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Oil and gas industries including lower carbon energy — Wet thermal insulation systems for pipelines and subsea equipment —

Part 3: Interfaces between systems, field joint systems, field repairs and pre-fabricated insulation

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Systèmes d'isolation thermique en milieu humide pour conduites et équipements sous-marins —

Partie 3: Interfaces entre systèmes, systèmes de joints soudés sur site, réparations sur site et isolation préfabriquée

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 2, *Pipeline transportation systems,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Oil and gas industries including lower carbon energy,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 12736-3, together with ISO 12736-1 and ISO 12736-2, cancels and replaces ISO ISO 12736:2014.

The main changes are as follows:

— clearer delineation between commercial projects and validation;

— introduction of material classes;

— introduction of interface types;

— elimination of system specific qualification testing tables;

— introduction of project specific functional tests;

— addition of items related to pre-fabricated insulation;

— addition of Annexes A, B and D with guidance for using this document, design of systems, and pre-fabricated insulation.

A list of all parts in the ISO 12736 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Oil and gas industries including lower carbon energy — Wet thermal insulation systems for pipelines and subsea equipment —

Part 3: Interfaces between systems, field joint systems, field repairs and pre-fabricated insulation

1 Scope

This document specifies requirements for project specific product and process qualification of field applied wet thermal insulation systems applied at interfaces (e.g. field joints) and pre-fabricated insulation in the petroleum and natural gas industries.

This document is applicable to wet thermal insulation systems submerged in seawater.

This document is not applicable to:

— the project qualification of anticorrosion coatings or the requirements for application thereof;

— thermal insulation in the annulus of a steel pipe-in-pipe system.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 48-4, *Rubber, vulcanized or thermoplastic — Determination of hardness — Part 4: Indentation hardness by durometer method (Shore hardness)*

ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1133-2, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 2: Method for materials sensitive to time-temperature history and/or moisture*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 2781, *Rubber, vulcanized or thermoplastic — Determination of density*

ISO 2884-2, *Paints and varnishes — Determination of viscosity using rotary viscometers — Part 2: Disc or ball viscometer operated at a specified speed*

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3219 (all parts), *Rheology*

ISO 6502 (all parts), *Rubber — Guide to the use of cure meters*

ISO 8502-3, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)*

ISO 8502-4, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 4: Guidance on the estimation of the probability of condensation prior to paint application*

ISO 12736-1, *Oil and gas industries including lower carbon energy — Wet thermal insulation systems for pipelines, flow lines, equipment and subsea structures — Part 1*

ISO 12736-2, *Oil and gas industries including lower carbon energy — Wet thermal insulation systems for pipelines, flow lines, equipment and subsea structures — Part 2*

ISO 80000-1, *Quantities and units — Part 1: General*

ISO 10474, *Steel and steel products — Inspection documents*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
agreed
specified in the purchase order

Note 1 to entry: To be discussed by the *system provider* (3.41) and *system purchaser* (3.42) with input from *end user* (3.9) as required.

3.2
application procedure specification
APS
quality specification document, or group of specifications, describing procedures, method, equipment, tools, etc. used for *system* (3.40) application

3.3
batch
quantity of *material* (3.22) produced in a continuous manufacturing operation using raw materials of the same source or grade

3.4
blown foam
insulation *material* (3.22) formed by incorporating a gas phase into a polymer matrix

3.5
certificate of analysis
document provided by the manufacturer that indicates results of specific tests or analysis, including test methodology, performed on a specified lot of the manufacturer's product and corresponding conformity ranges

3.6
chamfer
exposed pre-shaped termination of a *system* (3.40) to be interfaced with

Note 1 to entry: Chamfer geometry (e.g. angle, shape) and tolerances are project specific.

3.7
cool down time
time taken for a fluid contained within a *pipeline* (3.25) or *subsea equipment* (3.38) to reach a pre-determined temperature from specific start temperatures (internal and external) when flow is stopped

3.8
cutback
length of item left uncoated at each end for joining purposes

Note 1 to entry: Welding is an example of joining purposes.

3.9
end user
company that owns and/or operates the *pipeline* (3.25) or *subsea equipment* (3.38)

3.10
factory applied
applied in a permanent facility

3.11
field joint
field joint system
uncoated area that results when two pipe sections, or a pipe section and a *fitting* (3.12), with *cutbacks* (3.6) are assembled by welding or other methods

3.12
fitting
receptacle on a piece of *subsea equipment* (3.38), which interfaces to a *pipeline* (3.25)

3.13
high molecular weight precursor thermoset
material (3.22), which is a polymeric compound that remains malleable until application of sufficient heat to cause network formation and then does not flow upon reheating

EXAMPLE Butyl rubber.

3.14
inorganic syntactic foam
insulation *material* (3.22) formed by dispersing inorganic hollow particles within a polymer matrix

3.15
inspection and test plan
ITP
document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures

3.16
inspection document
document issued by the *system provider* (3.41) and attesting that the supplied *system* (3.40) is in conformity with the requirement given in the purchase order

Note 1 to entry: See also ISO 10474.

3.17
interface
location where two *systems* (3.40) meet and affect each other

Note 1 to entry: A *field joint* (3.11) *system* (3.40) has two interfaces.

Note 2 to entry: In the case of multilayer *systems* (3.40), interfaces can be made up of multiple sub-interfaces.

3.18
J-lay
method of *pipeline* (3.25) installation in which pipelines are assembled by welding together pre-insulated pipes with subsequent application of a *field joint* (3.11) *system* (3.40) in a vertical position, onboard an installation vessel with a tower

Note 1 to entry: The pipeline is lowered into the water vertically and creates a characteristic J-shape when touching the seabed.

Note 2 to entry: This method is used mainly for deep water.

3.19
liquid precursor elastomeric thermoset
material (3.22), which is a polymeric compound with its glass transition below ambient temperature, that is produced via combination of one or more components that can be pumped and flow as liquids and which react to create a crosslinked polymer that does not flow upon reheating

EXAMPLE Liquid precursor silicone rubber.

3.20
liquid precursor non-elastomeric thermoset
material (3.22), which is a polymeric compound with its glass transition above ambient temperature, that is produced via combination of one or more components that can be pumped and flow as liquids and which react to create a crosslinked polymer that does not flow upon reheating

EXAMPLE Liquid epoxy.

3.21
mainline
portion of a *pipeline* (3.25) that is not a *field joint* (3.11)

3.22
material
polymeric compound applied to the *substrate* (3.39) protected or insulated in units of discrete thickness (layers) to build up a *system* (3.40)

3.23
material data sheet
document containing typical data regarding the physical and mechanical properties of a particular *material* (3.22) used in the coating process including guidelines and recommendations for its processing and use

3.24
material manufacturer
entity responsible for the manufacture of one or more *materials* (3.22) utilized in a *system* (3.40)

3.25
pipeline
flowline
tubular piping used to convey fluids

Note 1 to entry: Pipeline includes jumpers, *risers* (3.32) and *field joints* (3.11).

3.26
pi tape
precision Vernier periphery tape that allows the direct and accurate measurement of the diameter of tubular objects without the need for callipers or micrometres

3.27
pre-fabricated insulation
section of stand-alone insulation, which is factory manufactured into its final form and then installed in the field by mechanically fastening or bonding to a corrosion protected structure

3.28
pre-production trial
PPT
series of tests performed immediately before the start of production, designed to demonstrate that the requirements of the *validated* (3.48) *system* (3.40) and *procedure qualification trial* (3.29) or both are achieved

Note 1 to entry: Requirements for PPT are as outlined in this document and as *agreed* (3.1).

3.29
procedure qualification trial
PQT
series of tests designed to demonstrate that the *materials* (3.22), *system provider* (3.41), equipment and procedures can produce the *system* (3.40) in accordance with the *validation dossier* (3.49) and meet specific *project* (3.30) requirements as *agreed* (3.1)

Note 1 to entry: Requirements for PQT are as outlined in this document and as *agreed* (3.1).

3.30
project
scope of work agreed upon contractually between *system purchaser* (3.42) and *system provider* (3.41)

3.31
R-lay
reel-lay
method of *pipeline* (3.25) installation in which long *stalks* (3.37) of pre-insulated pipes are pre-assembled by welding and application of *field joint* (3.11) *system* (3.40) onshore before being spooled onto large reels onboard the installation vessel, which then lays the pipes by unspooling the reel offshore

3.32
riser
vertical portion of a *pipeline* (3.25), including the bottom bend, arriving on or departing from an offshore surface installation

3.33
safety data sheet
SDS
DEPRACATED: material safety data sheet
document intended to provide workers and emergency personnel with procedures for handling and working with a *material* (3.22) utilized in the manufacture of the *system* (3.40) in a safe manner including physical data, first aid, etc.

Note 1 to entry: Physical data can include flash point and toxicity.

3.34
service life
specified period of use for a *system* (3.40) in service

3.35
S-lay
method of *pipeline* (3.25) installation in which pipelines are assembled by welding together pre-insulated pipes, with subsequent application of a *field joint* (3.11) *system* (3.40), onboard an installation vessel in a horizontal orientation

Note 1 to entry: The pipeline curvature created from the vessel down to the seabed is a characteristic S-shape.

Note 2 to entry: This method is used mainly for low to medium water depths.

3.36
solid/solid filled
insulation *material* (3.22) that systematically does not contain voids, or hollow particles

3.37
stalk
continuous string of welded and *field joint* (3.11) coated pipe, which is prepared in readiness for pipe spooling onto a R-*lay* (3.31) barge

Note 1 to entry: A number of stalks will normally be required to make up a *pipeline* (3.25).

3.38
subsea equipment
components from a subsea production system, including subsea processing items and structures, meant to control hydrocarbons, not including *pipelines* (3.25)

EXAMPLE Valve, connector, manifold, christmas tree, flowline end termination.

3.39
substrate
surface to which a *material* (3.22) is applied or will be applied

3.40
system
all of the various *materials* (3.22) and the combination thereof, which can include layers of anti-corrosion, insulation, adhesive, and protective materials, as defined by cross-section to the underlying *substrate* (3.39) at a single point, which function together to act as a *wet thermal insulation* (3.50)

3.41
system provider
entity which is selling the applied *system* (3.40)

3.42
system purchaser
entity which is purchasing the applied *system* (3.40)

3.43
thermal conductivity
k-value
conductivity
heat flow through a unit length of *material* (3.22) under the influence of a thermal gradient

Note 1 to entry: Thermal conductivity is expressed in $W \cdot m^{-1} \cdot K^{-1}$.

3.44
thermoplastic
material (3.22), which is a polymeric compound that solidifies upon cooling and can flow and be reformed upon reheating

EXAMPLE Polypropylene.

3.45
tie-in field joint
connection of a *pipeline* (3.25) to a facility or *subsea equipment* (3.38), to other pipeline, or the connecting together of different sections of a single pipeline

3.46
unit of production
quantity of product, given as either a percentage of total output, produced over a short period of time or produced from a specific combination of raw *material* (3.22) *batch* (3.3) numbers, as *agreed* (3.1)

Note 1 to entry: A short period of time can be for example up to 24 hours, or across shift changes, which is based on manufacturing capacity, job length and product line.

3.47
U-value
overall heat transfer coefficient
rate of heat transfer from a reference surface under the influence of a thermal gradient

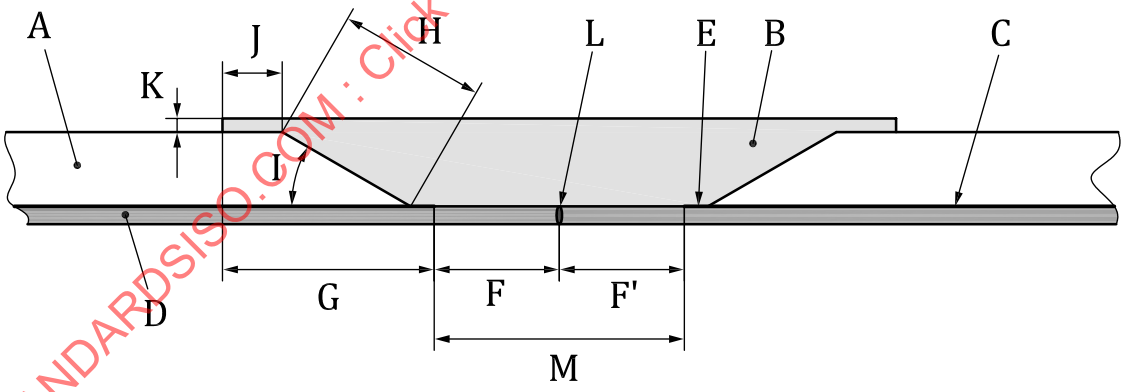
Note 1 to entry: U-value is expressed in $W \cdot m^{-2} \cdot K^{-1}$.

3.48
validation
demonstration of *material* (3.22) and *system* (3.40) performance during storage, handling and operation, within a specified envelope of use, as determined by the *system provider* (3.41)

3.49
validation dossier
collection of documentation and test reports, prepared in accordance with specific requirements, which provides detailed information on the proposed *system* (3.40), method of application, the *materials* (3.22) which form said *system* (3.40), and demonstration of *system* (3.40) performance

Note 1 to entry: Specific requirements are found in ISO 12736-1:2023, 7.6.

3.50
wet thermal insulation
system (3.40) that provides external corrosion protection and thermal insulation, and that is in direct contact with surrounding seawater



Key

A	factory applied mainline system	G	mainline system and field joint system interface
B	field joint system	H	chamfer
C	mainline ACC	I	chamfer angle
D	steel substrate	J	overlap length of field joint system over mainline system
E	exposed mainline ACC	K	thickness of field joint system overlap over mainline system
F	cutback	L	weld

F' cutback, may not be the same as F

M field joint

4 Abbreviated terms

ACC anti-corrosion coating

CP cathodic protection

HSE health, safety and the environment

MFR melt flow rate

OD outer diameter

QC quality control

ROV remotely operated vehicle

5 Conformance

5.1 Rounding

Unless otherwise stated in this document observed or calculated values shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with ISO 80000-1.

NOTE For the purpose of this provision, the rounding method of ASTM E29 is equivalent to ISO 80000-1:2022, Annex B, Rule A.

5.2 Conformity to requirement

Systems for quality and environmental management, and the competence of testing and calibration laboratories, should be used.

NOTE The following documents can be used:

— ISO 29001 gives sector-specific requirements with guidance for the use of quality management systems;

— ISO 14001 gives requirements with guidance for the use of environmental management systems;

— ISO/IEC 17025 gives general requirements for the competence of testing and calibration laboratories.

The system provider shall be responsible for conforming with all the applicable requirements for the application of this document. The system purchaser shall be allowed to make any investigation necessary to ensure conformity by the system provider and to reject any material and/or system that does not conform with this document.

6 Field joint material, system interfaces and repairs

6.1 Material classes

The wet thermal insulation systems covered by this document are based on materials classified in Table 1. Each material used to make up the field joint system shall have been classified into the appropriate class by the system provider as part of the validation dossier in accordance with ISO 12736-1.

Table 1 — Material classes

	Solid/solid filled	Blown foam	Inorganic syntactic foam
Thermoplastics	1A	1B	1C
Liquid precursor non-elastomeric thermosets	2A	2B	2C
Liquid precursor elastomeric thermosets	3A	3B	3C
High molecular weight precursor thermosets	4A	4B	4C
NOTE Reproduction of ISO 12736-1:2023, Table 1.			

6.2 Types of interfaces

The different types of interfaces shall be defined as per Table 2.

Table 2 — Types of interfaces

	Interface reference	Interface description
R-lay	a)	Between factory applied system on a pipeline and onshore field applied system applied over a field joint between two pipeline sections. This interface can be between similar or dissimilar materials.
	b)	Between factory applied system on a pipeline and onshore field applied system applied over a tie-in field joint between two pipeline sections. This interface can be between similar or dissimilar materials.
	c)	Between factory applied system on a pipeline and offshore field applied system applied over a tie-in field joint between two pipeline sections. This interface can be between similar or dissimilar materials.
S or J-lay	d)	Between factory applied system on a pipeline and onshore field applied system applied over a field joint between two pipeline sections. This interface can be between similar or dissimilar materials.
	e)	Between factory applied system on a pipeline and offshore field applied system applied over a field joint between two pipeline sections. This interface can be between similar or dissimilar materials.
Subsea equipment	f)	Between a field joint system bridging a factory applied system on a pipeline and a system on subsea equipment at the fitting. This interface is typically between dissimilar materials, possibly on both sides.

Each field joint has two interfaces. In the case of multilayer systems, interfaces may be made up of multiple sub-interfaces.

7 Project specific qualification processes for production and application procedures for field joints

7.1 General requirements

The following requirements apply for project specific qualification and QC activities:

a) All materials and systems shall be previously validated in conformity with the requirements of ISO 12736-1. ACC should be applied in accordance with ISO 21809-3.

b) The validation dossier of the materials and systems shall be given by the system provider to the system purchaser and/or end user for approval.

c) If the ACC selected by the system purchaser is different from the one used by the system provider for validation, both parties shall agree upon a test program to ensure that ACC and materials are compatible for the project requirements.

d) The preparation of a project specific APS and related ITP is required and shall be approved by the system purchaser and/or end user.

e) If requested by the system purchaser, a PQT can be performed for qualification of the approved APS (or part of it) and performed according to an approved ITP.

f) Before production starts, a PPT shall be performed according to a dedicated ITP. By agreement, the PPT and the PQT can be executed at the same time, i.e. the PQT and PPT can be merged.

g) Those parts of the project specific qualification process that are waived by the system purchaser shall be clearly stated and identified in the contract.

h) During the production, an inspection system shall be implemented by the system provider to monitor and execute all the inspection activities reported in the approved ITP for production.

i) Inspection and testing shall be carried out during production in accordance with the approved ITP.

j) Test procedures, testing frequencies and acceptance criteria shall be defined in the ITP.

k) If other materials than those classified in Table 1 are used, the system provider shall have identified the class that most closely represents the material and shall provide a gap analysis to the requirements for that class to be included in the validation dossier.

l) Damaged areas created by testing shall be removed and repaired in accordance with Clause 9.

m) The system provider shall prepare a set of samples or pipe sections according to the dimensions and characteristics approved by the system purchaser, in order to perform any required destructive tests on the applied system.

n) All data collected during inspections and tests shall be recorded in a proper form and shall be delivered to the system purchaser as required in the ITP.

7.2 Purchase order requirements

7.2.1 General information

The purchase order, and optionally the request for quotation if known, shall include the following information:

a) reference to this document (i.e. ISO 12736-3:2023);

b) type of interfaces as per 6.2, FJ system and system(s) as per 6.1 to be overlapped;

c) project conditions (e.g. water depth, operating and design temperature, installation method);

d) thermal performance requirements;

e) identification and description of item to be insulated (e.g. item quantity, outside diameter, external geometry, wall thickness, nominal length, grade of steel, cutback configuration and pipe ends finish, at least cutback length and chamfer angle, length of visible epoxy, presence of temporary protection;

f) identification of the ACC selected by system purchaser or already applied to the items to be insulated;

g) requirement for execution of any PQT;

h) type of inspection document in accordance with ISO 10474;

i) laying method and details of installation including, but not limited to, installation temperature, any bending strain or gripping requirements, time constraints, vessel space constraints, if relevant.

7.2.2 Additional information

The purchase order should specify which of the following provisions apply for the specific item ordered:

a) special requirements relative to supply of materials (e.g. manufacturer-specific products and certification);

b) items to be insulated tracking and traceability of items to material batches;

c) inspection of incoming items;

d) holiday inspection of ACC before application of system, including responsibility for repair of anticorrosion coating;

e) ITP and/or daily log;

f) required modifications to PQT, if applicable, PPT or production ITP requirements with respect to the requirements of this document;

g) additional PQT test requirements (e.g. functional testing);

h) marking of insulated item and any colour coding requirement at external surface;

i) permissible number of repairs on applied system, maximum area of repair and acceptable locations of repairs;

j) entity responsible for performing repairs;

k) handling and storage procedures;

l) protection against adverse ambient conditions during storage;

m) documentation and schedule for supply of documentation.

7.3 Production qualification process

7.3.1 Process description

The production qualification process consists of:

— PQT, if applicable, which shall be performed in conformance with an approved APS and its related ITP (see 7.3.3, 7.4.1 and 7.4.2, respectively);

— PPT, which shall be performed in conformance with an approved APS and its related ITP (see 7.3.4, 7.4.1 and 7.4.2, respectively);

— inspection during production (see 7.3.5), which shall be performed in conformance with an approved ITP.

If requested and agreed per 7.2.2 item f, the PQT and the PPT may be performed at the same time, just before production start. In this case, the PQT and PPT tests can be merged.

It is allowed to issue only one APS and one ITP grouping the PPT and production activities.

7.3.2 Project specific qualification considerations

Functional tests may be requested by the system purchaser if the specific project conditions are outside the test parameter ranges, reported in the validation dossier, or to provide additional information to support the specific project requirements (e.g. cyclic loading for steel catenary risers).

NOTE Examples of tests that can be applicable:

— Bend test (for interfaces types a and b);

— Roller box test for interface type e (S-lay only).

Special cases resulting in discontinuities and/or inclusions in the FJ shall also be considered (e.g. an anode bracket).

Typically, functional tests are performed during the PQT to allow for availability of results and identification of risks in advance of production.

7.3.3 Procedure qualification trial

If required by the system purchaser, the APS shall be validated by a PQT. Test methods, acceptance criteria and frequencies for the PQT shall be in accordance with Table 2 to Table 9 and shall be specified in the ITP.

The main purpose of the PQT is to demonstrate that the APS, ITP, equipment and personnel (e.g. skills relevant to their tasks) are able to apply the selected field joint system to achieve the stated performance of the system in accordance with the validation dossier. It is not intended to validate the selection of the system for a project. However, the APS and ITP used in the PQT can be compared with the APS and ITP used for the field joint system application during system validation and, if applicable, a gap analysis can be carried out.

For projects with specific requirements outside the envelope of testing and historical data contained within the validation dossier, the PQT may also be utilized to test and demonstrate project specific performance at the system purchaser's request.

Repair procedures shall be established for each system in accordance with Clause 9. Repair procedures shall include repair down to steel. Repair procedures shall be tested at the PQT stage.

Evaluation of the removal of deteriorated/damaged system and repair shall be part of the PQT. The selected methods shall be risk assessed to ensure there is no damage to the metallic substrate. HSE risks associated with removal of the system shall be assessed before the PQT.

The PQT should be carried out in the presence of the system purchaser (or their representative), unless otherwise agreed in the order.

The system provider may request the material manufacturer to assist during the PQT to ensure the correct processing and application of the material(s) and to train the system provider's personnel.

Qualification tests shall be carried out on representative pipes or subsea components. The shape of the workpiece shall simulate stress raisers present on the actual piece(s) to be coated. The length and volume of material on the workpiece shall be representative. A feature representing a weld cap in the steel structure shall be included in the test piece.

If heating of the area to be coated is specified in the APS, parameters shall be optimized to minimize detrimental effect to the existing system to be overlapped.

All tools and equipment (e.g. for induction heating, abrasive blasting, material application and inspection) to be used for PQT shall be of the same model/type as those to be used for the actual production (identical serial number on tools and equipment is not required for PQT vs production).

The system provider shall submit a complete report of the qualification test results to the system purchaser and/or end user for approval.

Relevant parameters for the application process recorded during PQT shall be implemented during PPT and production. The allowable ranges for these parameters should be agreed in the APS and ITP between the system provider and system purchaser. If these parameters fall outside the required ranges, additional testing shall be performed to demonstrate equal or better performance when compared to PQT and PPT.

7.3.4 Pre-production trial

A PPT shall be performed at start of production to verify the PQT or any previous qualification or historical data.

If agreed by the purchase order and if a PQT is performed just before production start, the PPT can be considered as included in the PQT itself with no need for repetition.

Test methods, acceptance criteria and frequencies for PPT are identified in the Table 3 to Table 10 (see 8.5) and shall be specified for the system in a dedicated ITP.

PPT shall be carried out in the presence of the system purchaser (or their representative) at the start of operations when equipment and personnel are mobilized on site or on the laying vessel. For special cases, the PPT can be performed at another location than actual production, as agreed. The PPT shall be performed on the first field joint to be coated or, if agreed, on a dummy pipe or structure which is representative of the project requirements in length, volume, and shape.

The system provider shall submit a complete report of the tests containing the values and other results obtained in the PPT.

7.3.5 Production testing

The system provider shall perform inspection and testing during production as detailed in Table 3 to Table 10 (see 8.5) and in accordance with an ITP to verify the substrate preparation, raw materials and system application.

The ITP shall be prepared by the system provider and shall be approved by the system purchaser and/or end user prior to the start of production. The ITP shall identify all inspection activities and tests, their frequency and the relevant inspection authorities.

7.4 Application procedures

7.4.1 Application procedure specification

The APS shall be prepared by the system provider based upon their experience and the material data sheet, SDS and application instructions. Before use and before the start of the PQT/PPT, the APS shall be approved by the system purchaser and/or end user. Once approved, the APS shall not be changed without prior written authorization from the system purchaser.

The responsibilities and interactions between each party involved in the process shall be clearly described.

The APS shall be specific to the system being applied.

The APS shall cover all items associated with quality control as defined in this document and any agreed options for the specific system.

All application work, testing and inspection shall be carried out according to the APS.

The APS shall address the following as a minimum, where applicable to the system:

a) material(s) identification;

b) tools, consumables, and equipment required to apply the system;

c) equipment set up and calibration of instrumentation;

d) approved solvents or other cleaning agents to be used to clean substrate;

e) inspection of existing ACC (e.g. cutback, bevel, holiday detection, repairs and precaution measures, when necessary);

f) preparation of substrates, including final surface profile, materials and contamination mitigation;

g) preheating methods, for existing system and repair material;

h) substrate temperature range for substrate preparation;

i) ambient conditions considering dew point temperature at the substrate to be coated;

j) material preparation requirements (e.g. drying, mixing, pot life and thinning procedures, vacuum, extrusion parameters, pre-heats);

k) system thickness range;

l) system application method and critical equipment range settings;

m) material/system curing or cooling schedule and conditions, including limitations, such as minimum time before mould removal and minimum time before movement of item;

n) overcoat time, if applicable;

o) repair methods, considering the range of possible repair scenarios from surface damage to damage down to steel, and repairs performed in the fabrication location and remote locations;

p) removal procedure;

q) remedial actions;

r) time to inspection;

s) handling and storage requirements for raw materials and insulating joints, including the following, as applicable:

   1) temperature limitations (e.g. freezing, excessive heat);

   2) humidity;

   3) protection from the elements (e.g. snow, rain, sunlight);

   4) protection from contaminants (e.g. dust, water, chemicals);

   5) expiration date;

   6) protection from physical damage.

t) handling of insulated pipes and cutback as applicable, including the following:

   1) temperature limitations (e.g. freezing, excessive heat);

   2) humidity;

   3) protection from the elements (e.g. snow, rain, sunlight);

   4) protection from contaminants (e.g. dust, water, chemicals);

   5) protection from physical damage.

7.4.2 Inspection and testing plan

A dedicated ITP shall be prepared by the system provider for each of the process steps (PQT, PPT, production). The contents of the ITP shall reflect all the process items, the items to be inspected and tested including the frequency thereof, and acceptance criteria.

The following activities shall be listed at the minimum:

a) description of the activities;

b) identification of coated item and substrate;

c) selected system;

d) inspection points for each of the activities;

e) applicable reference documents including procedures and methods;

f) applicable instruments and tools;

g) acceptance criteria;

h) frequency of the checks;

i) type of report;

j) persons/parties required to be present at the inspections/intervention points.

All reporting and logs (e.g. traveller sheets, job cards) shall at least include all the requirements of the ITP.

7.4.3 Qualification of operators

7.4.3.1 General

The qualification, via specific training scheme, may be verified by demonstration at PQT (if any), during PPT, or during supervised participation in production. The specific training scheme is established by the system provider subject to approval by the system purchaser and/or end user.

The system provider may request the material manufacturer(s) and equipment suppliers to provide technical assistance to the operators if necessary.

Proof of successful qualification shall be documented.

Inspectors carrying out the QC activities and inspection shall be trained and qualified.

The inspector competency may be demonstrated by attested experience, specific training by the system provider and/or by the certification body in conformance with the certification schemes approved by the system purchaser and/or end user.

7.4.3.2 Requirements

The system provider shall be responsible for ensuring that the operators are trained and qualified for their specific activity prior to the start of work by:

a) preparing test samples in accordance with the approved APS;

b) evaluating test samples against acceptance criteria;

c) evaluating general competency under criteria described in this subclause.

Test samples shall be made of pipe or components that approximate, as closely as practicable, to the situations and conditions that will be found during construction or repair.

The system purchaser may witness and/or audit any or all aspects of the operator training and qualification testing process or define a third party to follow the training process.

The training shall cover the appropriate APS for the applicable systems and shall include at least:

a) check of environmental conditions;

b) substrate cleanliness and profile;

c) preheating methods, if required;

d) substrate preparation (including ACC) and application procedures;

e) correct use of tools and operation of equipment;

f) inspection methods;

g) system removal and repair methods.

Involvement of the material manufacturer in system application training is recommended.

Upon successful completion of the operator qualification testing, the system provider or a third-party training body shall provide a certificate of operators' qualification that states the following:

a) name of applicator's operators;

b) systems for which the operator is qualified;

c) equipment which the operator is qualified to operate;

d) APS used to qualify the operator;

e) date of qualification testing.

For traceability, the documentary evidence shall provide a unique identifier for each qualified operator.

7.4.3.3 Competency determination

Competency shall be determined by:

a) reviewing the system provider's certificates of operator's qualification for appropriateness to the system and the version of the APS to be applied, in which the operator shall have:

   1) applied the selected system using the approved APS, including substrate preparation;

   2) applied the selected system within the previous year.

b) witnessing the coating operator in order to verify:

   1) applying the selected system to the piece in accordance with the APS, including substrate preparation;

   2) meeting the acceptance criteria for the selected sample(s).

The system purchaser may waive the requirements of item b), if the system provider demonstrates that the certificate of qualification, training and experience are sufficient to ensure competency.

8 Production testing and inspection for field joints

8.1 General

The field joint system, in addition to the materials/layers that make up said system, shall have been validated in conformance with the requirements of ISO 12736-1. The resulting validation dossier and PQT/PPT reports shall provide the baseline data required for quality control during production.

8.2 Material tests and inspection

Systems are typically built-up as single or multiple layers applied over a substrate, which may already be coated with an appropriate ACC.

Application and testing of ACCs shall be performed in accordance with the relevant standard as agreed upon in the order by the system provider, the system purchaser and/or end user.

Raw materials and material application shall meet the requirements of Table 3 to Table 7, dependent on classification of the material in question.

8.3 System test and inspection

The applied field joint systems shall meet the requirements of Table 8 to Table 10, dependent on classification of the materials which make up the system, as per Table 1.

8.4 Inspection documents and traceability

The inspection documents are released by the system provider and shall be in accordance with ISO 10474.

The system purchaser shall specify in the purchase order the required ISO 10474 designation of the inspection document and any specific requirements for the format and content of the document.

Records shall be maintained on a shift and daily basis and shall be available for inspection by the system purchaser (or their representative).

The inspection documents signed by the system provider shall be transmitted to the system purchaser at a frequency defined in the purchase order. Cumulative production records shall be maintained daily.

8.5 Guidance in generating an ITP

The inspection and test plan for the system shall be based upon Table 3 to Table 10. In each table, the property to be tested, test method, requirement for acceptance and the frequency of testing are identified. The properties indicated with a check mark in the appropriate column are required for each material class as per Table 1.

A system can be made up of either a single material layer or multiple material layers of the same or different classes. For each applied layer, the appropriate properties for the class of material shall be tested.

The following requirements shall be included in the ITP, where appropriate:

a) Raw material testing in Table 3 shall be applicable for each material used in the system.

b) Steel substrate preparation and inspection in Table 4 shall be applicable for a layer applied directly to a steel substrate. In case a reference standard is not available, ISO 21809-3 can be adopted as reference for steel substrate preparation requirements.

c) Polymeric substrate preparation and inspection in Table 5 shall be applicable for any layer that is to be applied on top of a polymeric substrate (not onto steel). This polymeric substrate may be an ACC layer or previously applied insulation layer.

d) If a liquid adhesion promotor is required between the insulation layer to be applied and the substrate, the inspection of Table 6 shall be applicable.

e) Inspection parameters in Table 7 shall be applicable for the application of each insulation layer.

f) Laboratory testing in Table 8 shall be applicable for each of the as-applied insulation layers.

g) For each insulation layer that does not include the final outer layer of the system, intermediate inspection in Table 9 of the outermost layer shall be applicable.

h) For the final layer applied, which is the outermost layer of the system, final inspection in Table 10 shall be applicable.

Table 3 — Raw material testing [a]

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Density /specific gravity of each material component	kg/m^3	ISO 1183-1 or ISO 2781 or material manufacturer's method	Within material manufacturer's certificate of conformity range	√	√	√	√	√	√	√	√	√	√	√	√	Each batch	Each batch	Each batch
Viscosity (of each component)	Pa.s	ISO 3104 or the ISO 3219 series or ISO 2884-2 or material manufacturer's method	Within material manufacturer's certificate of conformity range				√	√	√	√	√	√				Each batch	Each batch	Each batch
MFR	g/ min	ISO 1133-1 and ISO 1133-2 or material manufacturer's method	Within material manufacturer's certificate of conformity range	√	√	√										Each batch	Each batch	Each batch
Density of inorganic microspheres	g/cm^3	Material manufacturer's method	Within material manufacturer's certificate of conformity range			√			√			√			√	Each batch	Each batch	Each batch
Crush strength of inorganic microspheres	MPa	Material manufacturer's method	Within material manufacturer's certificate of conformity range			√			√			√			√	Each batch	Each batch	Each batch
Functionality content [b] (e.g. isocyanate)	%	Specific to functionality (e.g. ISO 14896)	Within material manufacturer's certificate of conformity range				√	√	√	√	√	√				Each batch	Each batch	Each batch
Gel time/ reactivity of cured system	s	Material manufacturer's method	Within material manufacturer's certificate of conformity range				√		√	√		√				Each batch	Each batch	Each batch

[a] Raw material testing to be found on material manufacturer's certificate of analysis/conformity or tested by system provider, if otherwise unavailable.

[b] If applicable per APS.

Table 3 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Cure characteristics	Nm	The ISO 6502 series (rheometer) or material manufacturer's method	Within material manufacturer's certificate of conformity range										√	√	√	Each batch	Each batch	Each batch
Density (of cured system)	kg/m^3	ISO 1183-1	Within material manufacturer's certificate of conformity range										√	√	√	Each batch	Each batch	Each batch
Hardness of cured system	Shore A or Shore D	ISO 868 or ISO 48-4	Within material manufacturer's certificate of conformity range										√	√	√	Each batch	Each batch	Each batch
Appearance	--	Visual	Within material manufacturer's certificate of conformity range	√	√	√	√	√	√	√	√	√	√	√	√	Each batch	Each batch	Each batch

[a] Raw material testing to be found on material manufacturer's certificate of analysis/conformity or tested by system provider, if otherwise unavailable.

[b] If applicable per APS.

Table 4 — Steel substrate preparation [a]

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Steel substrate preparation	-	As per applicable ACC standard, e.g. ISO 21809-3	As per applicable ACC standard, e.g. ISO 21809-3	√	√	√	√	√	√	√	√	√	√	√	√	As per applicable ACC standard	As per applicable ACC standard	As per applicable ACC standard

[a] Applicable if insulation material is being applied directly to steel substrate.

Table 5 — Previously applied substrate [a] and interface chamfer preparation

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Confirmation of cutback and chamfer dimensions	-	Visual or tape measure as necessary	As per ITP	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item
Cleaning of substrate, chamfer and overlap landing area	-	As per APS	Substrate to be cleaned	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item
Visual inspection of previously coated substrate for cleanliness	-	Visual inspection	The substrate shall be free from moisture, contamination, oil and grease	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item
Visual inspection of chamfer area	-	Visual inspection	No disbondment from substrate	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item
Environmental conditions Dew point and relative humidity to be recorded	°C	ISO 8502-4	Acceptable range to be established during PQT or PPT, Minimum 3°C above dew point	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Start of each shift
Substrate and/or chamfer abrasion [b]	-	Visual inspection	If applicable, abrasion with sand paper grit 40 minimum and dust vacuum cleaning (alternative methods of mechanical substrate preparation may be agreed) wipe substrate with lint free cloth	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item

[a] Applicable if insulation material is being applied to a previously applied polymeric substrate.

[b] If applicable per APS.

[c] Only applicable if substrate is abraded.

Table 5 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Dust test [c]	-	ISO 8502-3	Dust quantity and size ≤ class 2, rating 2	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	3 times per shift
Temperature of previously coated substrate and chamfer [b]	°C	Infrared pyrometer or equivalent	If applicable, acceptable range to be established during PQT or PPT	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	All items checked with infrared pyrometer or contact thermometer; recorded for each item

[a] Applicable if insulation material is being applied to a previously applied polymeric substrate.

[b] If applicable per APS.

[c] Only applicable if substrate is abraded.

Table 6 — Liquid adhesion promotor/primer application [a]

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Environmental conditions	°C	ISO 8502-4	Minimum 3 °C above dew point	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Start of each shift
Pot life	min	Stop watch	Cure time check in accordance with material manufacturer's recommendation	√	√	√	√	√	√	√	√	√	√	√	√	Start of PQT or each mix batch	Start of PQT or each mix batch	Start of each shift or each mix batch
Mix ratio [a]	ratio by weight	Weight measurement	Ratio and tolerance to material manufacturer's recommendation	√	√	√	√	√	√	√	√	√	√	√	√	Start of PQT or each mix batch	Start of PPT or each mix batch	Start of each shift or each mix batch
Over coating time	min	Stop watch	Time check in accordance with material manufacturer's recommendation	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item
Visual appearance	-	Visual	Within material manufacturer's recommendation Comparative visual test panels from PQT or PPT to be used for production	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item

[a] If applicable per APS.

Table 7 — Materials application

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Extrusion temperature	°C	Infrared pyrometer or equivalent on extrudate as it is exiting in the die	Acceptable range to be established during PQT or PPT	√	√	√										Each item	Each item	All items checked with infrared pyrometer; recorded for each item
Mix ratio	ratio by weight	Weight measurement	Ratio and tolerance to material manufacturer's recommendation				√	√	√	√	√	√				Start of PQT	Start of PPT	Start of each shift
Cupshot test [b]	-	Visual	Good mixing, no air, no discolouration from unmixed components etc.				√	√	√	√	√	√				Start of PQT	Start of PPT	Start of each shift
Gel time check (machine dispensed) [a]	s	Stop watch	For information, if applicable (to be used as reference for maximum pour time limitations)				√		√	√		√				Once	Once	Once per shift or start of each pouring
Visual inspection of the mould prior to moulding	-	Visual	Clean, correctly aligned and supported, adequate seal	√	√	√	√	√	√	√	√	√				Each item	Each item	Each item
Raw material processing temperature	°C	Thermocouple	Within material manufacturer's recommendation				√	√	√	√	√	√				Once	Once	Once per shift

[a] If applicable per APS.

[b] Alternative methods for offshore application to be agreed at PQT or PPT stage.

Table 7 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Mould temperature [a]	°C	Thermocouple, contact thermometer, or non-contact thermometer	Acceptable range to be established during PQT or PPT	√	√	√	√	√	√	√	√	√				Each item	Each item	Each item
Substrate surface temperature [a]	°C	Thermocouple, contact thermometer, or non-contact thermometer	If applicable, acceptable range to be established during PQT or PPT	√	√	√	√	√	√	√	√	√				Each item	Each item	All items checked with infrared pyrometer; recorded for each item
Chamfer surface temperature [a]	°C	Thermocouple, contact thermometer, or non-contact thermometer	If applicable, acceptable range to be established during PQT or PPT	√	√	√	√	√	√	√	√	√				Each item	Each item	All items checked with infrared pyrometer; recorded for each item
Exotherm temperature during moulding [a]	°C	Thermocouple, contact thermometer, or non-contact thermometer	Acceptable range to be established during PQT or PPT The exotherm should be checked at the centre of the maximum thickness during cure				√	√	√	√	√	√				One item	As agreed	n/a

[a] If applicable per APS.

[b] Alternative methods for offshore application to be agreed at PQT or PPT stage.

Table 7 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Minimum demoulding time	s (or h as applicable for materials)	Timing device	Acceptable range to be established during PQT or PPT	√	√	√	√	√	√	√	√	√				Each item	Each item	Each item
Vulcanisation temperature [a]	°C	Contact thermometer	Acceptable range to be established during PQT or PPT, or according to material manufacturer procedure										√	√	√	Each item monitored	Each item monitored	Each item monitored
Vulcanisation time	min	Stop watch	Acceptable range to be established during PQT or PPT										√	√	√	Each item	Each item	Each item
Vulcanisation pressure [a]	MPa	System provider specific	If applicable, acceptable range to be established during PQT or PPT										√	√	√	Each item	Each item	Each item

[a] If applicable per APS.

[b] Alternative methods for offshore application to be agreed at PQT or PPT stage.

Table 8 — System offline testing – Laboratory testing

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Density	kg/m^3	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Each item	N/A	N/A
Interlayer adhesion test between insulation layers and between insulation and substrate	MPa	Test method as supplied in validation dossier or as agreed with system purchaser and/or end user	Acceptable range to be established during PQT or PPT	√	√	√	√	√	√	√	√	√	√	√	√	Each item	N/A	N/A
Interface / sub interface adhesion	MPa	Test method as supplied in validation dossier or as agreed with system purchaser and/or end user. See Annex C for information	In accordance with value and range established during PQT or PPT	√	√	√	√	√	√	√	√	√	√	√	√	Each item	N/A	N/A
Thermal conductivity [a]	W.m^{-1}.K^{-1}	ISO 12736-2:2023, Annex D	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Once for PQT	N/A	N/A
Specific heat capacity	J.kg^{-1}.K^{-1}	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Once for PQT	N/A	N/A

[a] Not applicable for layers of a single material built up to <10 mm in thickness, which can be done in multiple applications.

[b] Applicable only for syntactic foams where the hollow particle is a glass microsphere or other inorganic microsphere.

[c] Not applicable for materials whose residual ash consists of more than the incorporated hollow particles (e.g. silicones).

Table 8 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Compressive strength [a]	MPa	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C		√	√		√	√		√	√		√	√	Once for PQT	N/A	N/A
Tensile strength and elongation at break	MPa %	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Once for PQT	N/A	N/A
Mass ratio of glass microspheres [b, c]		ISO 12736-2:2023, Annex E	Acceptable range to be established during PQT or PPT			√			√			√			√	Each item	N/A	N/A
Glass microspheres density after processing [b, c]	kg/m^3	ISO 12736-2:2023, Annex E	Acceptable range to be established during PQT or PPT			√			√			√			√	Each item	N/A	N/A
Entrapped air ratio [b, c]		ISO 12736-2:2023, Annex E	Acceptable range to be established during PQT or PPT			√			√			√			√	Each item	N/A	N/A
Closed cell content	%	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C					√			√					One item	N/A	N/A
Tear strength	N/mm	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C							√	√	√	√	√	√	Once for PQT	N/A	N/A

[a] Not applicable for layers of a single material built up to <10 mm in thickness, which can be done in multiple applications.

[b] Applicable only for syntactic foams where the hollow particle is a glass microsphere or other inorganic microsphere.

[c] Not applicable for materials whose residual ash consists of more than the incorporated hollow particles (e.g. silicones).

Table 8 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Notched Charpy impact test	kJ/m²	ISO 179-1 or similar	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√							Once for PQT	N/A	N/A
Glass transition temperature	°C	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C, if applicable				√	√	√	√	√	√	√	√	√	As agreed with system purchaser and/or end user	N/A	N/A
Hydrostatic collapse [a]	MPa	ISO 12736-1:2023, Annex C	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C		√	√		√	√		√	√			√	As agreed with system purchaser and/or end user	N/A	N/A
Project specific functional tests (see 7.3.2)	-	As agreed with system purchaser and/or end user	As agreed with system purchaser and/or end user	√	√	√	√	√	√	√	√	√	√	√	√	As agreed with system purchaser and/or end user	N/A	N/A
Project specific testing on ACC	-	As per applicable ACC standard	As per applicable ACC standard	√	√	√	√	√	√	√	√	√	√	√	√	As agreed with system purchaser and/or end user	N/A	N/A

[a] Not applicable for layers of a single material built up to <10 mm in thickness, which can be done in multiple applications.

[b] Applicable only for syntactic foams where the hollow particle is a glass microsphere or other inorganic microsphere.

[c] Not applicable for materials whose residual ash consists of more than the incorporated hollow particles (e.g. silicones).

Table 9 — Intermediate layer inspection [a]

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Surface temperature control after cooling	°C	Thermocouple	<80 °C	√	√	√										Each item	Each item	Three times per shift
Thickness control	mm	Pi tape / electronic equipment or as defined at PQT	As specified	√	√	√	√	√	√	√	√	√	√	√	√	Each item at 5 longitudinal locations	Each item at 5 longitudinal locations	Each item at 3 longitudinal locations for the first 5 item of each shift
Hardness	Shore A or Shore D	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at demoulding temperature				√	√	√	√	√	√	√	√	√	Each item	Each item	As agreed
Overlap length of field joint system over mainline system [b]	mm	Straight edge ruler, tape measure or electronic equipment at cutback area	As specified, if applicable	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item
Removal of release agent [b]	-	As qualified during PQT	-				√	√	√	√	√	√				Each item	Each item	Each item

[a] Intermediate layer inspection if additional layers are still to be applied.

[b] If applicable per APS.

Table 9 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Visual	-	Naked eye (no magnification)	Free from visible large air traps, porosity, debris, knit lines, cavities, unwetted fillers and disbondment at joints and/or substrate interfaces Cosmetic surface faults may be accepted	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item

a Intermediate layer inspection if additional layers are still to be applied.

b If applicable per APS.

Table 10 — Final inspection [a]

Property	Units	Test method	Requirements	Applicable classes												Frequency		
				Class 1			Class 2			Class 3			Class 4			PQT	PPT	Production
				A	B	C	A	B	C	A	B	C	A	B	C			
Total system thickness	mm	Pi tape or electronic equipment	As specified	√	√	√	√	√	√	√	√	√	√	√	√	Each item at 5 longitudinal locations	Each item at 5 longitudinal locations	As agreed
Hardness	Shore A or Shore D	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at demoulding temperature				√	√	√	√	√	√	√	√	√	Each item	Each item	As agreed
overlap thickness [b]	-	Vernier and straight edge	As specified	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	As agreed
Overlap length of field joint system over mainline system	mm		As specified	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Once per shift
Visual	-	Naked eye (no magnification)	criteria to be agreed at PQT/PPT stage	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item	Each item

[a] Final inspection after application of final layer.

[b] If applicable per APS.

9 Requirements for field repairs of wet thermal insulation and field joints

9.1 General

A detailed repair procedure, including stripping of the system if allowed, shall be established for each type of system and shall be qualified by testing before commencement of field jointing operations. Defects on the system shall be repaired and inspected using materials and procedures in accordance with the approved APS and ITP.

9.2 Damage/defect characterization

Repair procedures for damage or defects in the system can be categorized as:

— minor damage to the system not penetrating to the anticorrosion coat;

— minor damage penetrating to the steel;

— major damage greater than a specified surface area;

— major and minor damages across the field joint system and mainline system interface.

The requirements for each type of repair shall be documented in an APS. Repairs to both field joint and mainline or subsea equipment systems should be considered, as appropriate.

9.3 Repair materials for each of the material classes and compatibility

Wherever possible, the system shall be repaired with the same material applied. If this is not possible, repair materials shall be compatible with the applied system. Test areas can be prepared to check the manufacturer's recommendations and/or compatibility with the existing system.

The necessary surface preparation of applied system, substrate and ACC shall all be agreed for compatibility by agreement with the pipe supplier.

9.4 Repair execution

Three separate repairs shall be completed to demonstrate the process for each type of repair identified in 9.2.

Evaluation of the removal of field joints and reinstatement shall be included in the PQT. The selected methods shall be risk assessed to ensure there is no damage to the metallic substrate. HSE risks associated with removal of the system shall be assessed before the PQT.

Repair testing procedures shall be subject to agreement between the system purchaser and/or end user and the system provider.

10 Final documentation

Field joint system reports should identify each inspected pipeline section by a unique identifier and shall record the related material batch number for traceability. Test results shall be linked to the exact locations on which they were performed.

Records shall be maintained on a shift and daily basis and shall be available for inspection by the purchaser and/or end user.

The inspection documents signed by the system provider shall be transmitted to the system purchaser at a frequency defined in the purchase order. Cumulative production records shall be maintained daily.

The system provider shall provide the final project documentation that at least contains:

a) technical validation dossier;

b) field joint system geometry and expected thermal performance;

c) application procedures including repairs;

d) ITP;

e) qualification test report and records in accordance with this document;

f) manufacturing inspection report and records in accordance with this document;

g) raw material data sheet and SDS;

h) raw material certificates;

i) system record sheets and/or finished goods reports.

11 Pre-fabricated insulation

11.1 General

Pre-fabricated insulation can be used in many different ways, can take many different forms, and has different considerations for installation in comparison to direct applied insulation. As a result, it is not feasible to fully define system or project testing requirements within the scope of this document. Only evaluation of the insulative material as defined in ISO 12736-1 and requirements detailed in this clause are relevant. A validation dossier in accordance with ISO 12736-1 shall be provided.

Annex D provides further information and context relating to pre-fabricated insulation.

11.2 Material classes

Materials used for pre-fabricated insulative sections shall be identified in accordance with the material classes presented in Table 1.

Each material used to make up the system shall have been classified into the appropriate class by the system provider as part of the validation dossier in accordance with ISO 12736-1.

11.3 Project specific qualification processes

The following requirements shall be considered for project specific qualification and QC activities:

a) all materials and systems shall be previously validated in conformity with the requirements of ISO 12736-1;

b) the validation dossier of the materials and systems shall be given by the system provider to the system purchaser and/or end user for approval;

c) the preparation of a project specific ITP is required and shall be approved by the system purchaser and/or end user;

d) if requested by the system purchaser, a PQT can be performed for qualification and shall be performed according to an approved ITP;

e) before production starts, a PPT shall be performed according to a dedicated ITP; by agreement, the PPT and the PQT can be executed at the same time (i.e. the PQT and PPT can be merged);

f) Those parts of the project specific qualification process that are waived by the system purchaser, shall be clearly stated and shall be identified in the project/contract documentation;

g) During the production, an inspection system shall be implemented by the system provider to monitor and execute all the inspection activities reported in the approved ITP for production;

h) inspection and testing shall be carried out during production in accordance with the approved ITP;

i) Test procedures, testing frequencies, requirements, acceptance criteria and remedial actions shall be defined in the ITP;

j) If other materials than those classified in Table 1 are used, the system provider shall identify the class that most closely represents the material and shall provide a gap analysis to the requirements for that class to be included in the validation dossier;

k) All data collected during inspections and tests shall be recorded and shall be delivered to the system purchaser as required in the ITP.

11.4 Information to be supplied by the system purchaser

The system purchaser shall provide the following information:

a) project conditions (e.g. water depth, operating and design temperature, seawater temperature at surface and at maximum operating depth, and service duration);

b) thermal performance requirements, including tolerances, either specified as a required thermal conductivity, U-value or cool down time and temperature requirements;

c) identification and description of item to be insulated (e.g. item quantity, outside diameter, external geometry, size, with dimensions, geometry restrictions, wall thickness, associated tolerances on all parameters and grade of steel or detailed dimensional requirements for the pre-fabricated piece);

d) identification of the ACC selected by system purchaser or already applied to the structure to be insulated;

e) where applicable, cutback configuration and pipe ends finish, including at least cutback length and chamfer angle, length of visible ACC and associated tolerances on all parameters;

f) where applicable, CP systems or continuity connection requirements and, if required, the surface area needed for anode coverage;

g) where applicable, other specialty project specific product requirements;

h) installation method and orientation (e.g. installed on land, on the deck, by diver or by ROV);

i) assembly restrictions, structural obstacles such as pipe bends.

Referring to item h), where ROV installation is specified, details of ROV installation method, ROV tools and limitations shall be provided. Similarly, where the component to be insulated requires further installation after installation of pre-fabricated insulation, the method of component installation and component installation temperature range shall be provided.

11.5 Manufacturing of pre-fabricated insulation

Manufacturing procedures and the relevant validation dossier for the insulative material for the pre-fabricated insulation shall be made available by the system provider for review by the system purchaser. The requirements for qualification of procedures and addition of project specific requirements for manufacturing shall be as agreed by the system provider, the system purchaser and/or the end user, and shall be documented in the request for quotation or purchase order.

11.6 Inspection and testing plan

A dedicated ITP shall be prepared by the system provider for each of the manufacturing steps. The contents of the ITP shall reflect all the process items, the items to be inspected and tested, the frequency and acceptance criteria.

At least the following activities shall be listed in the ITP:

a) description of the activities relating to manufacture and testing;

b) responsible party for the activity;

c) description of the activity;

d) frequency of the checks;

e) applicable reference documents;

f) acceptance criteria;

g) applicable verifying documents;

h) intervention points, if applicable;

i) persons/parties required to be present at the inspections/intervention points, if applicable.

The ITP for the insulation system shall be based upon Table 11 to Table 14. In each table, the property to be tested, test method, requirement for acceptance and frequency of testing are identified. The properties indicated with a check mark in the appropriate column are required for each material class.

Unlike direct applied wet thermal insulation, since pre-fabricated insulation is manufactured in a factory environment, there are only two steps for ITP generation, namely PPT (pre-production testing or first off production) and production testing.

Pre-fabricated insulation is typically made up of a single material layer. The appropriate properties for the class of material shall be tested. As a minimum, the following shall be included in the ITP:

a) raw material testing in Table 11 shall be applicable for each material used in the pre-fabricated insulation system;

b) inspection parameters in Table 12 shall be applicable for the manufacture of pre-fabricated insulation sections;

c) laboratory testing in Table 13 shall be applicable for each of the as-made pre-fabricated insulation sections;

d) final inspection testing in Table 14 shall be applicable for each of the as-made pre-fabricated insulation sections.

The tests listed in Table 11 to Table 14 are relevant to any material that contributes to the thermal performance of the pre-fabricated insulation body. Any materials used for other purposes or for additional ancillary equipment used to allow the pre-fabricated insulation to function (e.g. strapping, fastening, sealing) do not require full testing in accordance with Table 11 to Table 14. However, the system provider shall propose to the system purchaser relevant tests to demonstrate the ancillary equipment is fit for its intended function.

11.7 Requirements for repairs

11.7.1 General

A detailed repair procedure shall be established for each material class.

11.7.2 Damage/Defect characterization

Repair procedures for damage or defects in the system shall be categorized by area, depth, volume or criticality, with a resulting repair method defined for each category as necessary.

11.7.3 Repair method

The repair method shall define the required surface preparation, repair material handling, mixing application, cure conditions and any subsequent post-repair finishing.

11.7.4 Repair materials

Wherever possible, the system shall be repaired with the same parent material as used for the pre-fabricated insulation. If this is not possible, alternative repair materials may be used where they can be shown to have sufficient bond strength to the parent material based on the required criticality of the bond and defect category.

11.8 Final documentation

Final project documentation for pre-fabricated insulation shall be provided by the system provider in accordance with system purchaser requirements. Documentation will typically consist of:

a) technical validation dossier;

b) engineering calculations;

c) engineering drawings;

d) ITP;

f) application/assembly/production/manufacture procedure;

g) test reports for PPT (production first article) and production where required;

h) QA/QC certification for the finished article;

i) handling, storage and installation procedures;

j) packing list.

Table 11 — Raw material testing for pre-fabricated insulation [a]

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Density /specific gravity of each material component	kg/m^3	ISO 1183-1 or ISO 2781 or material manufacturer's method	Within material manufacturer's certificate of conformity range	√	√	√	√	√	√	√	√	√	√	√	√	Each batch	Each batch
Viscosity (of each component)	Pa s	ISO 3104 or the ISO 3219 series or ISO 2884-2 or material manufacturer's method	Within material manufacturer's certificate of conformity range				√	√	√	√	√	√				Each batch	Each batch
MFR	g/ min	ISO 1133-1 and ISO 1133-2 or material manufacturer's method	Within material manufacturer's certificate of conformity range	√	√	√										Each batch	Each batch
Density of inorganic microspheres	g/cm^3	Material manufacturer's method	Within material manufacturer's certificate of conformity range			√			√			√			√	Each batch	Each batch
Crush strength of inorganic microspheres	MPa	Material manufacturer's method	Within material manufacturer's certificate of conformity range			√			√			√			√	Each batch	Each batch
Functionality content [b] (e.g. isocyanate)	%	Specific to functionality (e.g. ISO 14896)	Within material manufacturer's certificate of conformity range				√	√	√	√	√	√				Each batch	Each batch
Gel time/reactivity of cured system	s	Material manufacturer's method	Within material manufacturer's certificate of conformity range				√		√	√		√				Each batch	Each batch
Cure characteristics	Nm	The ISO 6502 series (rheometer) or material manufacturer's method	Within material manufacturer's certificate of conformity range										√	√	√	Each batch	Each batch

[a] Raw material testing to be found on material manufacturer's certificate of analysis/conformity or tested by system provider, if otherwise unavailable.

[b] If applicable.

Table 11 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Density (of cured system)	kg/m^3	ISO 1183-1	Within material manufacturer's certificate of conformity range										√	√	√	Each batch	Each batch
Hardness of cured system	Shore A or Shore D	ISO 868 or ISO 48-4	Within material manufacturer's certificate of conformity range										√	√	√	Each batch	Each batch
Appearance	--	Visual	Within material manufacturer's certificate of conformity range	√	√	√	√	√	√	√	√	√	√	√	√	Each batch	Each batch

[a] Raw material testing to be found on material manufacturer's certificate of analysis/conformity or tested by system provider, if otherwise unavailable.

[b] If applicable.

Table 12 — Manufacture of pre-fabricated insulation

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Extrusion temperature	°C	Infrared pyrometer or equivalent on extrudate as it is existing in the die	Acceptable range to be established during PQT or PPT	√	√	√										each item	All items checked with infrared pyrometer; recorded for each item
Mix ratio	ratio by weight	Weight measurement	Ratio and tolerance to material manufacturer's recommendation				√	√	√	√	√	√				Start of PPT	Start of each shift
Cupshot test	-	Visual	Good mixing, no air, no discolouration from unmixed components, etc.				√	√	√	√	√	√				Start of PPT	Once per shift or start of each pouring
Gel time check (machine dispensed) [a]	s	Stop watch	For information, if applicable (to be used as reference for maximum pour time limitations)				√		√	√		√				Start of PPT	Once per shift or start of each pouring
Visual inspection of the mould prior to moulding	-	Visual	Clean, correctly aligned and supported, adequate seal	√	√	√	√	√	√	√	√	√				Each item	Each item
Raw material processing temperature	°C	Thermocouple	Within material manufacturer's recommendation				√	√	√	√	√	√				Once	Once per shift
Mould temperature	°C	Thermocouple, contact thermometer, or non-contact thermometer	Acceptable range to be established during PQT or PPT	√	√	√	√	√	√	√	√	√				Each item	Each item
Mould fill	-	Visual	Ensure mould is completely full and ensure correct material used	√	√	√	√	√	√	√	√	√				Each item	Each item
Oven time check	min or hr	Visual	Cured for the minimum duration				√	√	√	√	√	√				Each item	Each item

[a] If applicable.

Table 12 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Oven temperature check	°C	Visual	Cured at the correct temperature				√	√	√	√	√	√				Each item	Each item
Vulcanisation temperature [a]	°C	Contact thermometer	Acceptable range to be established during PQT or PPT, or according to material manufacturer procedure										√	√	√	Each item monitored	Each item monitored
Vulcanisation time	min	Stop watch	Acceptable range to be established during PQT or PPT										√	√	√	Each item	Each item
Vulcanisation pressure [a]	MPa	System provider specific	If applicable, acceptable range to be established during PQT or PPT										√	√	√	Each item	Each item

[a] If applicable.

Table 13 — Material testing for pre-fabricated insulation – Laboratory testing

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Density	kg/m^3	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Each item	1 per unit of production
Thermal conductivity [a]	W. m^{-1}.K^{-1}	ISO 12736-2:2023, Annex D	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Once for PPT	1 per unit of production
Specific heat capacity	J.kg^{-1}.K^{-1}	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Once for PPT	1 per unit of production
Compressive strength [a]	MPa	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Once for PPT	1 per unit of production
Tensile strength and elongation at break	MPa %	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√	√	√	√	√	√	√	Once for PPT	1 per unit of production
Mass ratio of glass microspheres [b, c]		ISO 12736-2:2023, Annex E	Acceptable range to be established during PQT or PPT			√			√			√			√	Each item	N/A
Glass microspheres density after processing [b, c]	kg/m^3	ISO 12736-2:2023, Annex E	Acceptable range to be established during PQT or PPT			√			√			√			√	Each item	N/A
Entrapped air ratio [b, c]		ISO 12736-2:2023, Annex E	Acceptable range to be established during PQT or PPT			√			√			√			√	Each item	N/A

[a] Not applicable for layers of a single material built up to <10 mm in thickness.

[b] Applicable only for syntactic foams where the hollow particle is a glass microsphere or other inorganic microsphere.

[c] Not applicable for materials whose residual ash consists of more than the incorporated hollow particles (e.g. silicones).

[d] If applicable.

Table 13 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Closed cell content	%	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C					√			√					One Item	N/A
Tear strength	N/mm	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C							√	√	√	√	√	√	Once for PPT	N/A
Notched Charpy impact test	kJ/m^2	ISO 179-1 or similar	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C	√	√	√	√	√	√							Once for PPT	N/A
Glass transition temperature	°C	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C, if applicable				√	√	√	√	√	√	√	√	√	As agreed with system purchaser and/or end user	N/A
Hydrostatic collapse pressure [a, d]	MPa	ISO 12736-1:2023, Annex C	In accordance with the value and range reported in the validation dossier at 23 °C ± 2 °C			√			√			√			√	As agreed with system purchaser and/or end user	N/A
Tri axial creep	-	ISO 12736-1:2023, Annex C	In accordance with the predicted value		√			√			√			√		As agreed with system purchaser and/or end user	N/A

[a] Not applicable for layers of a single material built up to <10 mm in thickness.

[b] Applicable only for syntactic foams where the hollow particle is a glass microsphere or other inorganic microsphere.

[c] Not applicable for materials whose residual ash consists of more than the incorporated hollow particles (e.g. silicones).

[d] If applicable.

Table 14 — Final inspection of pre-fabricated insulation

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Visual	-	Naked eye (no magnification)	Free from voids, large air traps, porosity, debris, knit lines, cavities, unwetted fillers and disbondment at joints and/or substrate interfaces Cosmetic surface faults may be accepted	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item
Hardness	Shore A or Shore D	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at demoulding temperature				√	√	√	√	√	√	√	√	√	Each item	Each item
Critical dimensions	mm	Physical dimension measurement	In accordance with the approved inspection/ dimensioned drawings	√	√	√	√	√	√	√	√	√	√	√	√	1 item per design	Each item
Fit-up test (for sealed pre-fabricated systems only)	-	Complete assembly consisting of pre-fabricated insulation sections and mounting structure (or suitable mandrel)	Suitable fit between each section, where applicable, seals compress to the required minimum % as per design and pre-fabricated sections are aligned on the structure as expected in design.	√	√	√	√	√	√	√	√	√	√	√	√	1 item per design	Each item
Fit-up test (for non-sealed pre-fabricated systems only)	-	Complete assembly consisting of pre-fabricated insulation sections and mounting structure (or suitable mandrel)	Suitable fit between each section, where applicable and pre-fabricated sections are aligned on the structure as expected in design	√	√	√	√	√	√	√	√	√	√	√	√	1 item per design	Each item

Table 14 *(continued)*

Property	Units	Test method	Requirements	Applicable classes												Frequency	
				Class 1			Class 2			Class 3			Class 4			PPT (production first article)	Production
				A	B	C	A	B	C	A	B	C	A	B	C		
Visual	-	Naked eye (no magnification)	Free from voids, large air traps, porosity, debris, knit lines, cavities, unwetted fillers and disbondment at joints and/or substrate interfaces Cosmetic surface faults may be accepted	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item
Hardness	Shore A or Shore D	Test method as supplied in validation dossier	In accordance with the value and range reported in the validation dossier at demoulding temperature				√	√	√	√	√	√	√	√	√	Each item	Each item
Leak test (for sealed pre-fabricated systems only)	l/hr	Assessment of seal leak rate per Annex E	Leak rate shall not exceed the maximum permitted	√	√	√	√	√	√	√	√	√	√	√	√	1 item per design	N/A
Lifting-point load test	-	Test that each lifting point can withstand the minimum force expected in design (including an appropriate force safety factor multiplier)	Each lifting point tested meets the minimum expected force	√	√	√	√	√	√	√	√	√	√	√	√	1 item per design	Each lifting point
Weight in air	kg	Weigh product in air	Weight recorded for information only	√	√	√	√	√	√	√	√	√	√	√	√	Each item	Each item

11.9 Installation of pre-fabricated insulation

Installation procedures for the pre-fabricated insulation shall be made available by the system provider for review by the system purchaser. The requirements for qualification of procedures, addition of project specific requirements for installation, and responsibility for installation lies with the system purchaser.

12 Handling, storage and transportation at site for field joints and pre-fabricated insulation

If any of the raw materials are subject to specific transport and storage conditions, the party responsible for the delivery shall provide a full log of measurements verifying that these conditions have been met. This log shall cover the entire duration between departure from the premises of the delivering party and arrival at the system provider's work site.

In order to preserve the integrity of the system after its application, specifically during transport and installation, the system purchaser requires the system provider's expertise on the as-applied materials.

The system provider and material manufacturer shall review the system purchaser's transport and installation procedures and shall advise the system purchaser of the acceptability of the anticipated loads for the integrity of the insulation and its adhesion to the structure, item or component. This shall include an assessment of the scheduled time between application of the insulation and movement, transportation or installation of the structure, item or component.

If the system provider and material manufacturer cannot evaluate the acceptability of the transport and installation procedures, the system provider, if necessary, in consultation with the material manufacturer, shall advise the system purchaser of the maximum loads, local and global as well as the maximum torsional and bending moment that the insulation is able to withstand without incurring bulk damage or disbondment.

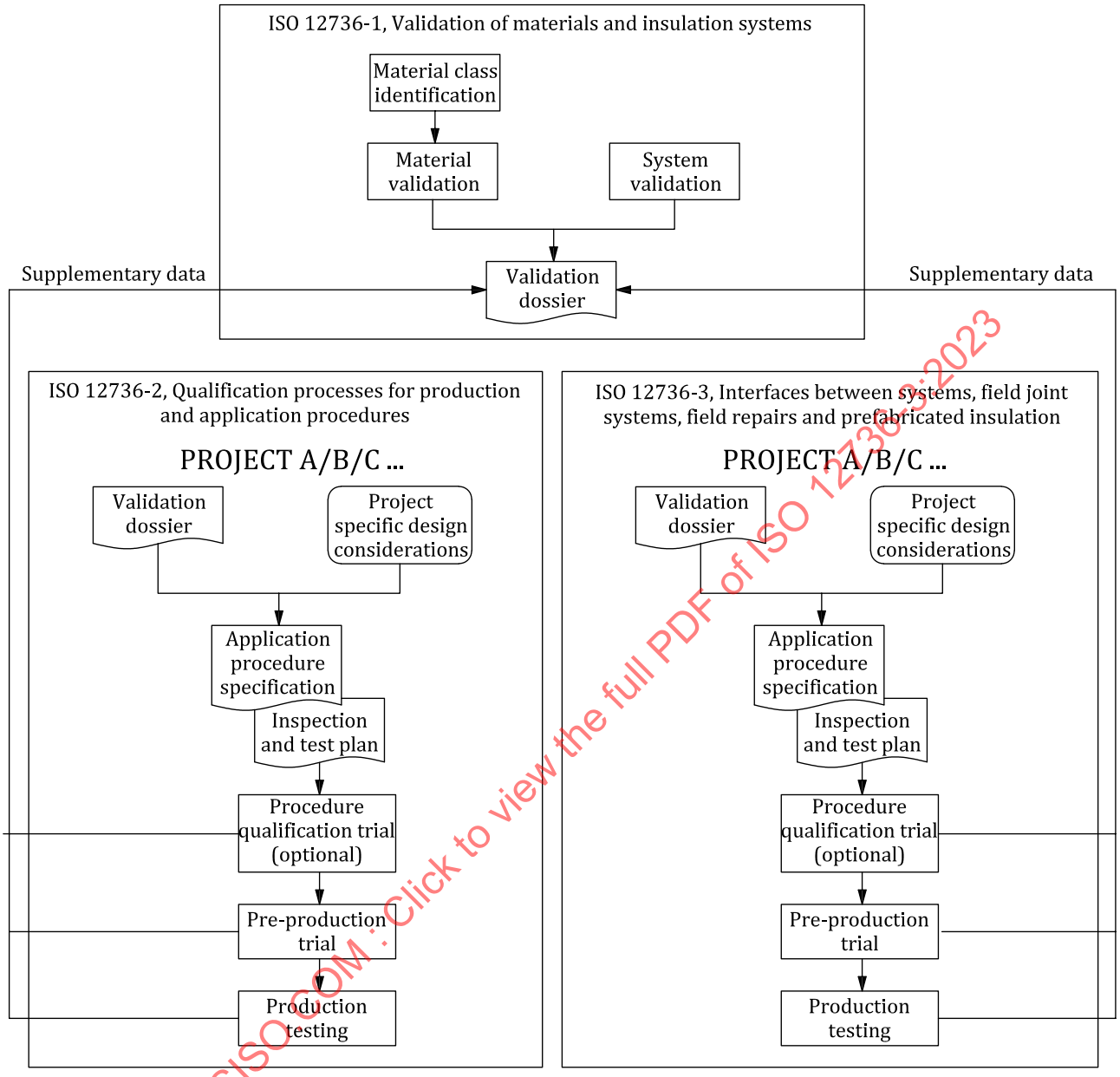
Annex A
(informative)

Guidelines for using this document

A.1 General

The intention of this annex is to provide guidelines for using this document.

The relation between this document with ISO 12736-1 and 12736-2 is represented in Figure A.1.



ISO 12736-1 focuses on requirements for validation of the material(s)and the wet thermal insulation system. The deliverable from ISO 12736-1 is a validation dossier for the wet thermal insulation system.

ISO 12736-2 focuses on the requirements for the project specific qualification, production, and repair of wet thermal insulation systems applied to pipelines in a factory and subsea equipment. The input for ISO 12736-2 is the validation dossier from ISO 12736-1. The results of the PQT, PPT and production testing are fed back into the validation dossier.

ISO 12736-3 focuses on the requirements for the project specific qualification and production of the interfaces between wet thermal insulation systems and field repairs. The input for ISO 12736-3 is the validation dossier from ISO 12736-1. The results of the PQT, PPT and production testing are fed back into the validation dossier.

Figure A.1 — Relation between this document, ISO 12736-1 and ISO 12736-2

A.2 Materials classes

Wet thermal insulation is provided by materials that are applied to the steel surface of pipes or subsea equipment. These materials may be applied in discrete layers which make up a system. In Table 1, the

known classes of materials are identified. All materials presently used for wet thermal insulation are defined by this class system.

The performance of new innovative materials and technologies, when developed at an industrial level, should be compared to the current technologies and defined in accordance with the classes presented in Table 1.

For systems with known track record, any deviations from required testing per ISO 12736-1 should be identified via a gap analysis and should be agreed between the system provider, the system purchaser and/or the end user. These deviations should be noted in the PO.

A material in a system is validated to the material maximum rated temperature and maximum rated pressure as defined by the system provider and as detailed in ISO 12736-1.

The system purchaser, on the basis of the validation dossier, can determine their own temperature and pressure limits for usage, which do not necessarily match to those given in the validation dossier either for materials and/or system.

A.3 Field joint system design

Design considerations for field joint system as well as their interfaces are addressed in Annex B.

Design considerations can be seen as advice for design of the steel structures to be insulated in order to avoid premature degradation of the insulation system or the structure itself by corrosion, and thermal and mechanical design considerations for the thermal insulation system.

A.4 Types of interfaces for field joint systems

As there are many types of interfaces that will see different types of service and loading during installation, these types of interfaces have been defined in Table 2 to allow for better identification for tests and requirements.

Interfaces between dissimilar materials can create challenges (e.g. with substrate/chamfer preparation requirements, application temperatures and adhesion). An insulation system map can be used to identify interfaces between different material types at an early phase in order that suitable application procedures and acceptance criteria can be defined, tested and mutually agreed with all parties (i.e. manufacturer, system provider, system purchaser and end user).

A.5 Qualification for production and application procedures for field joint system

This document is dedicated to the qualification and quality control of the actual production of interfaces for thermal insulation systems for a project.

For project specific qualification, a final APS and ITP are in place. The APS and ITP used for application of the wet thermal insulation system during the system validation are the basis of the final APS and ITP. An explanation of any changes made from the validation phase should be presented to the system purchaser.

In order to qualify an interface for a project, a PPT and optionally a PQT are required, which are conducted in accordance with the approved APS and ITP. If agreed with the system purchaser, the PQT can be performed immediately prior to production, in which case the PPT is included in the PQT.

The requirements for PQT, PPT and production are presented in 7.3.3, 7.3.4 and 7.3.5. For project with specific requirements outside the envelope of data contained within the validation dossier, the PQT can also be utilized to test and demonstrate project specific performance at the system purchaser's request as per 7.3.2. Examples of such project specific functional tests are simulated bend tests, stinger roller test and simulated service test.

As interfaces are highly project specific, it can be the case that no prior data exists for a specific interface, in which case it should be evaluated during a project PQT.

In addition to qualification of the process of application of the interface, the operators are required to be qualified as per 7.4.3.

A.6 Field repair

The requirements for field repair of factory applied systems or field joint systems are presented in Clause 9.

A.7 Final documentation

The requirements for final documentation for field joint systems are presented in Clause 10.

A.8 Handling, storage and transportation

Additional handling, storage and transportation requirements can be applicable for thermal insulation systems, for example if an insulated structure is transported before the system has properly cured. The requirements of the system should also be identified by the system provider to the system purchaser at an early stage in order that these can be incorporated in the handling, storage and transportation schedules.

A.9 Pre-fabricated insulation

Information regarding pre-fabricated insulation is provided in Annex D.