphere which prevails at sea, along coastlines and immediately in land, and characterised by the presence in the air of sea water spray, more or less saline mist and by the absence of dust.

Notes:

The **rural** and urban atmospheres are treated as **industrial** atmosphere for specification of insulation systems.

The **tropical** atmosphere is treated as **industrial** or **marine** atmosphere, depending on the geographic location of the structure.

Offshore environment shall be considered as specific atmospheres. Offshore atmospheres are assumed to represent exposure conditions that are always severe and represent a major external corrosion threat.

3.4 Parameters coding and identification of systems

3.4.1 Parameters coding

Environment	
IN	Rural, urban and industrial
MA	Marine and tropical
OS	Offshore

Temperature range:

SNNN/SNNN: two-part code comprising a sign (S) and three digits (NNN) indicating the minimum and maximum working temperatures.

Note:

The minimum operating temperature shall be used to select the thermal insulation system and to determine the thermal insulation thickness.

These temperatures will be those referenced in the line list associated with process design.

For a given unit, it may be necessary to define two or more thermal insulation systems.

3.4.2 Identification of systems

The systems defined in Appendix 1 must be used in conjunction with the installation principles in Appendix 3 and the material specification standards in Appendix 2.

Alternative protective jacketing may be used, depending on the area in which the equipment is installed.

4. Performance level

The specific insulation codes as provided below refer to **GS EP ECI 002** which is the controlling document for specification of insulation codes.

- **Class C** : Cold conservation
Maximum unit heat gain according to values given in the job specification (W/m^2 on equipment and W/ml on piping).
- **Class I** : Frost protection
Minimum surface temperature: $+ 5^{\circ}C$.
- **Class K** : Condensation prevention
No condensation due to ambient temperature and relative humidity.

The thermal efficiency and mechanical integrity of the thermal insulation system shall be guaranteed for a minimum of five years from the date of acceptance.

4.1 Fire Performance

Unless otherwise specified all the insulation materials shall meet the requirements of **ASTM E84** for flame spread index and smoke development index.

Other requirements for fire performance in terms of heat generation, flame spread and smoke development may apply depending on the facilities being assessed and local fire regulations may require to be specified e.g **BS 476** part 6,7 may be specified for Northern Continental shelf or IMO regulations for shipping or FPSO units.

5. Insulation materials

5.1 General

The main purpose of cold insulation in this specification is to maintain process temperatures at any temperature between ambient and minus $200^{\circ}C$. This temperature range is very wide and the specific insulation design may involve the use of single double or triple insulation layers with single or double vapour barriers as well as specific details for end terminations depending on minimum operating temperature and insulation materials.

The insulation design is also influenced by the insulation material as well as the construction practice. Consequently, for each situation the insulation design shall be agreed with the **SUPPLIER** and applicator of the system.

5.2 Cellular Glass Insulation

Cellular glass block insulation shall be manufactured in accordance with the general requirements of ASTM C 552 or other recognised international standard. Thermal conductivity values shall be as stated in material data sheets.

5.3 Polyisocyanurate (PIR) foam insulation

Low density Polyisocyanurate foam (PIR) insulation is generally specified for cold insulation due to its combination of mechanical and physical properties and fire resistance compared to PUR. The (PIR) shall be CFC and HCFC free and shall have mechanical and physical properties supplied in accordance with the material specification No 3 indicated in Appendix 3.

PIR insulation shall be manufactured in accordance with the general requirements of [ASTM C 591](#) or other recognised standard. Thermal conductivity values shall be as stated in material data sheets.

PUR is normally specified only for field application involving injection moulding (e.g. valves boxes, flanges boxes, etc). Thermal insulation material specification n°035 refers.

5.4 Contraction joint insulation

Contraction joints are required for horizontal piping and for equipment also. Requirements for contraction joints for each layer shall be in accordance with SUPPLIER recommendations.

Contraction joints for vertical insulated piping and equipment shall be installed beneath insulation supports and shall be in accordance with SUPPLIER recommendations.

5.5 Vapour Barriers

All cold insulation shall be provided with one and/or multiple vapour barriers specified strictly in accordance with manufacturers recommended practice to ensure that a fully airtight layer is produced.

Vapour barriers provided by use of aluminium polyester foil shall have a minimum thickness of 50 microns and a minimum overlap of 50 mm.

At end terminations or for complex configurations use of aluminium foil is not practical and fabric reinforced vapour retardant mastic vapour barrier is required. The mastic shall overlap the aluminium foil by 50mm minimum.

5.6 External Jacketing

All insulated equipment and piping shall be generally protected with jacket systems based on metal cladding, or mastic impregnated tapes.

GRE jacketing can also be considered on an individual project basis.

The jacketing system shall provide protection against water and external environment, fire when specified, and mechanical damage.

The choice of jacketing system shall take account of fire requirements, service life, external corrosion conditions, availability for local purchase of cladding materials, and ease of replacement. Due to these considerations several jacketing options are provided in this specification.

5.7 Sealants and adhesives and anti abrasive compound

Adhesives used for bonding insulation sections together or to metal surfaces shall be used in strict accordance with the insulation manufacturer's recommendations.

The adhesives and sealants shall be demonstrated to be suitable for the minimum operating temperature of the system.

Anti abrasive compounds shall meet the fire performance characteristics indicated in section 4.1 and shall be suitable for the operating temperatures of the system to be insulated. The anti abrasive compound shall be approved by the insulation material SUPPLIER.

5.8 Pipe supports for Cold Insulated Systems

High density PUR or PIR foam supports shall be specified for this application. The specific selection of material shall take account of the required fire performance of the system especially since high density PIR and PUR products have lower fire performance than low density PIR.

Supports shall be designed to withstand all service loads including thermal stresses as well as all mechanical loads and clamping forces.

6. General conditions for execution of works

6.1 Proficiency of installation Contractors

Personnel shall be individually qualified to tradesman level as "insulation applicator". This proficiency shall be documented by an approved trade organisation if possible or by SUPPLIERS' organisation. No untrained or unsupervised personnel shall be used for insulation installation. A register of qualified operators (with photographic record) shall be documented. Recertification of the Applicators is required to be performed on a two yearly basis.

6.2 Conditions on materials

6.2.1 Supply and storage

All materials shall be procured according to the material specifications in Appendix 2. They shall be accompanied by certificates of conformity.

6.2.1.1 Insulating materials

The materials required for insulation shall be procured before starting of operations, and shall remain in the original packaging, indicating the composition, type, density and thicknesses. They shall be stored sheltered from water and in accordance with the instructions in the SUPPLIER'S data sheets.

6.2.1.2 Fixing, sealing and vapour barrier materials (glues, mastics)

These shall be procured before starting of operations, unless the shelf life of the products is shorter than the duration of the works, and shall be stored in their original packaging according to instructions in the **SUPPLIER'S** data sheets. In some cases, it may be necessary to store them in air-conditioned premises to prevent them becoming denatured.

6.2.2 Sampling of insulation, fixing, sealing and vapour barrier materials

The CONTRACTOR shall take a sample for each batch of materials used to verify their compliance.

The dimensions and the necessary quantities shall be determined according to the requirements of the specifications pertaining to inspection of materials.

6.3 Preliminary conditions

The CONTRACTOR shall not start installation operations until a report on the premises has been prepared, indicating that:

- The thermal insulation supports (and insulation accessories) that are the responsibility of the equipment and piping SUPPLIERS have been installed according to pressure vessel and piping trade practises
- All tests have been completed
- The surfaces have been appropriately protected in accordance with **GS EP COR 350** for carbon steels with a temperature of between -200°C and +20°C
- Tightening and fixings on flanges, valves, nozzles, etc., have been inspected (after cooling the equipment or circuits)

6.4 Execution conditions

6.4.1 General

Cold service insulation shall be implemented in two phases.

- In the first phase, before cold service tests, the following shall be insulated: equipment shells and heads, straight sections of piping, elbows, tees, connection points, etc.
- In the second phase, after the equipment and circuits concerned have been cold service tested, accessories such as flanges, valves, manholes and nozzles shall be insulated.

The CONTRACTOR shall obtain technical assistance from the SUPPLIERS.

- Insulation shall be placed on dry, clean and degreased surfaces, treated if necessary with corrosion protection.
- Insulation shall only be fitted if the substrate temperature is at least 3°C above the dew point.
- No work shall be carried out during period of rain or in a damp environment, except under shelter and in a controlled atmosphere.
- Insulation shall be fitted in the second phase when the substrates have been de-iced by appropriate means and the surfaces have been dried (torch heating shall not be used).
- If sheet steel protective jacketing is fitted, the installation of M1 self-adhesive distancing strips is recommended between the vapour barrier and the plate to ensure that the vapour barrier is not perforated by the fixing screws (Refer to Appendix 3).

6.4.2 Insulating material installation conditions

Insulation thicknesses: these shall comply with the information contained in the job specification.

The materials shall be applied according to the erection principles (Appendix 3).

Only sound and dry materials shall be applied.

The minimum and maximum temperatures of the environment or the application surfaces shall be limited according to the SUPPLIER'S data sheets concerning the materials and products used.

Cut-outs in the insulation material shall be clean, and shall allow perfect juxtaposition of the items.

Insulation shall be mounted in zigzag fashion, and in the case of multi-layer insulation, the "upper layer joints shall be offset from those of the lower layers".

The jointing of components shall be executed in accordance with the SUPPLIER'S instructions and Appendices 2 and 3.

Each layer of insulation shall be secured independently.

The tension of the retaining straps shall be such that the insulation is not damaged before applying the vapour barrier.

The straps require to be removed on the last layer in the case of a finish without sheet steel protective jacketing.

6.4.3 Protective jacketing installation conditions

6.4.3.1 Vapour barrier

Before starting to fit the vapour barrier, it is required to check that the insulation complies with the specifications (if necessary, proceed with partial acceptance testing, see section 8).

Application of the vapour barrier shall immediately follow installation of the insulation and shall be in strict accordance with the SUPPLIER's application instructions.

Vapour barrier shall be applied in accordance with Appendix 3 and shall comprise at least two layers of mastic reinforced with a layer of reinforcing fabric.

At accessories such as supports, nozzles and manholes, the insulation materials cut-outs shall be made with precision and sealing by appropriate mastic will be performed.

Expansion joints shall be provided to absorb differential movements due to thermal variations.

Insulation of accessories such as flanges, valves and nozzles shall be provided by insulation fixed to "break joints" in accordance with Appendix 1.

6.4.3.2 Fixing and sealing materials.

Application of fabrication adhesive shall be such that there is 100 per cent coverage of the adhesive on mating surfaces. Joint sealants shall be applied on the full surface of longitudinal butt joint contact surfaces and circumferential surfaces as per SUPPLIER instructions.

There shall be no visible voids on the adhered joint nor shall the width of the adhered joint exceed 1.6 mm at any point

6.4.4 Equipment insulation

The insulating materials shall be fitted in accordance with section 5, and according to Appendix 2 and information provided by the SUPPLIERS.

6.4.5 Piping insulation

Insulation materials shall again be applied in accordance with section 5, and according to Appendix 3 and information provided by the SUPPLIERS.

On piping with diameters of less than 2", elbows may be made of angle iron.

Insulation of accessories such as flanges, valves and accessories shall be applied in the second phase using insulation fixed to "break joints" in accordance with Appendix 1. Specific design details need to be provided for these accessories based on information provided by the pipe support designers.

6.5 Repair of execution defects

By agreement with the COMPANY, after determining the extent of the defects, the following methods of repair shall be applied.

6.5.1 Minor cladding defects

Minor defects shall be repaired locally, overlapping the adjacent parts.

6.5.2 Insulation system execution defects

The elements shall be removed and replaced.

7. Technical content of tenders

Tenders shall include the following details for thermal insulation systems:

- Methods and means used to install the insulation
- Data sheets for the proposed materials, and their sources
- Certificates issued by approved laboratories (concerning trials and tests relating to the proposed materials)
- Detailed length measurements for each item of equipment, and summary by type of equipment and insulation classes
- A Quality Assurance Plan (QAP), including Inspection and Test Plan (ITP) and in particular:
 - A nominal functional organisation chart
 - The presence of an inspector at the request of the COMPANY shall be indicated in the job specification
 - The list of installation and inspection phases, and their associated procedures
 - List of installation and inspection equipment
 - Resources provided for protection against adverse climatic conditions.

8. Tests, inspections and acceptance

8.1 Tests

During the work, the CONTRACTOR shall check the following points, in accordance with the systems selected. The results of these checks shall be recorded in the control sheets.

- Conformity of thermal insulation supports
- Condition of surfaces to which the thermal insulation is applied
- Climatic conditions of application

- Surface temperatures
- Quality of materials (compliance with specifications)
- Thickness and number of layers
- Quality of implementation
- Effectiveness of fixings and sealants (remove excess overflow from joints and strips before applying the vapour barrier)
- Quality of application of the vapour barrier and sealing at terminations (first phase)
- Finishing (second phase)
- Compliance with specifications.

8.2 Inspection

As part of the Quality Plan, the CONTRACTOR shall produce an Inspection and Test Plan (ITP) including all the inspection operations and shall submit them to the COMPANY. These actions are linked to the different phases of execution and checking (see section 8).

8.3 Acceptance

8.3.1 Quality control

During acceptance testing by nominated Party, a check shall be run to ensure that all the inspections listed in section 8 (tests) have been carried out and that the results are satisfactory.

8.3.2 Thermal efficiency

Thermal efficiency shall be at least equal to that specified by the COMPANY.

After start-up of the installation, the following shall be checked:

- Absence of condensation and frost (according to design climatic parameters)
- Surface temperature
- Absence of ice on insulation (indicating bad workmanship).

The results of the tests shall be confirmed by a report.

A second check shall be carried out before the end of the warranty period.

Acceptance test operations shall be confirmed by a report.

The CONTRACTOR shall guarantee that the insulation has been executed in strict compliance with this document. The system is defined in the insulation thickness tables.

9. Technical documentation

The technical documentation submitted by the CONTRACTOR on completion of the work shall include:

- Certificates of conformity of the insulating materials
- Certificates connected with tests and inspections by approved laboratories
- Certificates of fire performance as required by this specification
- Particular execution standards
- Miscellaneous inspection forms
- Reports of tests and checks of thermal efficiency and effectiveness
- Acceptance test report.

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List of thermal insulation systems

Equipment	Parameters of choice	Env.	T°C min/max	Type of insulation	Type of jacket	System No.	Remarks
Pressure vessels Vertical or Horizontal	IN/MA/ OS	0°C to -50°C	Cellular glass	Without jacketing	001		
				AluZinc coated Carbon steel sheet	030	Not suitable for OS	
				galvanised steel sheet	002	Not suitable for OS	
				Aluminium sheet	031		
				Stainless steel sheet	003	Grades AISI 430 or AISI 316L Generally applicable to MA	
				316L Austenitic Stainless steel sheet	032	Generally applicable to OS	
	IN/MA	0°C to -70°C	PIR (1)	Without jacketing	004		
				AluZinc coated Carbon steel sheet	033		
				galvanised steel sheet	005		
				Aluminium sheet	034		
				Stainless steel sheet	006		
Note: (1) Polyisocyanurate foam							

Equipment \ Parameters of choice	Env.	T°C min/max	Type of insulation	Type of jacket	System No.	Remarks
Pressure vessels Vertical or Horizontal	IN/MA OS	-51 to -200°C	Cellular glass	Without jacketing	007	
				AluZinc coated Carbon steel sheet	035	Not suitable for OS
				galvanised steel plate	008	Not suitable for OS
				Aluminium sheet	036	
				Stainless steel sheet	009	Grades AISI 430 or AISI 316L Generally applicable to MA
				316L Austenitic Stainless steel sheet	037	Generally applicable to OS
	IN/MA	-71 to -200°C	PIR (1)	Without jacketing	010	
				AluZinc coated Carbon steel sheet	038	
				galvanised steel sheet	011	
				Aluminium sheet	039	
				Stainless steel sheet	012	
	Note: (1) Polyisocyanurate foam					

Parameters of choice Equipment	Env.	T°C min/max	Type of insulation	Type of jacket	System No.	Remarks
Piping	IN/MA OS	0°C to -50°C	Cellular glass	Without jacketing	013	
				AluZinc coated Carbon steel sheet	040	Not suitable for OS
				galvanised steel sheet	014	Not suitable for OS
				Aluminium sheet	041	
				Stainless steel sheet	015	Grades AISI 430 or AISI 316L Generally applicable to MA
				316L Austenitic Stainless steel sheet	042	Generally applicable to OS
	IN/MA	0°C to -70°C	PIR (1)	Without jacketing	016	
				AluZinc coated Carbon steel sheet	043	
				galvanised steel sheet	017	
				Aluminium sheet	044	
				Stainless steel sheet	018	
	IN/MA OS	- 51 to -200°C	Cellular glass	Without jacketing	019	
				AluZinc coated Carbon steel sheet	045	Not suitable for OS
				galvanised steel sheet	020	Not suitable for OS
				Aluminium sheet	046	
				Stainless steel sheet	021	Grades AISI 430 or AISI 316L Generally applicable to MA
				316L Austenitic Stainless steel sheet	047	Generally applicable to OS
	Note: (1) Polyisocyanurate foam					

Parameters of choice Equipment	Env.	T°C min/max	Type of insulation	Type of jacket	System No.	Remarks
Piping	IN/MA	- 71 to -200°C	PIR (1)	Without jacketing	022	
				AluZinc coated Carbon steel sheet	048	
				galvanised steel sheet	029	
				Aluminium sheet	049	
				Stainless steel sheet	024	
Note: (1) Polyisocyanurate foam						

**Description of system No. 001
To be used with standard drawing(s)
Appendix 3 No. 01 to 05**

Component	Description	Reference	Requirements	Remarks
Insulation	Cellular glass	No. 31	Minimum thickness of each layer: 40 mm	For insulation system ≥ 80 mm forecast a minimal two layers system
Bonding material	Adhesive	No. 520	Min. consumption 2.5 kg/m^2	The bonding adhesives and jointing mastic must be proven compatible with and chemically neutral to the equipment's anticorrosive system
Sealant	Mastic	No. 530 or 531 or 532 or 533	Min. consumption 3 kg/m^2	
Fixing	Adhesive tape	No. 579	Min. 2 per segments	
Vapour barrier	Mastic	No. 580 or (581*) or 582	Min. consumption: 4 kg/m^2 in two layers	
	Glass fabric	No. 610	100 mm overlap minimum	
Jacketing material	NOT SPECIFIED			
Jacket fixing				
Water-proofing sealants				

Note: *No incompatibility of adhesion between mastics 886.05/886.06 and HYPALKOTE coating.

Description of system No. 030
To be used with standard drawing(s)
Appendix 3 No. 01 to 05

Component	Description	Reference	Requirements	Remarks
Insulation	Cellular glass	No. 31	Minimum thickness of each layer: 40 mm	For insulation system ≥ 80 mm forecast a minimal two layers system
Bonding material	Adhesive	No. 520	Min. consumption 2.5 kg/m^2	The bonding adhesives and jointing mastic must be proven compatible with and chemically neutral to the equipment's anticorrosive system
Sealant	Mastic	No. 530 or 531 or 532 or 533	Min. consumption 3 kg/m^2	
Fixing	Adhesive tape	No. 579	Min. 2 per segments	
Vapour barrier	Mastic	No. 590 or 582	Min. consumption: 4 kg/m^2 in two layers	
	Glass fabric	No. 610	100 mm overlap minimum	
Spacer	Elastomer	No. 690	19 mm min. thick	
Jacketing material	AluZinc coated carbon steel sheets		Alu zinc steel jacketing to ASTM A792 or equivalent. Coating weight to be 185 g/m^2 both sides. Heads, shell and covers 0.63mm thick	
Jacket fixing	Self-tapping screws		Stainless steel cheese-head self-tapping screws, dia. $4.8 \times 15.9 \text{ mm}$ + neoprene spacers	Fixing sheets to sheets
	Straps		Stainless steel, $16 \times 0.5 \text{ mm}$ min	Retaining sheets (3)
Water-proofing sealants	Preformed cords	No. 534	Diameter according to swage	Applied continuously
	Neutral silicon mastic in cartridges	No. 535		For sealing the finishing work

Note: (3) If necessary, retaining strap on elevated equipment or piping jacket plates exposed to wind.

Description of system No. 002
To be used with standard drawing(s)
Appendix 3 No. 01 to 05

Component	Description	Reference	Requirements	Remarks
Insulation	Cellular glass	No. 31	Minimum thickness of each layer: 40 mm	For insulation system ≥ 80 mm forecast a minimal two layers system
Bonding material	Adhesive	No. 520	Min. consumption 2.5 kg/m^2	The bonding adhesives and jointing mastic must be proven compatible with and chemically neutral to the equipment's anticorrosive system
Sealant	Mastic	No. 530 or 531 or 532 or 533	Min. consumption 3 kg/m^2	
Fixing	Adhesive tape	No. 579	Min. 2 per segments	
Vapour barrier	Mastic	No. 590 or 582	Min. consumption: 4 kg/m^2 in two layers	
	Glass fabric	No. 610	100 mm overlap minimum	
Spacer	Elastomer	No. 690	19 mm min. thick	
Jacketing material	galvanised steel sheets		ASTM A653 with zinc layer 350g/m^2 for both sides Heads, shell 0.63 mm and covers	
Jacket fixing	Self-tapping screws		Stainless steel cheese-head self-tapping screws, dia. $4.8 \times 15.9 \text{ mm}$ + neoprene spacers	Fixing sheets to sheets
	Straps		Stainless steel, $16 \times 0.5 \text{ mm}$ min	Retaining sheets (3)
Water-proofing sealants	Preformed cords	No. 534	Diameter according to swage	Applied continuously
	Neutral silicon mastic in cartridges	No. 535		For sealing the finishing work

Note: (3) If necessary, retaining strap on elevated equipment or piping jacket plates exposed to wind.

Description of system No. 031
To be used with standard drawing(s)
Appendix 3 No. 01 to 05

Component	Description	Reference	Requirements	Remarks
Insulation	Cellular glass	No. 31	Minimum thickness of each layer: 40 mm	For insulation system ≥ 80 mm forecast a minimal two layers system
Bonding material	Adhesive	No. 520	Min. consumption 2.5 kg/m ²	The bonding adhesives and jointing mastic must be proven compatible with and chemically neutral to the equipment's anticorrosive system
Sealant	Mastic	No. 530 or 531 or 532 or 533	Min. consumption 3 kg/m ²	
Fixing	Adhesive tape	No. 579	Min. 2 per segments	
Vapour barrier	Mastic	No. 590 or 582	Min. consumption: 4 kg/m ² in two layers	
	Glass fabric	No. 610	100 mm overlap minimum	
Spacer	Elastomer	No. 690	19 mm min. thick	
Jacketing material	Aluminium sheets		Aluminium alloy AA3003 or 3005, H 24 temper to ASTM B209 or equivalent Heads, shell and covers 0.8 mm thick	
Jacket fixing	Self-tapping screws		Stainless steel cheese-head self-tapping screws, dia. 4.8 x 15.9 mm + neoprene spacers	Fixing sheets to sheets
	Straps		Stainless steel, 16 x 0.5 mm min	Retaining sheets (3)
Water-proofing sealants	Preformed cords	No. 534	Diameter according to swage	Applied continuously
	Neutral silicon mastic in cartridges	No. 535		For sealing the finishing work

Note: (3) If necessary, retaining strap on elevated equipment or piping jacket plates exposed to wind.

**Description of system No. 003
To be used with standard drawing(s)
Appendix 3 No. 01 to 05**

Component	Description	Reference	Requirements	Remarks
Insulation	Cellular glass	No. 31	Minimum thickness of each layer: 40 mm	For insulation system ≥ 80 mm forecast a minimal two layers system
Bonding material	Adhesive	No. 520	Min. consumption 2.5 kg/m ²	The bonding adhesives and jointing mastic must be proven compatible with and chemically neutral to the equipment's anticorrosive system
Sealant	Mastic	No. 530 or 531 or 532 or 533	Min. consumption 3 kg/m ²	
Fixing	Adhesive tape	No. 579	Min. 2 per segments	
Vapour barrier	Mastic	No. 590 or 582	Min. consumption 4 kg/m ² in two layers	
	Glass fabric	No. 610	100 mm overlap minimum	
Spacer	Elastomer	No. 690	19 mm min. thick	
Jacketing material	Flat stainless steel sheets		Type AISI 430 or AISI 316L or equivalent Finish/State MAT Heads, shell 0.50 mm and covers	
Jacket fixing	Self-tapping screws		Stainless steel cheese-head self-tapping screws, dia. 4.8 x 15.9 mm + neoprene spacers	Fixing sheets to sheets
	Straps		Stainless steel, 16 x 0.5 mm min	Retaining sheets (3)
Water-proofing sealants	Preformed cords	No. 534	Diameter according to swage	Applied continuously
	Neutral silicon mastic in cartridges	No. 535		For sealing the finishing work

Note: (3) If necessary, retaining strap on elevated equipment or piping jacket plates exposed to wind.

Description of system No. 032
To be used with standard drawing(s)
Appendix 3 No. 01 to 05

Component	Description	Reference	Requirements	Remarks
Insulation	Cellular glass	No. 31	Minimum thickness of each layer: 40 mm	For insulation system ≥ 80 mm forecast a minimal two layers system
Bonding material	Adhesive	No. 520	Min. consumption 2.5 kg/m ²	The bonding adhesives and jointing mastic must be proven compatible with and chemically neutral to the equipment's anticorrosive system
Sealant	Mastic	No. 530 or 531 or 532 or 533	Min. consumption 3 kg/m ²	
Fixing	Adhesive tape	No. 579	Min. 2 per segments	
Vapour barrier	Mastic	No. 590 or 582	Min. consumption 4 kg/m ² in two layers	
	Glass fabric	No. 610	100 mm overlap minimum	
Spacer	Elastomer	No. 690	19 mm min. thick	
Jacketing material	Flat stainless steel sheets		Quality AISI 316L or equivalent Finish/State MAT Heads, shell 0.50 mm and covers	
Jacket fixing	Self-tapping screws		Stainless steel cheese-head self-tapping screws, dia. 4.8 x 15.9 mm + neoprene spacers	Fixing sheets to sheets
	Straps		Stainless steel, 16 x 0.5 mm min	Retaining sheets (3)
Water-proofing sealants	Preformed cords	No. 534	Diameter according to swage	Applied continuously
	Neutral silicon mastic in cartridges	No. 535		For sealing the finishing work

Note: (3) If necessary, retaining strap on elevated equipment or piping jacket plates exposed to wind.

Description of system No. 004
To be used with standard drawing(s)
Appendix 3 No. 01 to 05

Component	Description	Reference	Requirements	Remarks
Insulation	Rigid polyisocyanurate foam	No. 36	If total thickness < 50 mm, 1 layer with longitudinal + circumferential stepped edges. If total thickness > 51 mm, multilayered max layer thickness 50 mm without stepped edges	
Bonding material	Adhesive	No. 520	Min. consumption 2.5 kg/m ²	The bonding adhesives and jointing mastic must be proven compatible with and chemically neutral to the equipment's anticorrosive system
Sealant	Mastic	No. 530 or 531 or 532 or 533	Min. consumption 3 kg/m ²	
Fixing	Adhesive tape	No. 579	Min. 2 per segments	
Vapour barrier	Mastic	No. 580 or (581*)	Min. consumption: 4 kg/m ² in two layers	
	Glass fabric	No. 610	100 mm overlap minimum	
Jacketing material	NOT SPECIFIED			
Jacket fixing				
Water-proofing sealants				

Note: No incompatibility of adhesion between mastics 886.05/886.06 and HYPALKOTE coating.