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Determination of the resistance to cryogenic spill of insulation materials —

Part 2: **Vapour exposure**

Détermination de la résistance des matériaux d'isolation thermique suite à un refroidissement cryogénique —

Partie 2: Phase vapeur

Reference number
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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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 9, *Liquefied natural gas installations and equipment*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 282, *Installation and equipment for LNG*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 20088 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.

Introduction

The test is intended to be, as far as practicable, representative of a potential accidental pressurised release of cryogenic LNG material manufactured in industrial plants. The test includes

a) release from of cryogenic liquid under pressure, and

b) scenarios where the conditions in the jet characterized predominantly by gaseous exposure.

Liquid jet release may be formed upon release of Liquified Natural Gas (LNG) from process equipment operating at pressure, e.g., some liquefaction processes utilise 40 - 60 bar operating pressure. However, at specific distances from the release point, it is expected that the liquid fraction will diminish such that there is practically no effect from liquid cooling in the stream.

This test is designed to give an indication of how cryogenic spill protection materials will perform in a sudden exposure to cryogenic jet where it is expected that little or no liquid fraction is present.

The dimensions of the test specimen might be smaller than typical items of structure and plant. The liquid cryogenic jet mass flow rates can be substantially less than that which might occur in a credible event. However, individual thermal loads imparted to the cryogenic spill protection materials, from the cryogenic release defined in the procedure described in this document, have been shown to be representative of areas exposed to a cryogenic LNG accidental release where little or no liquid is present.

Determination of the resistance to cryogenic spill of insulation materials —

Part 2:
Vapour exposure

CAUTION — The attention of all persons concerned with managing and carrying out cryogenic spill testing is drawn to the fact that liquid nitrogen testing can be hazardous and that there is a danger of oxygen condensation (risk of explosion), receiving a 'cold burn' and/or the possibility that harmful gases (risk of anoxia) can be evolved during the test. Mechanical and operational hazards can also arise during the construction of the test elements or structures, their testing and disposal of test residues.

An assessment of all potential hazards and risks to health shall be made, and safety precautions shall be identified and provided. Appropriate training and Personal Protection Equipment (PPE) shall be given to relevant personnel.

The test laboratory is responsible for conducting an appropriate risk assessment in order to consider the impact of liquid and gaseous nitrogen exposure to equipment, personnel and the environment.

1 Scope

This document describes a method for determining the resistance of Cryogenic Spill Protection (CSP) systems to vapour generated from a cryogenic liquid release where the liquid content is practically zero. It is applicable where CSP systems are installed on carbon steel.

The test provided in this document is not applicable to high pressure cryogenic liquid releases that can be found in refrigeration circuits and in LNG streams immediately post-liquefaction.

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 22899-1, *Determination of the resistance to jet fires of passive fire protection materials — Part 1: General requirements*

3 Terms and definitions

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

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

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

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

3.1
cryogenic spill protection
CSP
coating or cladding arrangement, or free-standing system which, in the event of a cryogenic jet release, provides insulation to restrict the heat transfer rate from the substrate

3.2
limiting temperature
minimum temperature that the equipment, assembly or structure that is protected can reach

3.3
nozzle
assembly from which the cryogenic liquid is released as a jet

3.4
sponsor
person or organization who/which requests a test

3.5
specimen owner
person or company that holds or produces a material to test

3.6
cooling power
amount of heat transferred per unit area per unit time from a surface (W/m^2)

4 Test configurations

The test is conducted with the plate specimen placed vertically. The material to be tested is exposed to a liquid nitrogen release under pressure where the liquid fraction is practically zero (i.e. gaseous exposure). Due to safety concerns, the test should only be performed outside unless there are sufficient safeguards implemented to mitigate the confined space and LN_2 (liquid nitrogen) safety risks.

5 Construction of the test apparatus and substrates

5.1 Apparatus

The key items required for the test are the following.

5.1.1 Nozzle and cryogenic liquid feed assembly, where the temperature and pressure of the liquid can be measured at the point the liquid enters the nozzle.

5.1.2 Environmental chamber, (3-sided plastic tunnel) up to a length of 6 m.

5.1.3 Liquid nitrogen, of sufficient volume for the test duration supplied from a tanker capable of offload via a pump to generate the required stable pressure at the nozzle.

5.1.4 Carbon steel specimen, protected with CSP.

5.1.5 Thermocouples, to determine the temperature as a function of time in the steel specimen and the atmosphere immediately in front of the test specimen.

5.2 Materials and tolerances

The steel grade used for the test shall be recorded. Where welded, construction shall be representative or the as-built structure. All dimensions are in millimetres and, unless otherwise stated, the following tolerances shall be used.

— whole number ±1,0 mm;

— decimal to point ,0 ±0,4 mm;

— decimal to point ,00 ±0,2 mm;

— angles ±0’ 30”;

— radius ±0,4 mm.

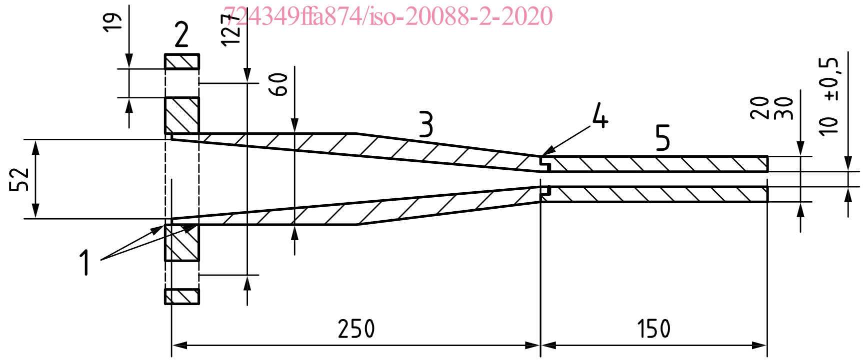
Test specimen shall be a structural steelwork test specimen as described in ISO 22899-1.

5.3 Release nozzle

5.3.1 Nozzle construction

Liquid nitrogen is released towards the specimen from a nozzle. An example of a suitable nozzle has the following characteristics. The nozzle of length 150 mm, constructed from a stainless-steel pipe of nominal diameter 10 mm ± 0,5 mm and of outside diameter 20 mm to 30 mm, giving a wall thickness between 5 mm and 10 mm. The nozzle shall not be tapered and the end shall be clean cut, with no chamfering of pipe walls. The nozzle is fed with liquid nitrogen from a DN50 diameter schedule 40S stainless steel pipe, with a machined section reducing in internal diameter to 10 mm over a 250 mm length as shown in Figure 1.

Dimensions in millimetres



Key

1 welds

2 slip-on flange

3 reducing section

4 butt weld

5 straight-sided nozzle

Figure 1 — Feed pipe and nozzle construction

5.3.2 Nozzle position

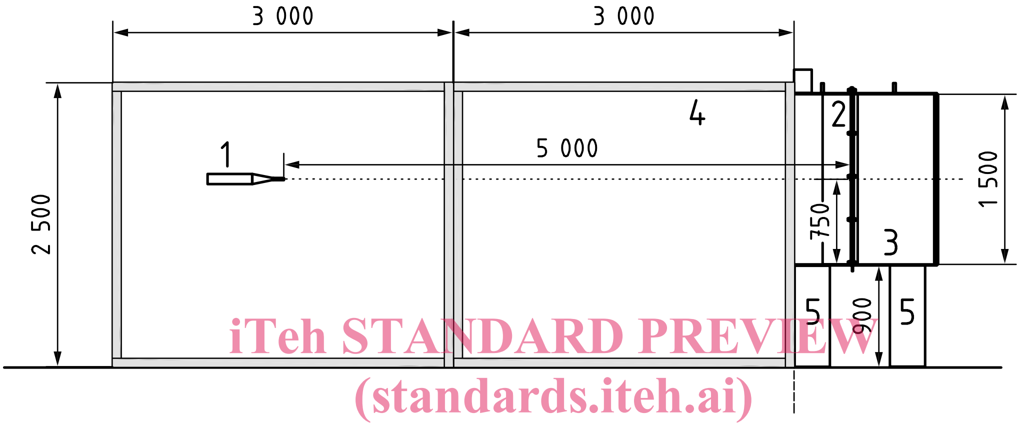
The nozzle shall be positioned horizontally in front of the test specimen, aligned with the centre point such that the cryogenic release impacts normal to the plate specimen as shown in Figure 2. The tip of the nozzle shall be located to give the required cooling power described in Clause 8.

EXAMPLE 5 000 mm ± 10 mm from the protected surface of the test specimen when the average outlet pressure is 8 barg (0,8 MPa) [standard deviation of 0,8 barg (0,08 MPa)] and liquid temperature lower than −170 °C (An example of specimen support and side view configuration is shown in Figure 2).

5.4 Test assembly supports

The test assembly shall be supported using material resistant to cryogenic temperatures.

Dimensions in millimetres



Key

1 release nozzle (piping omitted for clarity

2 recirculation chamber (insulated on back surface)

3 protective chamber

4 environmental chamber

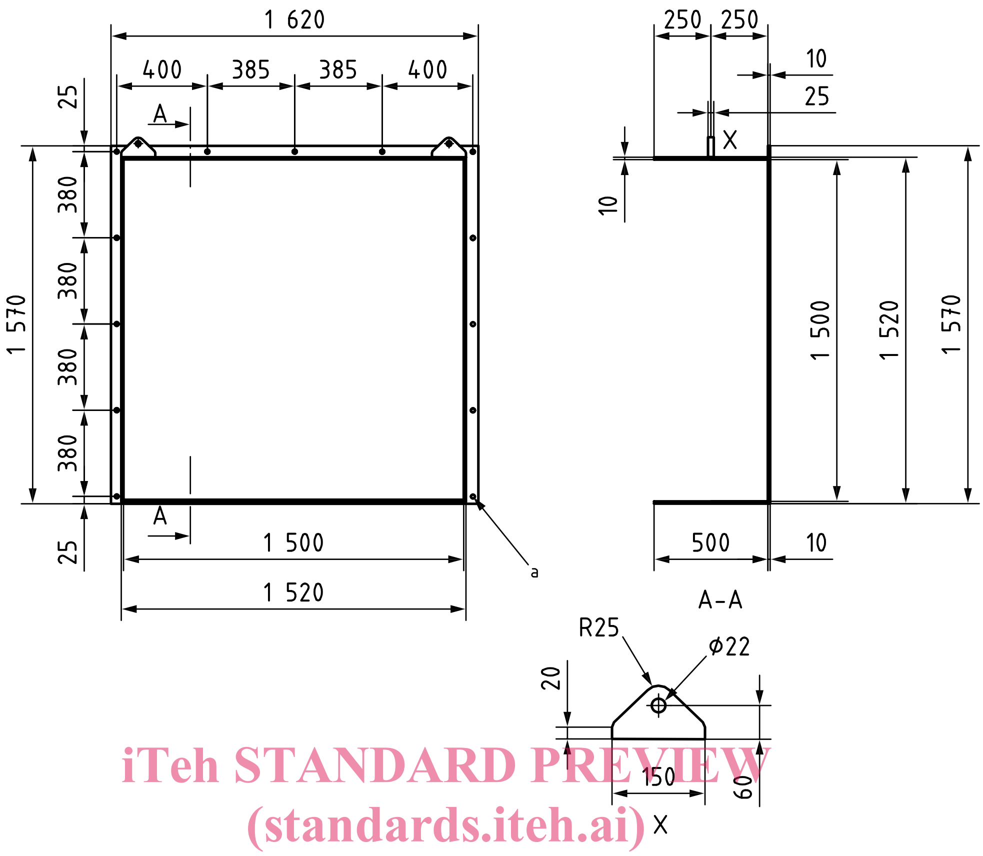
5 recirculation chamber and protective chamber supports

Figure 2 — Example of vapour test (side view)

5.5 Test specimen and recirculation chamber

It shall be the primary test piece to which the CSP is applied to the internal surface of the box. Dimension shall be as described in ISO 22899-1. To provide extra support and stability, the protective chamber shall be attached to the rear of the recirculation chamber as shown in Figure 3. Insulation board (U Value maximum 1,25 $W/m^2.K$) shall be affixed to the rear of the recirculation chamber.

Dimensions in millimetres



a Thirteen holes drilled.

Figure 3 — Recirculation chamber and test sample

6 Cryogenic spill protection materials

6.1 General

CSP systems generally come in two forms; wet applied materials/coatings and preformed systems. Preformed systems include boards, tiles, blankets, sandwich panels, etc. and are characterized by systems that include joints and fixings. Preformed systems can be used in conjunction with wet applied materials.

The application/installation methodology, including any necessary surface preparation, reinforcement, thickness, top-coats, field joints, etc. shall be determined by the sponsor and/or specimen owner and details provided for inclusion within the test report.

The thickness shall be measured at the positions specified in Figure 4 for sprayed applied systems. The measurement positions indicated shall be regarded as approximate. For preformed systems, thickness shall be measured for the protective layer at locations proximal to those presented in Figure 4. If there are clear signs of thinning or thickening at positions away from those indicated for measurement, additional measurements should be taken.