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

Part 2: Qualification processes for production and application procedures

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 2: Processus de qualification des modes opératoires de production et d'application

Reference number
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Foreword

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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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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 12736-2, together with ISO 12736-1 and ISO 12736-3, cancels and replaces ISO 12736:2014.

The main changes are as follows:

— clearer delineation between commercial projects and validation;

— introduction of material classes;

— elimination of system specific qualification testing tables;

— introduction of detailed thermal conductivity testing requirements;

— introduction of project specific functional tests;

— addition of Annexes A and B with guidelines for using this document and design of systems.

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 2: Qualification processes for production and application procedures

1 Scope

This document specifies requirements for project specific product and process qualification of wet thermal insulation systems applied to pipelines in a factory setting and subsea equipment in the oil and gas industries.

This document is not applicable to:

— pre-fabricated insulation;

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

— maintenance works on existing installed wet thermal insulation systems;

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

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 1183-3, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pyknometer 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 3451-1:2019, *Plastics — Determination of ash — Part 1: General methods*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

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 10474, *Steel and steel products — Inspection documents*

ISO 12736-1, *Petroleum and natural gas industries — Wet thermal insulation systems for pipelines, flow lines, equipment and subsea structures — Part 1: Validation of materials and insulation systems*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12736-1 and the following 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* (3.44) and *system purchaser* (3.45) with input from *end user* (3.11) as required.

3.2
application procedure specification
APS
quality specification document, or group of specifications, describing procedures, method, equipment, tools, etc. used for *system* (3.44) application

3.3
batch
quantity of *material* (3.25) produced in a continuous manufacturing operation using raw materials of the same source or grade

3.4
bend
permanently curved or angled section of tubular pipe

3.5
blown foam
insulation *material* (3.25) formed by incorporating a gas phase into a polymer matrix

3.6
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

3.7
chamfer
exposed pre-shaped termination of a *system* (3.43) to be interfaced with

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

3.8
construction joint
interface (3.19) where both *systems* (3.43) are identical

3.9
cool down time
time taken for a fluid contained within a *pipeline* (3.27) or *subsea equipment* (3.41) to reach a pre-determined temperature from specific start temperatures (internal and external) when flow is stopped

3.10
cutback
length of item left uncoated at each end for joining purposes

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

3.11
end user
company that owns and/or operates the *pipeline* (3.27) or *subsea equipment* (3.41)

3.12
factory applied
applied in a permanent facility

3.13
field joint
uncoated area that results when two pipe sections, or a pipe section and a *fitting* (3.14), with *cutbacks* (3.10) are assembled by welding or other methods

3.14
fitting
receptacle on a piece of *subsea equipment* (3.41), which interfaces to a *pipeline* (3.27)

3.15
high molecular weight precursor thermoset
material (3.25), 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.

3.16
inorganic syntactic foam
insulation *material* (3.25) formed by dispersing inorganic hollow particles within a polymer matrix

3.17
inspection and test plan
ITP
document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures

3.18
inspection document
document issued by the *system provider* (3.44) and attesting that the supplied *system* (3.43) is in conformity with the requirement given in the purchase order

Note 1 to entry: See also ISO 10474.

3.19
interface
location where two *systems* (3.43) meet and affect each other

Note 1 to entry: A *field joint* (3.13) *system* (3.43) has two interfaces.

Note 2 to entry: In the case of multilayer *systems* (3.43), interfaces can be made up of multiple sub-interfaces.

3.20
J-lay
method of *pipeline* (3.27) installation in which pipelines are assembled by welding together pre-insulated pipes with subsequent application of a *field joint* (3.13) *system* (3.43) 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.

3.21
jumper
short section of *pipeline* (3.27) that transfers fluid between two pieces of *subsea equipment* (3.41)

3.22
liquid precursor elastomeric thermoset
material (3.25), 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.

3.23
liquid precursor non-elastomeric thermoset
material (3.25), 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.

3.24
mainline
portion of a *pipeline* (3.27) that is not a *field joint* (3.13)

3.25
material
polymeric compound applied to the *substrate* (3.42) to be protected/insulated in units of discrete thickness (layers) to build up a *system* (3.43)

3.26
material manufacturer
entity responsible for the manufacture of one or more *materials* (3.25) utilized in a *system* (3.43)

3.27
pipeline
flowline
tubular piping used to convey fluids

Note 1 to entry: Pipeline includes *jumpers* (3.21), *risers* (3.34) and *field joints* (3.13).

3.28
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

3.29
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

3.30
pre-production trial
PPT
series of tests performed immediately before the start of production, designed to demonstrate that the requirements of the *validated* (3.49) *system* (3.43), the *procedure qualification trial* (3.31) or both are achieved

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

3.31
procedure qualification trial
PQT
series of tests designed to demonstrate that the *materials* (3.25), *system provider* (3.44), equipment and procedures can produce the *system* (3.43) in accordance with the *validation dossier* (3.50) and meet specific *project* (3.32) requirements

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

3.32
project
scope of work agreed upon contractually between *system purchaser* (3.45) and *system provider* (3.44)

3.33
R-lay
reel-lay
method of *pipeline* (3.27) installation in which long *stalks* (3.40) of pre-insulated pipes are pre-assembled by welding and application of *field joint* (3.13) *system* (3.43) onshore before being spooled onto large reels onboard the installation vessel, which then lays the pipes by unspooling the reel offshore

3.34
riser
vertical portion of a *pipeline* (3.27), including the bottom bend, arriving on or departing from an offshore surface installation

3.35
safety data sheet
SDS
DEPRECATED: material safety data sheet
document intended to provide workers and emergency personnel with procedures for handling and working with a *material* (3.25) utilized in the manufacture of the *system* (3.43) in a safe manner including physical data, first aid, etc.

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

3.36
service life
specified period of use for a *system* (3.43) in service

3.37
rough coat
modification of the outermost layer of the *system* (3.43) for increased roughness

3.38
S-lay
method of *pipeline* (3.27) installation in which pipelines are assembled by welding together pre-insulated pipes, with subsequent application of a *field joint* (3.13) *system* (3.43), 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.

3.39
solid/solid filled
insulation *material* (3.25) which systematically does not contain voids or hollow particles

3.40
stalk
continuous string of welded and *field joint* (3.13) coated pipe, which is prepared in readiness for pipe spooling onto a *R-lay* (3.33) barge

Note 1 to entry: A number of stalks will normally be required to make up a *pipeline* (3.27).

3.41
subsea equipment
components from a subsea production system, including subsea processing items and structures, meant to control hydrocarbons, not including *pipelines* (3.27)

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

3.42
substrate
surface to which a *material* (3.25) is applied or will be applied

3.43
system
all of the various *materials* (3.25) 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* (3.42) at a single point, which function together to act as a *wet thermal insulation* (3.51)

3.44
system provider
entity that is selling the applied *system* (3.43)

3.45
system purchaser
entity that is purchasing the applied *system* (3.43)

3.46
thermal conductivity
k-value
heat flow through a unit length of *material* (3.25) under the influence of a thermal gradient

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

3.47
thermoplastic
material (3.25), which is a polymeric compound that solidifies upon cooling and can flow and be reformed upon reheating

EXAMPLE Polypropylene.

3.48
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 $W \cdot m^{-2} \cdot K^{-1}$.

3.49
validation
demonstration of *material* (3.25) and *system* (3.43) performance during storage, handling and operation, within a specified envelope of use, as determined by the *system provider* (3.44)

3.50
validation dossier
collection of documentation and test reports, prepared in accordance with specific requirements, which provides detailed information on the proposed *system* (3.43), method of application, the *materials* (3.25) which form said *system* (3.43), and demonstration of *system* (3.43) performance

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

3.51
wet thermal insulation
system (3.43) that provides external corrosion protection and thermal insulation, and that is in direct contact with surrounding seawater

4 Symbols and abbreviated terms

4.1 Symbols

C_p	specific heat capacity, expressed in joules per kilograms kelvin
k	thermal conductivity, expressed in watts per meter kelvin
M	mass, expressed in grams
M_{ash}	mass of inorganic microspheres in the inorganic syntactic foam material sample, expressed in grams
M_{total}	mass of the inorganic syntactic foam material sample, expressed in grams
Q_{ave}	average value of heat flux transducers signals, expressed in microvolts
Q_{Lower}	lower plate heat flux transducer signal, expressed in microvolts
$Q_{Lower,Average}$	average lower plate heat flux transducer signal, expressed in microvolts
$Q_{Ref\ Mat\ ave}$	average value of heat flux transducers signals for reference material sample, expressed in watts per microvolts
$Q_{Ref\ Mat\ ave,i}$	average value of heat flux transducers signals for reference material sample *i*, where *i* = 1 or 2, and 1 is typically the thinner sample, expressed in watts per microvolts

Q_{Upper} upper plate heat flux transducer signal, expressed in microvolts

$Q_{Upper,Average}$ average upper plate heat flux transducer signal, expressed in microvolts

S_{Cal1} single-thickness calibration factor, proportional factor between the electrical signal and heat flow, expressed in watts per microvolts

S_{Cal2} two-thickness calibration factor, proportional factor between the electrical signal and heat flow, expressed in watts per microvolts

$S_{Cal,Lower}$ lower plate calibration factor, expressed in watts per microvolts

$S_{Cal,Upper}$ upper plate calibration factor, expressed in watts per microvolts

R_{cal} calibration contact resistance, expressed in metre square degrees kelvin per watt

$2R_{Cal,Lower}$ lower plate calibration contact resistance, expressed in metre square degrees kelvin per watt

$2R_{Cal,Upper}$ upper plate calibration contact resistance, expressed in metre square degrees kelvin per watt

ΔT average temperature difference across the sample(s), expressed in degrees Celsius

T_g glass transition temperature, expressed in degrees Celsius

T_{Lower} lower plate temperature, expressed in degrees Celsius

T_{Upper} upper plate temperature, expressed in degrees Celsius

V_{ash} volume of inorganic microspheres in the inorganic syntactic foam material sample, expressed in cubic centimetres

$V_{polymer}$ volume of polymer in the inorganic syntactic foam material sample, expressed in cubic centimetres

V_{total} volume of the inorganic syntactic foam material sample, based on the measured M_{total} and ρ_{total}, expressed in cubic centimetres

V_{void} volume of entrapped air in the inorganic syntactic foam material sample, expressed in cubic centimetres

W_{ash} mass ratio of inorganic microspheres in the inorganic syntactic foam material sample as per Formula (E.1), dimensionless

$W_{polymer}$ mass ratio of polymer in the inorganic syntactic foam material sample, calculated as per Formula (E.4), dimensionless

x_{ave} average measured thickness of the sample, expressed in metres

$x_{Ref Mat ave}$ average thickness of the reference material sample, expressed in metres

$x_{Ref Mat ave,i}$ average thickness of reference material sample i, where i = 1 or 2, and 1 is typically the thinner sample, expressed in metres

$\lambda_{Ref Mat}$ thermal conductivity of the calibration reference material, expressed in watts per metre kelvin

$\lambda_{sampleB1}$ single thickness sample thermal conductivity, Test Type B1, expressed in watts per metre kelvin