



Exploration & Production

GENERAL SPECIFICATION

CORROSION

GS COR 226

**Materials for thermal insulation of pipeline, piping
and subsea components**

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1. Scope

This GS covers:

- Integral External Insulation (IEI) where the insulation is bonded to the outer surface of a structure or to a corrosion protective layer on the outer surface of a structure.
- Insulation Modules (IM) which consists of a discrete pre-formed component attached onto the structure to be installed.

Pipe in pipe, active systems and internal insulation systems are not covered by this document.

This GS has been developed on the basis of known materials (elastomers, PU, PP, epoxy, in solid, blown foam, syntactic and composite syntactic foam). It shall be used for qualification of other materials. In that case, additionnal (or different) requirements and/or data might be needed, based on COMPANY approval.

Materials concerned by this GS are typically used for the insulation of the following:

- Pipe lines
- Steel flowlines and risers, including riser tower
- Subsea components such as wellheads, Chrismass trees, manifold and jumpers.

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
ISO 1183	Plastics-Test method for determining the density and relative density of non-cellular plastics
ISO 8302	Thermal insulation-Determination of steady state thermal resistance and related properties-Guarded hot plate apparatus
ISO 11359-2	Plastics-Thermomechanical analysis (TMA) - Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature
ISO 11357-4	Test method for determination of specific heat capacity by differential scanning calorimetry
ISO 527	Plastics-Determination of tensile properties
ISO 178	Plastics-Determination of flexural properties of rigid plastics
ISO 868	Test method for hardness measurements of plastics
ISO 844	Rigid cellular plastics-determination of compression properties
ASTM G8	Test method for cathodic disbonding of pipe line coating
ISO 4892-1	Plastics-Methods of exposure to laboratory light sources - Part 1: General guidance
ISO 4892-2	Plastics-Methods of exposure to laboratory light sources - Part 2: Xenon arc sources
ISO 62	Test method for water absorption of plastics

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

**Other documents**

Reference	Title
InSpec JIP Doc. 1-1-4-140/SP01, Rev.03, Oct 2002	Specification for insulation and buoyancy materials
InSpec JIP Doc. 1-1-4-140/RP01, Rev. 01, July 2002	Recommended practice for insulation and buoyancy systems

Total General Specifications

Reference	Title
GS COR 220	Three-layer PE external coating for pipelines
GS COR 221	Three-layer PP external coating for pipelines
GS COR 420	External field joint coating of pipelines
GS PLR 151	Design of steel catenary riser systems
GS PLR 401	Installation of submarine pipelines
GS PLR 406	Packaging and transportation of line pipes
GS SPS 007	Tie-in systems
GS SPS 008	Thermal insulation of subsea stations
GS SPS 009	Corrosion protection of subsea stations

3. Definitions**3.1 COMPANY**

TOTAL SA or its subsidiary or agent acting on its behalf shall be referred to herein as the "COMPANY".

3.2 Raw materials and raw materials producer

Materials used to produce thermal insulation coating systems (for instance, polypropylene pellets for multilayers PP coatings) shall be referred to herein as "RAW MATERIALS". Producers of such materials shall be referred to as "RAW MATERIALS PRODUCER".

3.3 MANUFACTURER

"MANUFACTURER" shall be referred to herein as the COMPANY manufacturing EIE or IM and applying it to the structure to be thermally insulated.

3.4 Inspector

The COMPANY's representatives or members from COMPANY elected Inspection Agencies for the time being or from time to time duly appointed in writing by the COMPANY to act as its representatives for the purpose of the contract shall be referred to herein as the "INSPECTOR".

4. Raw materials requirements

The COMPANY shall have access to all raw materials tests results and manufacturing procedures.

4.1 Marking and identification

The MANUFACTURER shall ensure that raw materials are traceable and suitably marked for easy identification.

4.2 Storage and handling

Raw materials shall be stored and handled according to raw materials supplier recommendation. Materials Safety Data Sheets shall be made available to MANUFACTURER and their instructions strictly enforced.

4.3 Raw material specifications

During qualification, MANUFACTURER shall obtain from raw material supplier a conformity certificate (for each individual materials) with the following informations:

- Product name and producer.
- Manufacturing plant.
- Properties to be checked with every batches and corresponding conformity ranges.
- Date of issue.
- Signature of authorized personnel (with name and fonction).

For each batch of raw materials used by the MANUFACTURER, content of certificate of analysis (obtained with every batches and deliveries) shall be verified against content of conformity certificate. Values reported shall be within conformity certificate ranges.

Conformity certificate shall be submitted to COMPANY for approval during qualification process.

5. Materials requirements

The MANUFACTURER shall document the properties listed below, for all individual materials. In case of multi layers systems, each layer shall be documented independantly with regard to the relevant properties of this chapter. ***For multi layer systems, the maximum temperature shall be considered individually for each layer and might be different from maximum design temperature, provided a detailed thermal profile within the insulation coating has been performed by the MANUFACTURER and submitted prior to qualification to COMPANY for approval.***

If the above is not applicable or not done, maximum design temperature shall apply to all layers. Testing at maximum temperature shall be understand as minimum temperature for test (i.e. test available at higher temperature might be submitted to the COMPANY for approval).

5.1 General information

- Full and detailed description of insulating system (use of corrosion protection layer, external mechanical protection layer, adhesives layers etc...)

Each individual material (i.e.: each layer for multi layers system) shall be documented for:

- Chemical nature of material
- Fillers content (by weight and volume) and type
- Recommended maximum operating temperature in wet and dry environment
- Recommended maximum operating water depth

5.2 Thermo-mechanical properties

Each individual material (i.e.: each layer for multi layers system) shall be documented for:

- Differential Scanning Calorimeter (DSC) spectra up to a temperature of T_g (glass transition) + 50°C for thermosets and T_f (melting point) + 20°C for thermoplastics. First and second heating and cooling shall be documented. Heating rate: 20°C/min, cooling rate: 10°C/min.
- Dynamic Mechanical Thermal Analysis (DMTA) spectra at a frequency of one Hertz and up to a temperature of T_g + 50°C for thermosets and T_f + 10°C for thermoplastics. Elastic modulus, loss modulus and loss angle (Tan Delta) shall be reported. Heating rate: 20°C/min.

5.3 Insulation properties

For the individual materials concerned (i.e.: for each relevant layer of multi-layer system):

- Density at 23°C and atmospheric pressure ([ISO 1183](#))
- Density at 23°C after application of a hydrostatic pressure equivalent to the maximum water depth at maximum temperature (for at least 48 hrs) ([ISO 1183](#))
- Thermal conductivity at 23°C and maximum temperature at atmospheric pressure ([ISO 8302](#))
- Specific heat capacity at 23°C and maximum temperature at atmospheric pressure ([ISO 11357-4](#))
- Thermal expansion coefficient over the full temperature range (-20°C to maximum temperature) ([ISO 11359-2](#)).

In case density after application of a pressure equivalent to the maximum water depth at maximum temperature has increased by at least 10% of original value, then a measurement of thermal conductivity and specific heat capacity at 23°C shall be done after such treatment.

In case water absorption at saturation as per 5.8 is equal or higher than 5% by weight, then a measurement of thermal conductivity and specific heat capacity shall be done at 23°C with water saturated samples.

5.4 Mechanical properties

For the individual materials concerned (i.e.: for each relevant layer of multi-layer system):

- Tensile strain and stress at break at 23°C and maximum temperature ([ISO 527](#))
- Flexural modulus at 23°C and maximum temperature ([ISO 178](#))
- Hardness at 23°C ([ISO 868](#))

- Compression strength and modulus at 23°C and maximum temperature ([ISO 844](#))
- For IM only: Hydrostatic strength at 23°C and maximum temperature (test method to be submitted to COMPANY for approval)

5.5 Corrosion protection

- For IEI: Cathodic disbondment test for 28 days at 23°C +/-2°C (whether there is a corrosion protection primer or not) (ASTM G8)
- For IM: Cathodic disbondment test at 23°C +/-2°C for 28 days for corrosion protection primer shall be documented (ASTM G8).

Disbonded radius after test shall be less or equal to 5 mm.

5.6 Ageing properties

Due to the complex nature of insulation systems, a precise description of the physical and chemical environment of each layer shall be reported by the MANUFACTURER and submitted to the COMPANY for approval (see also introduction to chapter 5 for definition of maximum temperature).

Based on this description, the COMPANY will decide which of the following ageing tests shall apply for each individual layers:

- UV resistance: according to [ISO 4892-1](#) and [ISO 4892-2](#):
 - Artificial weathering: Table 1-Method A of [ISO 4892-2](#)
 - Black pannel temperature (BST) : 65+/-3°C
 - Relative humidity: 65%
 - Cycle: 18 min humid-102 min dry
 - Total radiant energy: 5GJ/m2
 - Continuous exposure

After UV ageing, measurement of mechanical properties as per 5.4 at 23°C only. Aged samples shall be suited in size for mechanical properties testing with no further preparation (machining and the likes prohibited).

- Ageing in water at maximum temperature and maximum temperature +20°C for 3000 hours. After ageing, measurement of mechanical properties as per 5.4 at 23°C only. Aged samples shall be suited in size for mechanical properties testing with no further preparation (machining and the likes prohibited). Intermediate measurements (every 1000 hours) shall be performed.
- Dry heat ageing at maximum temperature and maximum temperature + 20°C for 3000 hours. After ageing, measurement of mechanical properties as per 5.4 at 23°C only. Aged samples shall be suited in size for mechanical properties testing with no further preparation (machining and the likes prohibited). Intermediate measurements (every 1000 hours) shall be performed.

Unless otherwise specified, water is fresh water. In both ageing cases, attention will be given to oxygen content, which shall be as close as possible to actual content in service.

5.7 Adhesion properties

Insulation systems range from multi-layers materials physically bonded to the substrate to adjusted modules of single material. Adhesion shall be checked between each layer of the insulation system and between the steel and the primer. Adhesion shall be measured at 23°C

and maximum temperature. Particular attention shall be given to substrate-primer adhesion, with absolutely no bare substrate accepted after peeling (i.e. primer shall not peel off the steel).

It might not always be easy to perform such tests on insulation layers. Therefore, MANUFACTURER shall provide the COMPANY with its own testing procedure for approval.

Effect of ageing on adhesion properties shall also be assessed. Accordingly, a precise description of the physical and chemical environment of each interface within the insulation system shall be reported by the MANUFACTURER and submitted to the COMPANY for approval. Based on this description, the COMPANY will decide which one of the test ageing test procedure of paragraph 5.6 apply for each interface (if any tests needed).

5.8 Water absorption

Water is fresh water.

For the individual layers concerned (i.e.: for each relevant layer of multi-layer system):

Water uptake shall be reported as weight increase (compared to initial sample before test) with time and reported on a graph. Surface to volume ratio of the test sample should be selected as to obtain enough sensitivity in the measurement related to the time interval chosen in between measurements. Test samples shall be such that length and width are much higher than thickness.

Temperature of the test is 23°C. Referenced standard is [ISO 62](#).

The duration of the test shall be such that saturation is reached (no further evolution of weight with time). The value at saturation shall be reported.

6. Field joint

The field joints shall be designed to be compatible with the main insulation system. The overall properties (insulation, thermal, mechanical) shall be as close as possible to the main insulation system. Whenever variations in properties between main insulation system and field joints exist, they shall be quantified by MANUFACTURER and submitted to COMPANY for approval.

Insulation properties and calculations shall include field joints whenever applicable. Mechanical properties shall be such that no buckling of the pipe and/or the field joints appears during installation.

7. Quality control of final product

The Inspector shall have free access to all departments of the plants where both IM and IEI are manufactured and applied. An office and all necessary means to the perfect completion of his work shall be made available for him.

The COMPANY shall have access to all tests results and manufacturing procedures for both IM and IEI.

The MANUFACTURER's quality plan shall specify inspection points, inspection methods and acceptance criteria. It shall be submitted to the COMPANY during qualification for approval. Results of all inspections shall be recorded and made available to the COMPANY upon request.