
**Fire test procedures for divisional
elements that are typically used in oil,
gas and petrochemical industries —**

**Part 1:
General requirements**

*Méthodes d'essais au feu des éléments de séparation habituellement
utilisés dans les industries pétrolières, gazières et pétrochimiques —*

Partie 1: Exigences générales

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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).

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

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

A list of all parts in the ISO 20902 series can be found on the ISO website.

Introduction

This document describes a test procedure to assess the protection afforded by fire protection materials and systems to divisional elements. It gives an indication of how fire protection materials perform when exposed to a set of specified fire conditions.

The classification of divisional elements (bulkheads and decks) in the marine industry (i.e. ships as defined by IMO, SOLAS) is primarily undertaken in accordance with classification society procedures through testing to the FTP codes, IMO resolution 307(88), formerly IMO A.754(18). Historically FTP code compliant test evidence has been used to support non-marine applications by implementing hydrocarbon time temperature regime profiles. To reduce the burden on industry, this document is compatible with MSC 307(88) where relevant, allowing testing to both IMO and ISO test procedures for specific classification ratings.

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Fire test procedures for divisional elements that are typically used in oil, gas and petrochemical industries —

Part 1: General requirements

1 Scope

This document specifies a test procedure for determining the fire resistance of divisional elements with a fire protection system, when exposed to cellulosic or hydrocarbon-pool type fire conditions. It is applicable to divisional elements intended for non-marine applications but suitable for offshore fixed and mobile installations.

The test data obtained, when used in conjunction with published fire test standards, permit subsequent classification of the divisional elements based on the duration of their performance against specified criteria.

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 834-1:1999, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 13943 and the following apply.

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

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 bulkhead

vertical divisional element typically used in the marine industry

3.2 deck

horizontal divisional element typically used in the marine industry

3.3 divisional element

element that is intended for use in maintaining separation between two adjacent areas of facilities within the oil and gas industry, and which may or may not be load bearing

**3.4
critical temperature**

temperature at which the yield strength of the material is reduced to the minimum allowable under operating loading conditions

**3.5
structural core**

primary component or components of the divisional element responsible for providing load bearing capability or integrity (as appropriate), excluding additional components provided for insulation purposes

Note 1 to entry: This typically consists of a metallic plate (either flat or corrugated) with stiffeners.

4 Principle

The method provides an indication of how divisional elements protected with fire protection systems or materials perform when they are exposed to fire conditions specified by furnace time-temperature curves. It simulates the thermal and mechanical loads to a divisional element engulfed in fire, through the use of furnace testing and exposed external loads, if necessary. To maintain compatibility with both prescriptive regulations and performance-based requirements derived from risk-analysis, it is non-prescriptive in terms of failure criteria and thermal loads. Classification procedures are given to facilitate the correct interpretation of test results derived in compliance with this standard.

5 Test specimen

5.1 General

The test specimen shall be representative of the construction for which classification is required. Test specimens intended to satisfy the requirements of the FTP Code, IMO Resolution MSC 307(88), Annex 1, Fire Test Procedures, Part 3, "Test for "A" (et al.) class divisions" are subject to additional requirements relating to their design and construction as described within the above resolution. Additional requirements within MSC 307(88) beyond the scope of this document shall be considered compatible with the requirements herein, i.e. tests may comply with both MSC 307(88) and this document.

Test results shall only be applicable in the orientation in which they have been tested; therefore, vertical divisional elements shall be tested vertically mounted, and horizontal divisional elements shall be tested horizontally mounted.

Vertical divisional elements shall be tested in the most onerous manner, which is considered to be with the insulation on the unexposed face and the stiffeners also on that side. For "restricted application", i.e. where the fire hazard has been identified as being from the insulated side only, the vertical divisional element can be tested with the insulation on the exposed face and with the stiffeners also on that side.

If approval of a vertical divisional element is being sought involving fire-hazard from both sides and the use of "double-sided application" of the insulation, the thickness of the insulation being equal on both sides of the structural core, it shall be tested with the stiffeners on the unexposed side of the vertical divisional element, otherwise it shall be tested with the side with the thinnest thickness of insulation on the exposed face.

5.2 Vertical divisional element dimensions

The minimum overall dimensions of the test specimen, including the perimeter details at the top, bottom and vertical edges, are 2 440 mm width and 2 500 mm height. When the maximum overall height in practice is less than that given above, then the test specimen shall be of the maximum height to be used in practice and the tested dimensions reported.

The overall dimensions of the structural core shall 20 mm less in both the width and the height than the overall dimensions of the specimen. Any joints in the plating shall be fully welded, at least from one side.

Flat bar of thickness 6 mm shall be welded across the edges of the structural core perpendicular to the stiffeners or the corrugation flute direction. The flat bars shall extend the full length and width of corrugation or stiffeners and shall not protrude beyond the extents of the structural core.

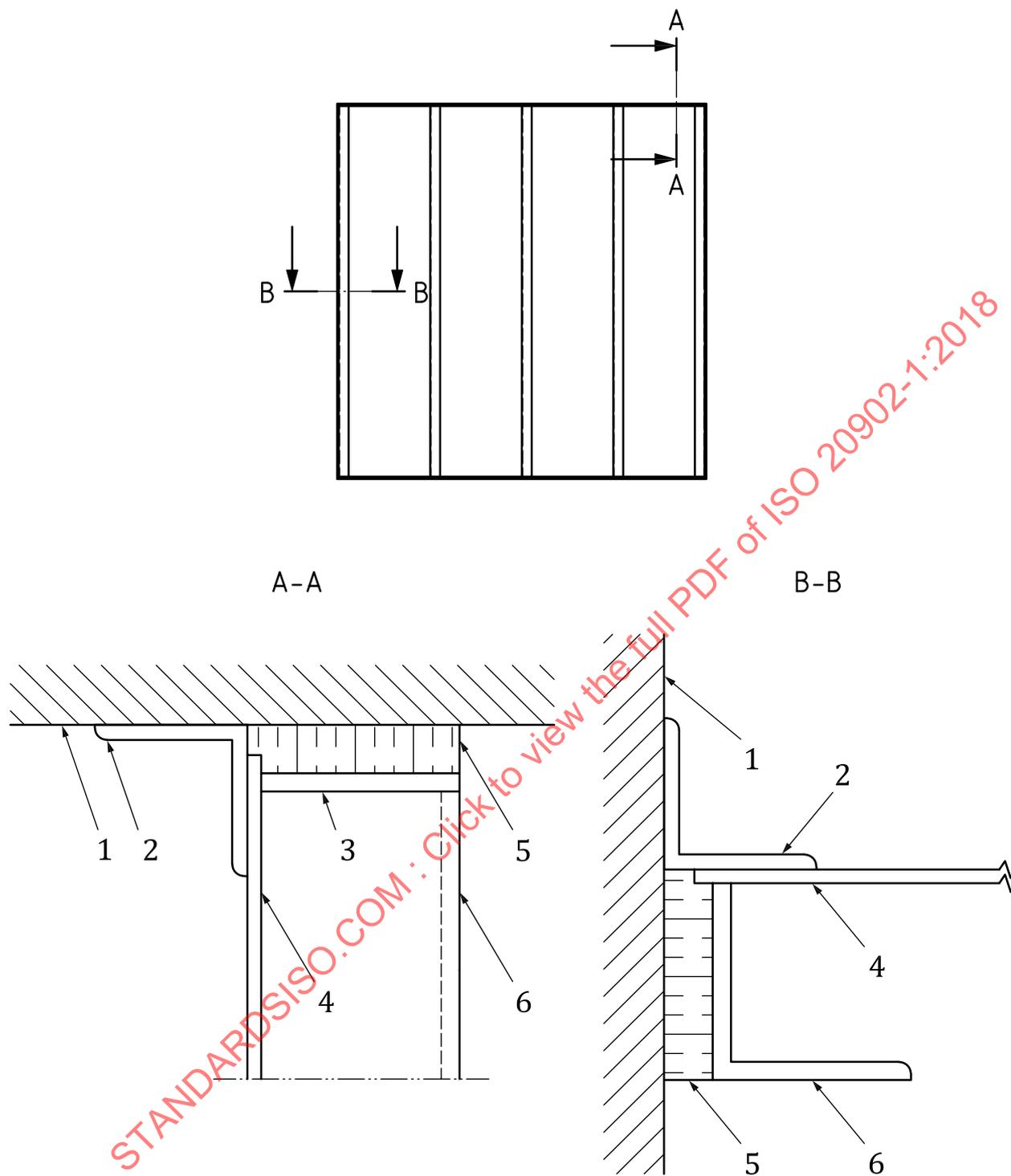
Structural cores constructed from flat plate with stiffeners may alternatively weld the flat bar across the top and bottom of the stiffeners. In this case, a minimum clearance of 16 mm shall be provided between the furnace and any stiffeners or flat bar.

Mineral wool packing shall be used to fill any clearance and gaps present.

The structural core shall be fixed to the furnace by means of L-shaped fixing cleats as shown in [Figure 1](#). Cleats shall be fixed to the structural core by continuous weld, and fixed to the furnace frame by bolt or weld. Cleats shall be positioned adjacent to the ends of each stiffener if present, or at 1 000 mm spacing if stiffeners are not present.

Examples of test specimen construction are given in [Annex A](#).

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Key

- 1 furnace frame
- 2 fixing cleat, 50 mm × 50 mm × 5 mm L-shaped angle, 100 mm length, bolted or welded to frame
- 3 flat bar, 6 mm
- 4 structural core
- 5 mineral wool packing to fill clearance
- 6 stiffener (if present)

Figure 1 — Structural steel core for a vertical divisional element

5.3 Horizontal divisional element dimensions

The minimum overall dimensions of the test specimen, including the perimeter details at all the edges, are 2 440 mm width and 3 040 mm length. When the maximum dimensions in practice are less than that given above, the test specimen shall be of the maximum size to be used in practice and the tested dimensions shall be reported.

The overall dimensions of the structural core shall be 20 mm less in both the width and length than the overall dimensions of the specimen. Any joints in the plating shall be fully welded, at least from one side.

Flat bar of thickness 6 mm shall be welded across the edges of the structural core perpendicular to the stiffeners or the corrugation flute direction. The flat bars shall extend the full length and width of corrugation or stiffeners and shall not protrude beyond the extents of the structural core.

Structural cores constructed from flat plate with stiffeners may alternatively weld the flat bar across the top and bottom of the stiffeners. In this case, a minimum clearance of 16 mm shall be provided between the furnace and any stiffeners or flat bar.

Mineral wool packing shall be used to fill any clearance and gaps present.

The structural core shall be fixed to the furnace by means of L-shaped fixing cleats as shown in [Figure 1](#). These shall be fixed to the structural core by continuous weld, and fixed to the furnace frame by bolt or weld. Cleats shall be positioned adjacent to the ends of each stiffener if present, or at 1 000 mm spacing if stiffeners are not present.

Examples of test specimen construction are given in [Annex A](#).

5.4 Design

Where the construction incorporates panels, the specimen shall be constructed such that at least one of the panels is of full width and this, or these, shall be positioned such that both its/their longitudinal edges are jointed to an adjacent panel and are not secured to the restraint frame.

The overall dimensions of the panel insulation system, including the perimeter details at all the edges, shall be 20 mm greater in each direction than the equivalent dimensions of the structural core.

Where the insulation consists of blankets, the blankets shall be arranged so that not less than two transverse joints between blankets are included. The joints shall be located not less than 600 mm from the edges of the divisional element.

5.5 Description

The test sponsor shall provide full construction details of the test specimen in the form of drawings (including a detailed schedule of components) and method of assembly, such that the laboratory is able to confirm agreement between the actual specimen and the drawings and specifications prior to the test. The drawings shall include dimensions and details of the thicknesses of insulation used in way of the plating and the stiffeners, the method of securing the insulation system and details of the components used for this purpose, details of joints, detail of fittings, connections, air gaps and all other details.

5.6 Material specification

Prior to the test, all necessary information for each of the materials used in the construction of the test specimen shall be submitted to the laboratory by the applicant in accordance with ISO 834-1:1999, 7.5 [and where applicable, MSC 307 (88)].

5.7 Control measurements

5.7.1 Thickness

The thickness of each non-spray applied material and combination of non-spray applied materials shall be $\pm 10\%$ of the value stated as the nominal thickness when measured by using a suitable gauge or callipers.

The thickness of a sprayed insulation material shall be measured using a suitable probe at positions adjacent to each of the unexposed-face thermocouples. Measurements should be taken by non-destructive methods such as ultrasonic or eddy current depth gauges. Equipment should be described in the report with the method of calibration. Care should be taken to ensure mesh reinforcement does not lead to a false reading. If necessary, the thickness may be measured by drilling a 1,5 mm hole and then using a depth gauge. For cementitious sprays, a thickness gauge may be used with the measurement needle penetrating the soft sprayed material.

For reactive coatings and other spray applied fire protection materials, the average primer thickness (if present) shall be measured first and subtracted from the total average primer and reactive coating thickness. The resulting permitted thickness tolerances, excluding primer and topcoat (assuming normal distribution of measured thickness), shall be as follows:

- a minimum of 68 % of readings shall be within $\pm 20\%$ of the mean;
- a minimum of 95 % of readings shall be within $\pm 30\%$ of the mean;
- all readings shall be within $\pm 45\%$ of the mean.

If the thickness is outside these limits, the test specimens shall be adjusted to comply with the above requirements.

Authorities having jurisdiction may require more stringent thickness measurement position requirements and tolerances than those given in this clause. Such additional requirements, while not required for compliance with this document, should be considered compatible with this document.

The tolerances stated above are applicable to mineral-fibre based materials and epoxy intumescent. For other types of material or systems, alternative measurement control limits may be appropriate and these shall be agreed by the testing laboratory and the approval authorities under whose jurisdiction the system may fall when used in practice.

5.7.2 Density

The density of fibre-type materials, mineral wool or any similar compressible material shall be related to the nominal thickness and the density of each material used in the test specimen shall be $\pm 10\%$ of the value stated as the nominal density.

5.8 Conditioning

5.8.1 General

The test specimen shall be protected against adverse environmental conditions until the time of the test. The requirements of ISO 834-1:1999, 7.4 shall be applied.

5.8.2 Verification

Where applicable, the condition of the test specimen can be monitored and verified by use of special samples for the determination of moisture content of constituent materials, as appropriate. These samples shall be so constructed as to represent the loss of water vapour from the specimen by having similar thicknesses and exposed faces. They shall have minimum linear dimensions of 300 mm by 300 mm and a minimum mass of 100 g. Constant weight shall be considered to be reached when two

successive weighing operations, carried out at a minimum interval of 24 h, do not differ by more than 0,3 % of the mass of the reference specimen or 0,3 g, whichever is the greater.

Other reliable methods of verifying that the material has reached equilibrium moisture content may be used by the testing laboratory.

When the test specimen incorporates encapsulated materials, it is important to ensure that these materials have reached an equilibrium moisture content prior to assembly, and special arrangements shall be made with the applicant for the test to ensure that this is so.

When the test specimen incorporates encapsulated materials, the requirement relevant to equilibrium moisture in this clause shall apply.

5.9 Mounting of test specimens

All test specimens shall be mounted within substantial concrete, or concrete or masonry-lined frames, which are capable of providing a high degree of restraint to the expansion forces generated during the tests. The concrete or the masonry shall have a density between 1 600 kg/m³ and 2 400 kg/m³. The concrete or masonry lining to a steel frame shall have a thickness of at least 50 mm.

The rigidity of the restraint frames shall be evaluated by applying an expansion force of 100 kN within the frame at mid-width between two opposite members of the frame and measuring the increase in the internal dimensions at these positions. This evaluation shall be conducted in the direction of the divisional element stiffeners, and the increase of the internal dimension shall not exceed 2 mm.

The structural core to a divisional element shall be fixed into the restraint frame and sealed around its perimeter as shown in [Figure 1](#). Steel spacers, with an approximate thickness of 5 mm, may be inserted between the fixing cleats and the restraint frame if the laboratory finds this necessary.

When the structural core of a divisional element is to be exposed to the heating conditions of the test, i.e. when the fixing cleats are on the exposed side of the structural core, then a 100 mm wide perimeter margin adjacent to the restraint frame shall be insulated such that the fixing cleats and the edges of the structural core are protected from direct exposure to the heating conditions. In no other situations, irrespective of the type of test specimen, shall the perimeter edges be protected from direct exposure to the heating condition.

5.10 Examination of the test specimen

The laboratory shall verify the conformity of the test specimen with the drawings and method of assembly provided by the applicant (see [5.5](#)), and any area of discrepancy shall be resolved prior to commencement of the test.

On occasion it may not be possible to verify the conformity of all aspects of the specimen construction prior to the test and adequate evidence may not be available after the test. When it is necessary to reply on information provided by the applicant then this shall be clearly stated in the test report. The laboratory shall nevertheless ensure that the design of the test specimen is fully appreciated and that the construction details are accurately recorded in the test report.

Photographs of the test specimen shall be taken before the test.

6 Instrumentation

6.1 General

The instrumentation of the furnace and the instrumentation of the test specimen shall be in accordance with ISO 834-1:1999, except where amended by [Clause 6](#).

6.2 Ambient temperature thermocouple

A thermocouple shall be used to indicate the ambient temperature within the laboratory in the vicinity of the test specimen both prior to and during the test period. The thermocouple shall be of nominal 3 mm diameter, mineral insulated, stainless steel type K. The measuring junction shall be protected from radiated heat and draught. The ambient temperature shall be monitored at a distance of between 1 m and 3 m horizontally away from the unexposed face of the test specimen.

6.3 Furnace temperature thermocouples

6.3.1 Design

The furnace thermocouples shall be plate thermometers, constructed in accordance with ISO 834-1:1999.

Before the plate thermometers are first used, the complete plate thermometer shall be aged by immersing in a pre-heated oven at 1 000 °C for 1 h, or by exposure in a fire resistance test furnace for 90 min under the standard temperature/time.

When a plate thermometer is used more than once, a log of its use shall be maintained indicating, for each use, the checks made and duration of use. The thermocouple and the insulation pad shall be replaced after 50 h exposure in the furnace.

6.3.2 Number

At least six furnace thermocouples shall be provided for the specimens meeting the minimum dimensions specified in [Clause 5](#). For specimens larger than those specified in [Clause 5](#), additional thermocouples shall be provided in the proportion of one per 1,5 m² of the specimen area.

6.3.3 Positioning

The thermocouples employed to measure the temperature of the furnace shall be uniformly distributed so as to give a reliable indication of the average temperature in the vicinity of the specimen. At the commencement of the test, the measuring junctions shall be 100 mm from the face of the specimen and they shall be maintained at a distance of 50 mm to 150 mm during the test. The method of support shall ensure that thermocouples do not fall away or become dislodged during the test. Where it is convenient to pass thermocouple wires through the test construction, then the steel support tube shall not be used. The plate thermometers shall not be located at positions within the furnace where they are subject to direct flame impingement.

The plate thermometer shall be orientated so that side A faces the back wall of the wall furnace and the floor of the horizontal furnace.

The thermocouple wire shall be either continuous to the recording instrument or suitable compensating wire shall be used with all junctions maintained as near as possible at ambient temperature conditions.

6.4 Furnace pressure sensors

The mean value of the furnace pressure shall be measured using one of the designs of sensing heads described in ISO 834-1:1999, 5.5.2.

6.5 Unexposed-face temperature thermocouples

6.5.1 Design

The temperature of the unexposed surface shall be measured by means of disc thermocouples of the type described in ISO 834-1:1999, 5.5.1.2.

6.5.2 Preparation of surfaces to receive thermocouples

Steel surface finishes shall be removed and the surface cleaned with a solvent. Loose rust and scale shall be removed by wire brush.

Irregular surfaces shall be prepared by a suitable abrasive paper to ensure an area, not greater than 2 500 mm², of adequate adhesive bond for each thermocouple. The material removed shall be the minimum to provide an adequate bonding surface. Where the surface cannot be smoothed, fillings shall be used of minimum quantity to provide a suitable surface. The filling shall comprise a ceramic cement and when the filled surface is dry it shall be smoothed, if necessary with abrasive paper.

6.5.3 Fixing of thermocouples

6.5.3.1 Steel

The insulating pad with the thermocouple fitted shall be bonded to the cleaned surface of the steel using a "water-based ceramic cement" produced by integrating the components to form a high-temperature-resistant adhesive. The adhesive shall be of such a consistency that no mechanical aid is necessary for retention purposes during the drying process, but, where difficulty in bonding is experienced, retention by adhesive tape may be employed provided that the tape is removed sufficiently long in advance of the test to allow complete drying of the adhesive. Care is required in the removal of the tape to ensure that the insulating pad is not damaged. If the thermocouple pad is damaged when the tape is removed, then the thermocouple shall be replaced.

6.5.3.2 Mineral wool

The thermocouples with insulating pads fitted shall be arranged in such a way that if a surface wire mesh is present it may aid retention, and in all cases the bond to the fibrous surface shall be made using a "contact adhesive". The nature of the adhesive necessitates a drying time before mating surfaces are put together, thus removing the need for external pressure.

In all cases of adhesive bonding, the adhesive shall be applied in a thin film sufficient to give an adequate bond and there shall be a sufficient lapse of time between the bonding of the thermocouples and the test for stable moisture conditions to be attained in the case of the ceramic adhesive and evaporation of the solvent in the case of the "contact adhesive".

Where gluing is not possible, pins, screws or clips which are only in contact with those parts of the pad which are not over the (copper) disc shall be used. (Example: U-shaped clips approximately 30 mm × 15 mm × 30 mm × 0,5 mm, which are in contact only with the extreme corners of the pad. Heat transfer to the copper disc is negligible.)

6.5.3.3 Mineral fibre spray

Thermocouples shall not be fitted until the insulation has reached a stable moisture condition. In all cases the bonding technique for steel shall be used and where a surface wire mesh is present the thermocouples shall be affixed to the insulation in such a way that the wire mesh aids retention.

6.5.3.4 Vermiculite/cement type spray

The technique specified for wet fibrous spray shall be employed.

6.5.3.5 Boards of fibrous or mineral aggregate composition

The bonding technique for steel shall be used.

6.5.3.6 Superimposed finishes

If a material or panel is only tested with a superimposed finish, it shall be removed locally over an area as small as possible to allow fixing of the thermocouples to the non-combustible part or insulation material, if present.

6.6 Positioning of thermocouples on the specimen

6.6.1 General

Test specimens intended to comply with the requirements of IMO MSC 307(88) may have requirements that vary from those described in this section.

6.6.2 Structural core temperature thermocouples

Nine thermocouples shall be fixed to the core material. They shall be nominally positioned in a 3×3 grid, with equal spacing between the thermocouples and the edge of the structural core. Thermocouple positions within 100 mm of a stiffener shall be moved horizontally to a distance of 100 mm from the stiffener, as shown in [Figure 2](#). Corrugated structural cores shall ensure at least three thermocouples are on the inner flutes and three are on the outer.

Where the exposed face insulation system includes joints, two additional thermocouples shall be fitted, each placed over a vertical (longitudinal) joint. For vertical divisional elements, they shall be placed at 0,75 height of the specimen, for horizontal divisional elements they shall be placed at mid-length.

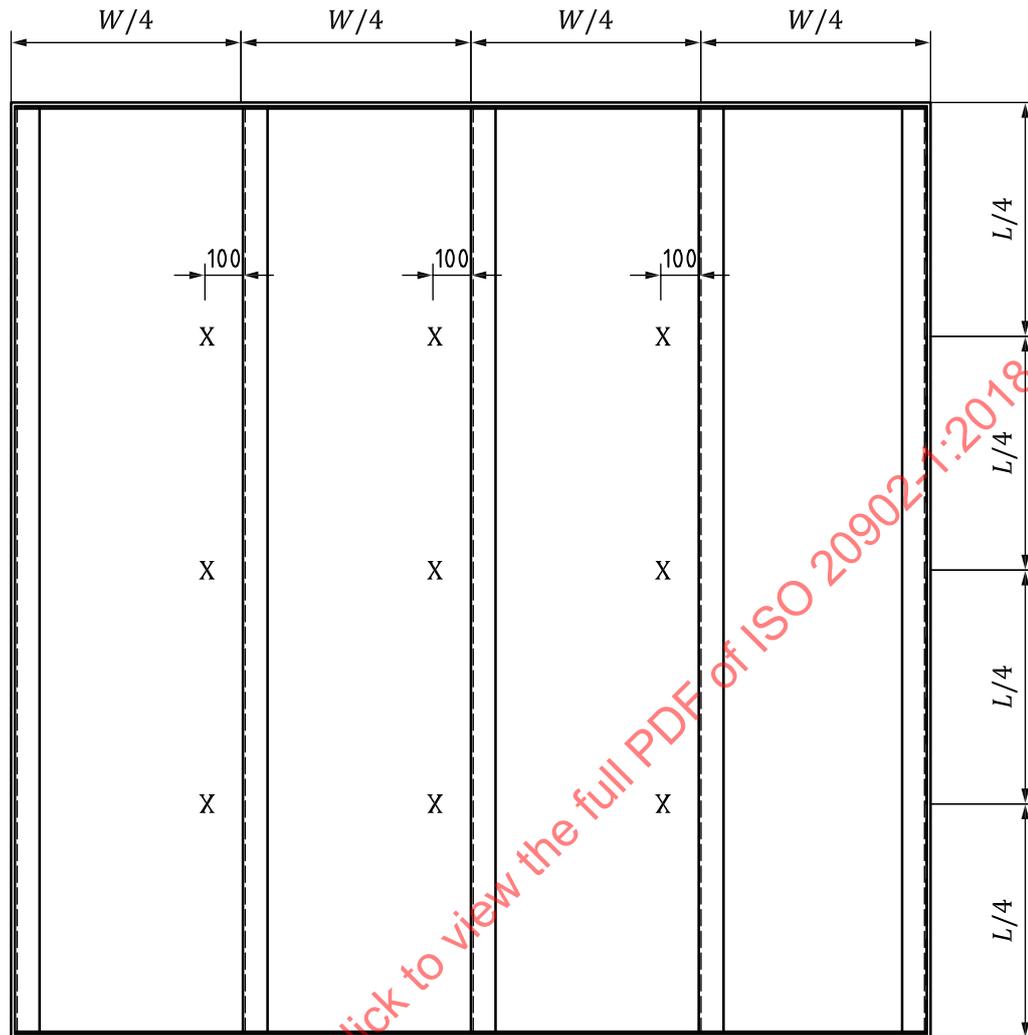
When a construction has two differently orientated joint details, for example normal to each other, then two thermocouples additional to those already described above shall be used, one on each of two intersections.

When a construction has two different types of joint detail, then two thermocouples shall be used for each type of joint.

Additional thermocouples, at the discretion of the testing laboratory, shall be fixed over special features or specific construction details if it is considered that temperatures higher than those measured by the thermocouples listed above may result.

Additional thermocouples used shall, where possible, be positioned in the upper half of the specimen.

The thermocouples shall be fixed so that their hot junctions are attached to the appropriate positions by suitable means, including peening into the structural core. The wires shall be prevented from becoming hotter than the junction. The first 50 mm shall be in an isothermal plane.



Key

- X thermocouple
- W width
- L length (or height)

Figure 2 — Position of unexposed face thermocouples (insulated face to the laboratory)

6.6.3 Stiffeners

Test specimens with stiffeners shall be fitted with a minimum of four further thermocouples, one placed on each of the stiffeners excluding edge stiffeners. For vertical divisional elements they shall be placed at 0,75 height of the specimen, for horizontal divisional elements they shall be placed at mid-length.

6.6.4 Unexposed face thermocouples

When the unexposed face is not the structural core, the surface temperature on the unexposed face of the test specimen shall be measured by nine additional thermocouples corresponding to the structural core thermocouples shown in [Figure 2](#).

Where the unexposed face insulation system includes joints, two additional thermocouples shall be fitted, each placed over a vertical (longitudinal) joint. For vertical divisional elements, they shall be placed at 0,75 height of the specimen, for horizontal divisional elements they shall be placed at mid-length.

When a construction has two differently orientated joint details, for example normal to each other, then two thermocouples additional to those already described above shall be used, one on each of two intersections.

When a construction has two different types of joint detail, then two thermocouples shall be used for each type of joint.

Additional thermocouples, at the discretion of the testing laboratory, shall be fixed over special features or specific construction details if it is considered that temperatures higher than those measured by the thermocouples listed above may result.

Additional thermocouples used shall, where possible, be positioned in the upper half of the specimen.

6.7 Measuring and recording equipment for thermocouples

The measuring and recording equipment shall be capable of operating within the limits specified in ISO 834-1.

6.8 Cotton-wool pads

The cotton-wool pad employed in the measurement of integrity shall be as described in ISO 834-1:1999, 5.5.5.1.

6.9 Gap gauges

Two types of gap gauge shall be available for the measurement of integrity as described in ISO 834-1:1999, 5.5.5.2.

6.10 Infrared camera

An infrared thermal imager shall be used to identify any localized temperature rises not detected by the unexposed face thermocouples. A roving thermocouple shall be used to establish the temperature at the positions identified by the infrared thermal imager.

Localized temperatures rises within 250 mm of the edge of the specimen shall be ignored.

The infrared camera shall be capable of detecting temperatures up to the insulation criteria required by the test, as determined in advance of the test by the test sponsor.

The infrared camera shall be properly calibrated prior to the test.

7 Test method

7.1 General

The test shall be carried out in accordance with ISO 834-1:1999, except where amended by this clause.

7.2 Commencement of the test

Not more than 5 min before the commencement of the test, the initial temperatures recorded by all thermocouples shall be checked to ensure consistency, and the datum values shall be noted. Similar datum values shall be obtained for deformation, and the initial condition of the test specimen shall be noted.

At the time of the test, the initial average internal temperature and unexposed surface temperature of the specimen shall be from 10 °C to 35 °C and shall be within 5 °C of the initial ambient temperature.

Prior to the commencement of the test, the furnace temperature shall be less than 50 °C. The commencement of the test shall be considered to be the moment when the programme to follow the required heating curve has been initiated.

7.3 Ambient conditions

The laboratory shall be virtually draught free during the test. The ambient temperature shall be from 10 °C to 35 °C at the commencement of the test and during the test the temperature shall not decrease more than 5 °C or increase more than 20 °C for all insulated divisional elements while they are still satisfying the insulation criterion.

7.4 Furnace control

7.4.1 Furnace temperature

The average temperature of the furnace as derived from the furnace thermocouples specified in [6.3](#) shall be monitored and controlled such that it follows the required time-temperature relationship. The test laboratory should be aware that non-insulated divisional element tests may lose heat to an extent that makes control of the furnace in accordance with the time-temperature relationship a significant challenge.

7.4.2 Time-temperature relationship

The time-temperature relationship required shall be supplied by the test sponsor in advance of the test, and agreed with the test laboratory. Examples of time-temperature relationships are given in [Annex B](#).

7.4.3 Permitted deviations

Where the required time-temperature curve is described in a published standard, the permitted deviations described within the standard shall be adhered to.

In the absence of otherwise described permitted deviations, the percentage deviation in the area of the curve of the average temperature recorded by the specified furnace thermocouples versus time from the area of the standard heating curve shall be as described in ISO 834-1:1999, 6.1.2.

7.4.4 Furnace pressure

A linear pressure gradient exists over the height of a furnace, and although the gradient varies slightly as a function of the furnace temperature, a mean value of 8 Pa per metre height may be assumed in assessing the furnace pressure conditions. The value of the furnace pressure shall be the nominal mean value, disregarding rapid fluctuations of pressure associated with turbulence, etc., and shall be established relative to the pressure outside the furnace at the same height. It shall be monitored and controlled continuously; by 5 min from the commencement of the test it shall be achieved within ± 5 Pa, and by 10 min from the commencement of the test it shall be achieved and maintained within ± 3 Pa.

For vertically orientated specimens, the furnace shall be operated such that a pressure of zero is established at a height of 500 mm above the notional floor level to the test specimen. However, for specimens with a height greater than 3 m, the pressure at the top of the test specimen shall not be greater than 20 Pa, and the height of the neutral pressure axis shall be adjusted accordingly.

For horizontally orientated specimens, the furnace shall be operated such that a pressure of 20 Pa is established at a position 100 mm below the underside of the specimen.

7.5 Measurements and observations on the test specimen

7.5.1 Unexposed face temperature

All temperature measurements shall be recorded at intervals not exceeding 1 min.

The maximum temperature rise on the unexposed surface of the test specimen shall be the maximum of the highest individual thermocouple or the maximum temperature recorded by the infrared camera as described in 6.10.

The average temperature rise on the unexposed surface shall be calculated as the average of the rises recorded by the unexposed face thermocouples, as specified in 6.6.2, excluding those on stiffeners or additional thermocouples fitted by the test laboratory.

7.5.2 Structural core temperatures

All temperature measurements shall be recorded at intervals not exceeding 1 min.

The maximum temperature rise of the structural core shall be calculated on an individual thermocouple-by-thermocouple basis.

The average temperature rise on the unexposed surface shall be calculated as the average of the rises recorded by structural core thermocouples, as specified in 6.6.2, excluding those on stiffeners or additional thermocouples fitted by the test laboratory.

7.5.3 Flaming on unexposed face

The occurrence and duration of any flaming on the unexposed surface, together with the location of the flaming, shall be recorded. In cases where it is difficult to identify whether or not there are flames, then the cotton-wool pad shall be applied to the area of such disputed flaming to establish whether ignition of the pad can be initiated.

7.5.4 Cotton-wool pad

Tests with the cotton-wool pad are used to indicate whether cracks and openings in the test specimen are such that they could lead to the passage of hot gases sufficient to cause ignition of combustible materials.

A cotton-wool pad shall be employed as described in ISO 834-1:1999, 8.4.1. The cotton-wool pad need not be used on the unexposed face after the period relevant to the insulation classification of the product.

The cotton-wool pad shall be applied freely and not necessarily parallel to the surface of the specimen, and not always such that the crack or openings is central to the pad. The pad shall be positioned in the flow of hot gases but shall never be positioned such that any part of the pad is closer than approximately 25 mm from any point of the test specimen.

7.5.5 Gap gauges

Tests with the gap gauges are used to indicate whether cracks and openings in the test specimen are of such dimensions that they could lead to the passage of hot gases sufficient to cause ignition of combustible materials.

Gap gauges shall be employed as described in ISO 834-1:1999, 8.4.2.

If gaps in divisional elements are fully or partly sealed by intumescent materials, the gap gauge test shall be performed as if no intumescent material is present.

7.5.6 Deformation

The deflection of the test specimen shall be recorded during the test. These deflections and displacements shall be measured with an accuracy of ± 2 mm.

7.5.7 General behaviour

Observations shall be made of the general behaviour of the specimen during the course of the test and notes concerning the phenomena such as cracking, melting or softening of the materials, spalling or charring, etc., of materials of construction of the test specimen shall be made. If quantities of smoke are emitted from the unexposed face this shall be noted in the report. However, the test is not designed to indicate the possible extent of hazard due to these factors.

Photographs of the test specimen shall be taken as soon as is practicable after the fire has been extinguished and also approximately 1 h after the fire is extinguished. These shall be included in the test report.

8 Test duration

This document is non-prescriptive in terms of test duration and structural stability, integrity and insulation rating criteria to be attained. Test sponsors seeking to perform tests compatible with the requirements of MSC 307(88) should note that prescriptive ratings may specify a minimum test duration and minimum rating criteria. Further guidance on prescriptive ratings is given in [Annex C](#).

The test may be terminated for one or more of the following reasons:

- a) safety of personnel or impending damage to equipment;
- b) attainment of selected criteria;
- c) request of the sponsor.

The test may be continued after failure under item b) above to obtain additional data.

9 Fire protection systems

9.1 General

The fire protection systems are either coated directly onto the substrate, or mounted onto a frame, or alternatively the system may be of composite construction. The surface of the test specimen shall be prepared and the fire protection system applied in a manner representative of practice. The protection material shall be installed or applied to protect the entirety of the test specimen, at a uniform thickness of protection.

9.2 Applied fire protection materials

For coatings and other applied fire protection materials, the average primer thickness shall be measured first and subtracted from the total average primer and coating thickness. The resulting permitted thickness tolerances excluding primer and topcoat (assuming normal distribution of measured thickness) shall be as follows:

- a minimum of 68 % of readings shall be within ± 20 % of the mean;
- a minimum of 95 % of readings shall be within ± 30 % of the mean;
- all readings shall be within ± 45 % of the mean.

If the thickness is outside these limits, the test specimens shall be adjusted to comply with above requirements.

If the fire protection is a coating material, the thickness shall be measured at positions specified in [Figure 3](#). If there are clear signs of thinning or thickening at positions away from those indicated, additional measurements shall be taken. Measurements shall be taken by non-destructive methods whenever possible, such as ultrasonic or eddy current depth gauges. Equipment shall be described in

the report with the method of calibration. Care shall be taken to ensure mesh reinforcement, if present, does not lead to a false reading. If non-destructive methods cannot be used, the thickness shall be measured by drilling a 1,5 mm hole and then using a depth gauge.

For thermo-setting (e.g. intumescent) materials, hardness measurements shall be made at a minimum of three positions, selected at the discretion of the test laboratory.

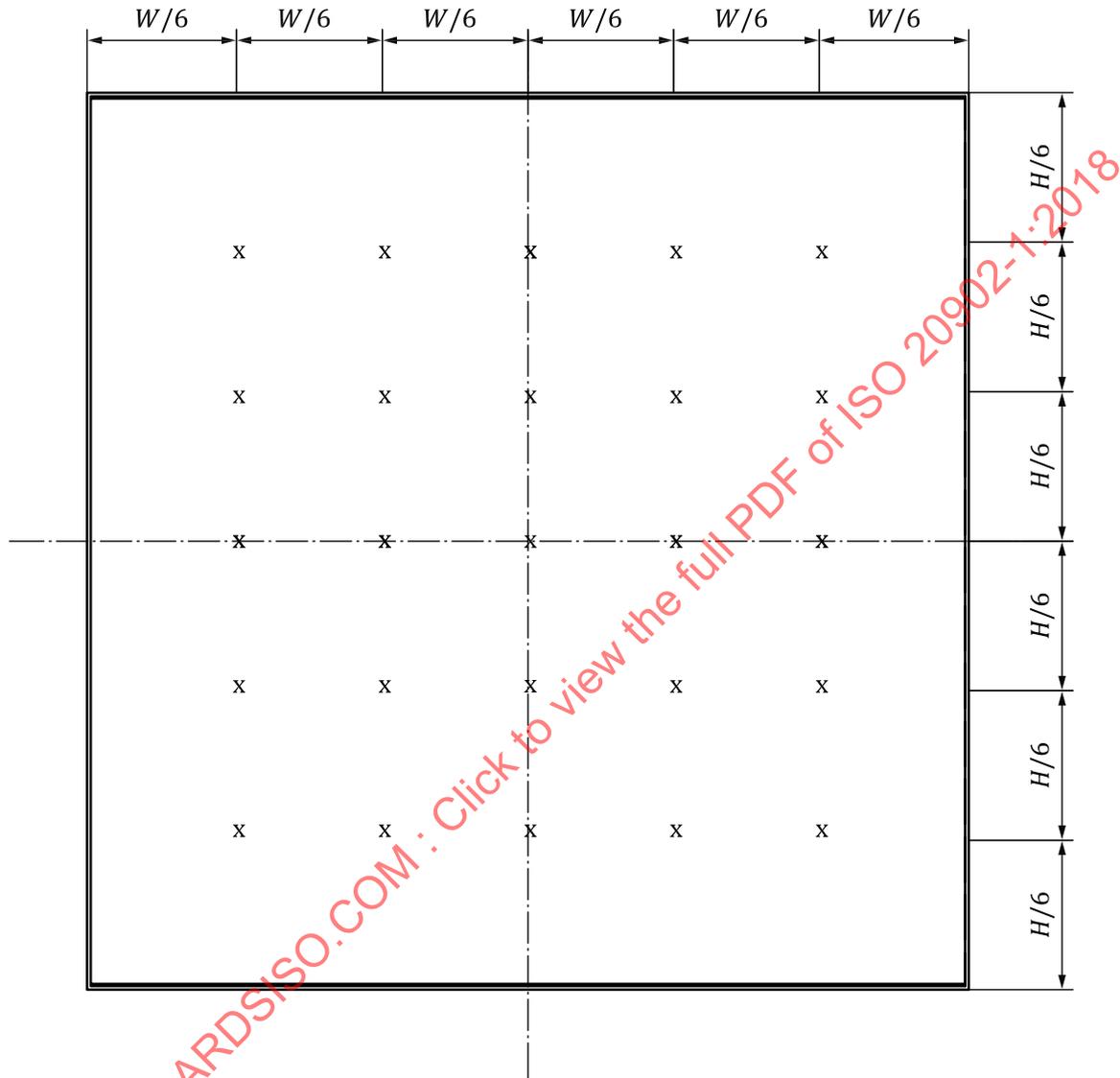


Figure 3 — Fire protection system thickness measurement positions

9.3 Assemblies and mounted fire protection materials

Mounted protective systems shall be installed ensuring at least one joint is present. The type and orientation of joints or fittings used to secure the protection system shall be the same as used in actual site-installation.

10 Test report

The test report shall include the following information as a minimum. A clear distinction shall be made between the data provided by the sponsor and the data determined by the test:

- a) reference that the test was carried out in accordance with this document, and reference that the test was carried out in accordance with the 2010 FTP Code, Part 3, if applicable;
- b) any deviations from the test method;
- c) name and address of the testing laboratory;
- d) date and identification number of the report;
- e) name and address of the sponsor;
- f) name and/or identification of the product tested;
- g) name of the manufacturer of the test specimen and of the products and components used in the construction;
- h) type of the test specimen, e.g. vertical divisional element, etc.;
- i) constructional details of the test specimen, including description and drawing and principal details of components. The description and the drawings which are included in the test report shall, as far as practicable, be based on information derived from a survey of the test specimen. When full and detailed drawings are not included in the report, then the applicant's drawing(s) of the test specimen shall be authenticated by the laboratory and at least one copy of the authenticated drawing(s) shall be retained by the laboratory; in the case reference to the applicant's drawing(s) shall be given in the report together with a statement indicating the method of endorsing the drawings;
- j) photographs of the test specimen;
- k) all properties of materials used that have a bearing on the fire performance of the test specimen together with measurements of thickness, density and, where applicable, the moisture and/or organic content of the insulation material(s) as determined by the test laboratory;
- l) date of the test specimen arrival;
- m) details of specimen conditioning;
- n) date of test;
- o) test results:
 - 1) information concerning the location of all thermocouples fixed to the specimen, together with tabulated data obtained from each thermocouple during the test. Additionally, a graphical depiction of the data obtained may be included. A drawing shall be included which clearly illustrates the positions of the various thermocouples and identifies them relative to the temperature-time data;
 - 2) the temperature rise of individual thermocouples reported at an appropriate time interval;
 - 3) the average and the maximum structural core temperature rises and the average and maximum unexposed face temperature rises at an appropriate time interval;
 - 4) the maximum deflection of the specimen;
 - 5) the classification attained by the test specimen (refer to [Clause 14](#)).

11 Uncertainty of measurement

There are many factors that may affect the result of a fire resistance test. Key factors requiring close control are the fuel flow rate, the geometry of the test specimen and the burner arrangement. Environmental conditions outside the operators control can have a significant effect, hence the restrictions on environmental conditions imposed.

12 Performance criteria

12.1 General

This test method does not provide guidance on the acceptability of a particular parameter, e.g. thickness, of fire protection coating or method of assembly. Although the method specified has been designed to simulate some of the conditions that occur in fire, it cannot reproduce them all exactly. The results may be used as elements of a fire risk assessment for a plant. This should also take into account all the other factors that are pertinent to an assessment of the fire hazard for a particular end use.

The criterion of performance, provided by the test, is the minimum time required to reach the critical temperature associated with the classification rating and fire scenario to be protected against. However, the factors in subsequent clauses shall also be considered when assessing performance.

12.2 Substrate temperature

The time temperature profile at each measurement position shall be used to determine the maximum temperature at each position during the test. The position and time of any sudden increase in the rate of temperature rise, if any, shall be recorded as it is indicative of possible failure of the coating/system/assembly at that point. The localized maximum temperature rise shall be reported in conjunction with the nearest fire protection material thickness for coatings type systems.

12.3 Coatings and spray-applied materials

The amount of unreacted/partially reacted material remaining and the amount and condition of the reacted material (char for epoxy intumescent or subliming materials) provides an indication of performance. Particularly for the protection of any edge features, the condition of any reinforcement is important. The condition of the reacted material and the amount of unreacted/partially reacted material may be evaluated in terms of:

- a) bare metal exposed and reinforcement destroyed;
- b) no bare metal exposed but the reinforcement in poor condition and the reacted material easily detachable;
- c) reacted material firmly attached and the majority of the reinforcement intact and attached;
- d) unreacted/partially reacted material present, reacted material and reinforcement firmly attached.

If the temperature criterion is met, then a specimen meeting criterion d) clearly provides a wider safety margin than a specimen meeting criterion a). A statement of the criterion that is most appropriate shall be included in the report.

Cementitious materials lose retained water during the test and then act as passive insulators. The external appearance and material thickness may not change significantly; however, while water is present, the temperature of the substrate remains at 100 °C and, when all the water has been driven off, the temperature increases to above 100 °C. Examination of the temperature-time curves provides an indication of whether there is retained water (unreacted or partially reacted material) at the end of the test.

12.4 Systems and assemblies

The penetration of flames or hot gases through any cracks, holes or breaches in joints shall be considered when assessing the integrity of a system. Particularly for flexible systems (e.g. fibre-based materials), the condition of the method of fixing (straps, etc.) is also important. The amount of penetration and condition of the method of fixing may be evaluated in terms of:

- a) evidence of passage of flames through the system with the fixing system ineffective;
- b) evidence of passage of hot gases/smoke through the system with the fixing system effective;
- c) no passage of hot gases through the system and with the fixing system effective.

If the temperature criterion is met, then a specimen meeting criterion c) clearly provides a wider safety margin than a specimen meeting criterion a). A statement of the criterion that is most appropriate shall be included in the report.

13 Factors affecting the validity of the test

13.1 Interruption of the test

It is likely that in some tests a control or instrumentation failure will result in an interruption. Restarting the test shall not be permitted. In the event of unintentional interruption occurring within the first 2 min of the test (e.g. failure to light all burners), the test may be restarted, commencing at a time of 0.

13.2 Failure of thermocouples

Up to 1 thermocouple may fail prior to a test after application or fitting of the protection material and the test shall be allowed. During fire testing, a maximum of 3 thermocouples may fail and the test shall still be considered valid. This shall be reduced to a maximum of 2 thermocouples if one failed prior to commencement of the test. At least 7 of the structural core thermocouples described in [6.6.2](#), 2 of the stiffener thermocouples described in [6.6.3](#) (if present), and 7 of the unexposed face thermocouples described in [6.6.4](#) shall remain valid throughout the test.

14 Classification procedures

14.1 General

The classification is based on a selected and defined temperature rise above the initial temperature observed during the test and the period of exposure to the fire. The procedure used is based on that proposed in ISO 13702, adapted to accommodate the multiple and concurrent types of fire resistance classification ratings required of divisional elements. The classification rating is specified as below:

Fire exposure type/Protected element/Structural stability rating (R)/Integrity rating (E)/Insulation rating (I).

Where no claim is made as to a specific rating type, it may be omitted from the description.

Examples of classification descriptions are given in [Annex D](#).

14.2 Fire exposure type

ISO 13702 distinguishes between cellulosic fires (CF), hydrocarbon pool fires (HC) and jet fires (JF). The test standard shall be referenced, if applicable. If the procedures within this document are used

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in conjunction with a custom furnace exposure that cannot be referenced to a public document then classification cannot be claimed and the procedures stated in [Clause 14](#) are not applicable.

EXAMPLE ISO 834-1 (CF) or UL 1709 rev 4 (HC).

14.3 Protected element

The specimen shall be designated as a vertical or horizontal divisional element (or appropriate alternative description e.g. bulkhead, deck). The construction material shall be stated along with the structural core material, core thickness, and unexposed insulation present.

EXAMPLE 5 mm steel bulkhead with 50 mm unexposed face insulation.

14.4 Structural stability rating (R)

The structural stability rating shall be defined as the test period taken for the average structural core temperature rise as defined in [7.5.2](#) to increase to the specified critical temperature. The period of resistance shall be rounded down to the nearest 5 min.

Tests which choose to omit the structural core temperature thermocouples shall have a structural stability rating of R0.

The corresponding critical temperature shall be stated in parenthesis.

EXAMPLE R60 (400 °C).

14.5 Integrity rating (E)

The integrity rating shall be determined using the methodology described in [7.5.3](#) and [7.5.4](#). The period of resistance shall be rounded down to the nearest 5 min.

14.6 Insulation rating (I)

The insulation rating shall be defined as either the test period taken for the average unexposed face temperature to increase to the specified temperature, or that taken for the maximum unexposed face to increase to the specified temperature, noting these specified temperatures may differ. The average and maximum unexposed face temperatures shall be determined as defined in [7.5.1](#). The period of resistance shall be rounded down to the nearest 5 min. The corresponding temperature shall be stated in parenthesis.

14.7 Compatibility with existing prescriptive ratings

A number of existing prescriptive ratings are described in more detail in [Annex C](#). Classification may be expressed either in terms of the R, E or I criteria as described above, or by substituting these by the prescriptive rating itself.

EXAMPLE 1 Prescriptive rating "A60 bulkhead"

a) Classification using prescriptive rating:

ISO 834-1(CF)/5 mm steel bulkhead with 50 mm mineral wool unexposed face insulation/A60

b) Classification using REI ratings:

ISO 1 (CF)/5 mm steel bulkhead with 50 mm mineral wool unexposed face insulation/E120/I60 (140 °C av, 180 °C point)

EXAMPLE 2 Prescriptive rating "H0 deck"

- c) Classification using prescriptive rating:
BS476:20-app D/4,5 mm steel deck/0 (400 °C)
- d) Classification using REI ratings:
UL 1709/4,5 mm steel deck/R120 (400 °C)/E120

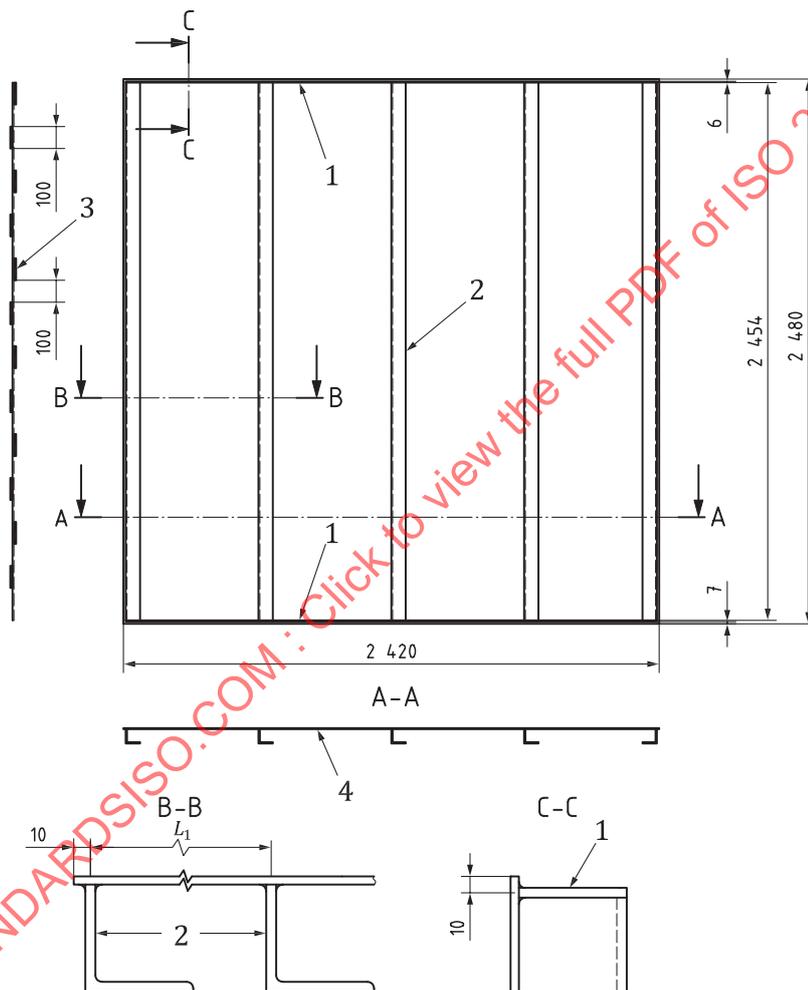
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Annex A (informative)

Examples of specimen construction

A.1 MSC 307(88)-style stiffened flat plate specimens

A.1.1 Vertical specimen

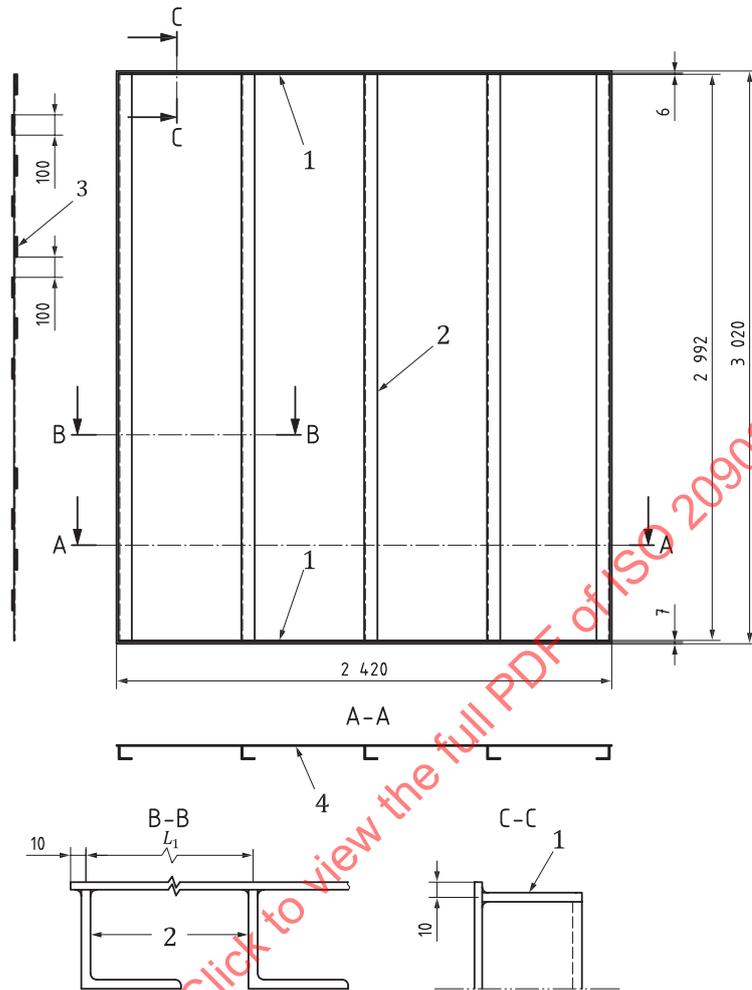


Key

- 1 65 mm × 6 mm × 2 406 mm flat bar
- 2 65 mm × 65 mm × 6 mm L-shaped angle stiffener, 2 454 mm long, 5 off (alternatively 6 off)
- 3 leg of stiffener fixed to structural core with staggered 100 mm fillet welds at 200 mm centres
- 4 4,5 mm steel plate structural core
- 5 65 mm × 6 mm × 2 406 mm flat bar
- L1 600 mm (when 5 equally spaced stiffeners used)

Figure A.1

A.1.2 Horizontal specimen



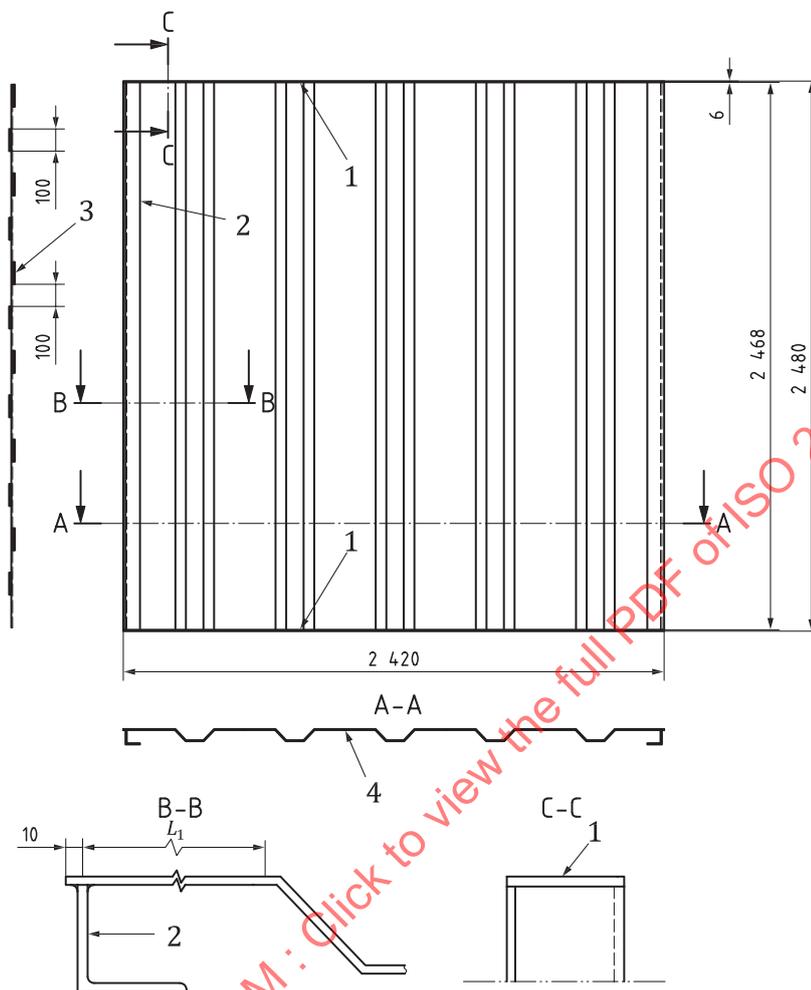
Key

- 1 100 mm × 8 mm × 2 408 mm flat bar
- 2 100 mm × 70 mm × 8 mm L-shaped angle stiffener, 2 992 mm long, 5 off (alternatively 6 off)
- 3 leg of stiffener fixed to structural core with staggered 100 mm fillet welds at 200 mm centres
- 4 4,5 mm steel plate structural core
- 5 100 mm × 8 mm × 2 408 mm flat bar
- L1 600 mm (when 5 equally spaced stiffeners used)

Figure A.2

A.2 Corrugated specimens

A.2.1 Vertical specimen



Key

- 1 50 mm × 6 mm × 2 420 mm flat bar
- 2 65 mm × 65 mm × 6 mm L-shaped angle stiffener, 2 454 mm long, 5 off (alternatively 6 off)
- 3 leg of stiffener fixed to structural core with staggered 100 mm fillet welds at 200 mm centres
- 4 4,5 mm steel plate structural core
- L1 minimum 150 mm

Figure A.3