

Resolution A.754(18)

*Adopted on 4 November 1993
(Agenda item 11)*

**RECOMMENDATION ON FIRE RESISTANCE TESTS
FOR "A", "B" AND "F" CLASS DIVISIONS**

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

RECALLING ALSO the Recommendation on Fire Test Procedures for "A", "B" and "F" Class Divisions, adopted by resolution A.517(13),

RECOGNIZING the need to improve test procedures for determining insulating values in compliance with the provisions of the International Convention for the Safety of Life at Sea, 1974, as amended, as well as the Torremolinos Protocol of 1993 relating to the Torremolinos International Convention for the Safety of Fishing Vessels, 1977,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its sixty-first session,

1. ADOPTS the Recommendation on Fire Resistance Tests for "A", "B" and "F" Class Divisions, set out in the annex to the present resolution;
2. INVITES Governments to apply the Recommendation in compliance with relevant definitions in the International Convention for the Safety of Life at Sea, 1974, as amended, and the Torremolinos Protocol of 1993 relating to the Torremolinos International Convention for the Safety of Fishing Vessels, 1977;
3. REVOKES resolution A.517(13).

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FOR "A", "B" AND "F" CLASS DIVISIONS**

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FIRE RESISTANCE TESTS FOR "A", "B" and "F" CLASS DIVISIONS*

1 GENERAL

1.1 Under the provisions of the International Convention for the Safety of Life at Sea, 1974, and subsequent amendments thereto, and the Torremolinos Protocol of 1993 relating to the Torremolinos International Convention for the Safety of Fishing Vessels, 1977, constructions for use in passenger ships, cargo ships, and fishing vessels should have a 'fire insulation' to the satisfaction of, and be approved by, the Administration. In this context 'fire insulation' is the ability of the construction to insulate/protect an area from the influences of a fire in an adjoining area by having separating performance during fire. Such constructions are "A" class bulkheads and decks, "A" class doors, "B" class bulkheads, decks, ceilings and linings, "B" class doors, "F" class bulkheads, decks, ceilings and linings, and "F" class doors.

The approval will be given by the Administration based on results of tests carried out on the construction and material in question. Tests should be conducted at a testing laboratory recognized by the Administration. The applicant for the test, i.e., the manufacturer or agent, should if required submit test specimens and information to the testing laboratory as prescribed in this document.

1.2 Approval of constructions will be restricted to the orientation in which they have been tested; therefore bulkheads, linings and doors should be tested vertically mounted and decks and ceilings should be tested horizontally mounted. It is only necessary to test decks with the underside exposed to the heating conditions, and "B" and "F" class ceilings and linings are required only to be tested from the side incorporating the ceiling or the lining.

For "A" class bulkheads and doors for "general application", i.e. for use of the insulation material on either side of the structural core, and also for "B" class bulkheads and doors, approval usually requires that the construction has been tested from each side separately, using two separate specimens, unless the Administration considers that only a single test to one side, that being the side expected to provide a performance inferior to the other side, is appropriate.

In tests for "A" class bulkheads for "general application" it may be possible for approval to be granted on the basis of a single test only, provided that the bulkhead has been 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.

In tests for "A" class bulkheads for "restricted application", i.e. where the fire hazard has been identified as being from the insulated side only, the bulkhead can be tested with the insulation on the exposed face and with the stiffeners also on that side.

If approval of an "A" class bulkhead is being sought involving the use of "double-sided application" of the insulation, the thickness of the insulation being equal on both sides of the structural core, it should be tested with the stiffeners on the unexposed side of the bulkhead, otherwise it should be tested with the side with the thinnest thickness of insulation on the exposed face.

If insulation of an "A" class division is to be provided by membrane protection, i.e. by a "B" class ceiling to a structural steel core or a "B" class lining to a structural steel core, the distance between the membrane, i.e. the ceiling or the lining, and the structural core should be the minimum for which approval is being sought. For "A" class bulkheads, the division is required to be tested both from the structural core side, and from the "B" class lining side. For both ceilings and linings which may form part of such deck or bulkhead constructions, they should satisfy at least B-0 classification.

When the insulation of an "A" class division is provided by membrane protection, the stiffeners of the structural core should be positioned in the cavity between the steel plate of the structural core and the membrane protection. For an "A" class bulkhead the Administration may accept or require the stiffeners to be on the opposite side of the steel plate of the structural core to enable the distance between the membrane protection and the structural core to be reduced to a minimum.

* As defined in the International Convention for the Safety of Life at Sea, 1974, chapter II-2, part A and the Torremolinos Protocol of 1993 relating to the Torremolinos International Convention for the Safety of Fishing Vessels, 1977, chapter V except that "F" class divisions are defined only in the latter Convention.

1.3 The dimensions of the structural cores of the test specimens given in section 2 are intended for structural cores of stiffened flat plates of steel or aluminium alloy. The Administration may require tests to be carried out on specimens having structural cores of materials other than steel or aluminium alloy if such materials are more representative of the construction to be used on board ships.

1.4 "A" class divisions which consist of an uninsulated steel bulkhead or deck of suitable scantlings and without openings can be deemed to satisfy the requirements for class A-0 divisions, i.e. to satisfy the requirements for the passage of smoke and flame, without the need for testing. All other divisions, including class A-0 divisions with a structural core of aluminium, are required to be tested.

1.5 Results obtained on an insulating material used in conjunction with an "A" class division may be applied to constructions incorporating heavier scantlings than those tested and providing the orientation of the construction is the same, i.e. results from bulkhead tests should not be applied to decks and vice versa.

1.6 The construction to be tested should be, as far as possible, representative of that to be used on board ships, including the materials and method of assembly.

The designs of the specimens proposed in this resolution are considered to reflect the worst case situations in order to provide maximum usefulness of the classifications to end use applications. However, the Administration may accept or request special test arrangements which provide additional information required for approval, especially of those types of constructions which do not utilize the conventional components of horizontal and vertical divisions, e.g. where cabins may be of a modular type construction involving continuous connections between bulkheads, decks and ceilings.

1.7 Constructions should be tested without paint or other superimposed finish, provided that where they are only produced with a superimposed finish, and subject to the agreement of the Administration, they may be tested as produced. Such constructions may be required to be tested with a superimposed finish if such a finish is considered by the Administration to have a detrimental effect on the performance of the construction in the test.

2 NATURE OF TEST SPECIMENS

2.1 "A" class bulkheads

2.1.1 Dimensions

The minimum overall dimensions for the test specimen are given in SOLAS regulation II-2/3.2, but the recommended 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.

The overall dimensions of the structural core should be 20 mm less in both the width and the height than the overall dimensions of the specimen, and the other dimensions of the structural core should be as follows:

- thickness of plating:	steel	4.5 ± 0.5 mm
	aluminium	6.0 ± 0.5 mm
- stiffeners spaced at 600 mm:	steel	$65 \pm 5 \times 65 \pm 5 \times 6 \pm 1$ mm
	aluminium	$100 \pm 5 \times 75 \pm 5 \times 9 \pm 1$ mm

The width of the structural core may be greater than the specified dimensions providing that the additional width is in increments of 600 mm to maintain the stiffener centres and the relationship between the stiffeners and the perimeter detail.

Any joints in the plating should be full welded, at least from one side.

The construction of a structural steel core having the recommended dimensions is shown in figure 1; the thickness of the plating and dimensions of the stiffeners shown are nominal dimensions. Irrespective of the dimensions of the structural core and the material of manufacture, the details around the perimeter should be as illustrated in figure 3.

2.1.2 Design

Where insulation is provided by panels (e.g. a “B” class lining), then the test specimen should be designed such that at least one of the panels is of full width and this, or these, should 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, should be 20 mm greater in each direction than the equivalent dimensions of the structural core.

If the insulation system is a lining which may incorporate electrical fittings, e.g. light fittings and/or ventilation units, it is necessary that initially a test is performed on a specimen of the lining itself, without the incorporation of these units, to establish the basic performance. A separate test(s) may be performed on a specimen(s) with the units incorporated to ascertain their influence on the performance of the lining.

2.1.3 Description

The applicant should provide full constructional 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 should 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, connections, air gaps and all other details.

2.2 “A” class decks

2.2.1 Dimensions

The minimum overall dimensions for the test specimen are given in SOLAS regulation II-2/3.2, but the recommended dimensions of the test specimen, including the perimeter details at all edges, are 2,440 mm width and 3,040 mm length.

The overall dimensions of the structural core should be 20 mm less in both the width and length than the overall dimensions of the specimen, and the other dimensions of the structural core should be as follows:

- thickness of plating:	steel	4.5 ± 0.5 mm
	aluminium	6.0 ± 0.5 mm
- stiffeners spaced at 600 mm:	steel	$100 \pm 5 \times 70 \pm 5 \times 8 \pm 1$ mm
	aluminium	$150 \pm 5 \times 100 \pm 5 \times 9 \pm 1$ mm

The width of the structural core may be greater than the specified dimensions providing that the additional width is in increments of 600 mm to maintain the stiffener centres and the relationship between the stiffeners and the perimeter detail.

Any joints in the plating should be full welded, at least from one side.

The construction of a structural steel core having the recommended dimensions is shown in figure 2; the thickness of the plating and dimensions of the stiffeners shown are nominal dimensions. Irrespective of the dimensions of the structural core and the material of manufacture, the details around the perimeter should be as illustrated in figure 3.

2.2.2 Design

Where insulation is provided by panels (e.g. a “B” class ceiling), then the test specimen should be designed such that at least one of the panels is of full width and this, or these, should 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, should be 20 mm greater in each direction than the equivalent dimensions of the structural core.

If the ceiling incorporates panels, the specimen should include examples of both the lateral and longitudinal joints between the panels. If the specimen is to simulate a ceiling where the maximum length of the panels is greater than the length of the specimen, then a joint should be positioned at a distance of approximately 600 mm from one of the shorter ends of the test specimen.

If the insulation system is a ceiling which may incorporate electrical fittings, e.g. light fittings and/or ventilation units, it is necessary that initially a test is performed on a specimen of the ceiling itself, without the incorporation of these units, to establish the basic performance. A separate test(s) may be performed on a specimen(s) with the units incorporated to ascertain their influence on the performance of the ceiling.

2.2.3 Description

The applicant should provide full constructional 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 should 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, connections, air gaps and all other details.

2.3 “A” class doors

2.3.1 Dimensions

The test specimen should incorporate the maximum size (in terms of both the width and the height) of door leaf or leaves for which approval is to be sought. The maximum size of a door which can be tested will be determined by the requirement to retain certain dimensions of the structural core (see 2.3.2.2).

2.3.2 Design

2.3.2.1 The door leaf and frame should be constructed of steel or other equivalent material and insulated as necessary to achieve the desired standard of insulation.

Door furniture such as hinges, locks, latches, shoot bolts, handles, etc. should be constructed of materials having melting points of not less than 950°C.

2.3.2.2 The door leaf and frame should be mounted into a structural core constructed in accordance with 2.1.1.

An opening to accommodate the door assembly should be provided in the structural core; the maximum dimensions of the opening will be determined by a requirement to retain a minimum width of the structural core of 300 mm to each vertical side of the opening and a minimum distance of 100 mm from the top edge of the structural core.

No additional stiffening should be provided to the structural core unless provided as part of the door frame.

The method of fixing the door frame into the opening in the structural core should be as used in practice.

2.3.2.3 The structural core should be mounted such that the stiffeners are on that side which is intended to face away from the heating conditions of the test (i.e. the unexposed face), whilst the insulating system should be on the side intended to be exposed to the heating conditions of the test (i.e. the exposed face).

2.3.2.4 The insulation system should be approved by the Administration to at least the same standard as that which the door is intended to achieve. If the insulation performance of the door is unknown the structural core should be insulated to A-60 standard. The insulation of the structural core should not be extended beyond the outer web of the door frame.

2.3.2.5 The door should be mounted into the structural core such that the side expected to give the inferior performance will be exposed to the heating conditions of the test.

A hinged door should be tested with the door leaf opening away from the heating conditions unless the Administration deems otherwise.

For sliding doors it is not possible to state generally from which side the door should be tested to give the inferior performance. It will, therefore, be necessary to conduct two separate tests, one with the door mounted to the exposed face and one with the door mounted to the unexposed face of the bulkhead. If, for practical reasons, a sliding door cannot be fixed to the stiffened face of the structural core, then, subject to the agreement of the Administration, the stiffeners may be positioned on the exposed face.

2.3.3 *Description*

The applicant should provide full constructional 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 should include dimensions and details of the following:

- the bulkhead;
- the door leaf and frame construction, including the clearances between the door leaf and the frame;
- the connection of the door frame to the bulkhead;
- the method of securing insulation and details of components used for this purpose (e.g. the type and rate of application of any adhesive);
- fittings such as hinges, shoot bolts, latches, locks, etc.

2.4 "B" and "F" class bulkheads

2.4.1 *Dimensions*

The minimum overall dimensions for the test specimen are given in SOLAS regulation II-2/3.2, but the recommended 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 to be less than given above, then the test specimen should be of the maximum height to be used in practice.

2.4.2 *Design*

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

If the bulkhead may incorporate electrical fittings, e.g. light fittings and/or ventilation units, it is necessary that initially a test is performed on a specimen of the bulkhead itself, without the incorporation of these units, to establish the basic performance. A separate test(s) should be performed on a specimen(s) with the units incorporated to ascertain their influence on the performance of the bulkhead.

2.4.3 *Description*

The applicant should provide full constructional 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 should include dimensions and details of the thicknesses of materials used in the insulation system (e.g. of any panels), the method of securing the panels and details of the components used for this purpose, details of joints, connections, air gaps and all other details.

2.5 “B” and “F” class decks

2.5.1 Dimensions

The minimum overall dimensions for the test specimen are given in SOLAS regulation II-2/3.2, but the recommended 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 given above then the test specimen should be of the maximum size to be used in practice.

2.5.2 Design

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

2.5.3 Description

The applicant should provide full constructional 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 should include dimensions and details of the thicknesses of materials used in the insulation system (e.g. of any panels), the method of securing the insulation system and details of the components used for this purpose, details of joints, connections, air gaps and all other details.

2.6 “B” and “F” class doors

2.6.1 Dimensions

The test specimen should incorporate the maximum size (in terms of both the width and the height) of door leaf or leaves for which approval is to be sought. The maximum size of a door which can be tested will be determined by the requirement to retain certain dimensions of the bulkhead (see 2.6.2.3).

2.6.2 Design

2.6.2.1 Door furniture such as hinges, locks, latches, shoot bolts, handles, etc. should be constructed of materials having melting points of not less than 850°C unless it can be shown by the fire test that materials having melting points below 850°C do not adversely affect the performance of the door.

2.6.2.2 The door leaf and frame should be mounted as appropriate into a “B” or “F” class bulkhead of compatible construction, thereby reflecting an actual end use situation. The bulkhead should have dimensions as prescribed in 2.4.1.

The bulkhead should be of a construction approved by the Administration as having at least a similar classification to that required by the door.

The method of fixing the door frame to the bulkhead should be as used in practice.

2.6.2.3 The door should be positioned such that there is a minimum width of the bulkhead of 300 mm to each vertical side of the door and a minimum distance of 100 mm from the top edge of the bulkhead.

2.6.2.4 The door should be mounted into the bulkhead such that the side expected to give the inferior performance will be exposed to the heating conditions of the test.

A hinged door should be tested with the door leaf opening away from the heating conditions unless the Administration deems otherwise.

For sliding doors it is not possible to state generally from which side the door should be tested to give the inferior performance. It will, therefore, be necessary to conduct two separate tests, one with the door mounted to the exposed face and one with the door mounted to the unexposed face of the bulkhead.

2.6.2.5 For a door which incorporates a ventilation opening within its construction, the ventilation grille(s) should be open at the commencement of the test. Temperature measurements on such a door should not be made over the face of the grille(s).

2.6.3 *Description*

The applicant should provide full constructional 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 should include dimensions and details of the following:

- the bulkhead;
- the door leaf and frame construction, including the clearances between the door leaf and the frame;
- the connection of the door frame to the bulkhead;
- the method of securing insulation and details of components used for this purpose (e.g. the type and rate of application of any adhesive);
- fittings such as hinges, shoot bolts, latches, locks, handles, ventilation louvres, escape panels, etc.

2.7 *“B” and “F” class linings*

2.7.1 *Dimensions*

The minimum overall dimensions for the test specimen are given in SOLAS regulation II-2/3.2, but the recommended 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. Irrespective of the overall dimensions, the width and the height of the lining should each be 20 mm greater than the equivalent dimensions of the structural core.

2.7.2 *Design*

The lining should be positioned alongside a structural core constructed in accordance with 2.1.1. The design of the lining should be such that it facilitates its assembly with the limited access provided by the proximity of the structural core, i.e. it should be mounted with the structural core in place.

During a test on an “A” class bulkhead which utilizes membrane protection along its exposed side, e.g. a “B” class lining, it is possible also to evaluate the performance of the lining with a view to classification providing that the necessary thermocouples are attached to the lining and providing that the necessary integrity measurements are made.

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

If the lining may incorporate electrical fittings, e.g. light fittings and/or ventilation units, it is necessary that initially a test is performed on a specimen of the lining itself, without the incorporation of these units, to establish the basic performance. A separate test(s) may be performed on a specimen(s) with the units incorporated to ascertain their influence on the performance of the lining.

2.7.3 *Description*

The applicant should provide full constructional 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 should include dimensions and details of the thicknesses of materials used in the insulation system (e.g. of any panels), the method of securing the insulation system and details of the components used for this purpose, details of joints, connections, air gaps and all other details.

2.8 “B” and “F” class ceilings

2.8.1 Dimensions

The minimum overall dimensions for the test specimen are given in SOLAS regulation II-2/3.2, but the recommended dimensions of the test specimen, including the perimeter details at all edges, are 2,440 mm width and 3,040 mm length. Irrespective of the overall dimensions, the width and the length of the ceiling should each be 20 mm greater than the equivalent dimensions of the structural core.

2.8.2 Design

The ceiling should be positioned below a structural core constructed in accordance with 2.2.1. The design of the ceiling should be such that it facilitates its assembly with the limited access provided by the proximity of the structural core, i.e. it should be mounted with the structural core in place.

During a test on an “A” class deck which utilizes membrane protection along its underside, e.g. a “B” class ceiling, it is possible also to evaluate the performance of the ceiling with a view to classification providing that the necessary thermocouples are attached to the ceiling and providing that the necessary integrity measurements are made.

If the ceiling incorporates panels, the specimen should include examples of both the lateral and longitudinal joints between the panels. If the specimen is to simulate a ceiling where the maximum length of the panels is greater than the length of the specimen, then a joint should be positioned at a distance of approximately 600 mm from one of the shorter ends of the test specimen.

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

If the ceiling may incorporate electrical fittings, e.g. light fittings and/or ventilation units, it is necessary that initially a test is performed on a specimen of the ceiling itself, without the incorporation of these units, to establish the basic performance. A separate test(s) may be performed on a specimen(s) with the units incorporated to ascertain their influence on the performance of the ceiling.

2.8.3 Description

The applicant should provide full constructional 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 should include dimensions and details of the thicknesses of materials used in the insulation system (e.g. of any panels), the method of securing the insulation system and details of the components used for this purpose, details of joints, connections, air gaps and all other details.

3 MATERIALS FOR TEST SPECIMENS

3.1 Specifications

Prior to the test, the following information should be submitted to the laboratory by the applicant for each of the materials used in the construction:

- the identification mark and trade name;
- principal details of composition;
- nominal thickness;

- nominal density (for flexible materials this should be related to the nominal thickness);
- nominal equilibrium moisture content (at relative humidity of 50% and a temperature of 23°C);
- specific heat at ambient temperature;
- thermal conductivity at ambient temperature.

The density of each material used in the test specimen should be within $\pm 10\%$ of the value stated as the nominal density.

Where materials used in the construction of the specimen are required to be non-combustible, i.e. for “A” class and “B” class, evidence in the form of test reports in accordance with the test method for qualifying marine construction materials as non-combustible, developed by the Organization, and from a testing laboratory recognized by the Administration and independent of the manufacturer of the material should be provided. These test reports should not be more than 24 months old at the date of the performance of the fire resistance test. If such reports cannot be provided then tests as prescribed in 3.2.3 below should be conducted.

3.2 Control measurements

3.2.1 General

The testing laboratory should take reference specimens of all those materials whose characteristics are important to the performance of the specimen (excluding steel and equivalent material).

The reference specimens should be used for the non-combustibility test, if appropriate, and for the determination of the thickness, the density and, where appropriate, the moisture and/or binder content.

The reference specimens for sprayed materials should be made when the material is sprayed on the structural core and they should be sprayed in a similar manner and in the same orientation.

The laboratory should conduct the following control tests, as appropriate to the type of material and the proposed classification, on the reference specimens after they have been conditioned as specified in section 4.

For the determination of the thickness, the density and the moisture and/or binder content three specimens should be used, and the value quoted as the mean of the three measurements.

3.2.2 Encapsulated materials

When an insulation material is encapsulated within the construction and it is not possible for the laboratory to take specimens of the material prior to the test for conducting the control measurements, the applicant should be requested to provide the requisite samples of the material. In these cases it should be clearly stated in the test report that the measured properties were determined from samples of the material provided by the applicant for the test.

Notwithstanding the above, the laboratory should attempt, wherever possible, to verify the properties by using samples which may be cut from the specimen before test or by checking against similar properties determined after test. When samples of the material are cut from the test specimen before test, the specimen should be repaired in a manner such that its performance in the fire test is not impaired.

3.2.3 Non-combustibility

If necessary (see 3.1), non-combustibility tests in accordance with the test method for qualifying marine construction materials as non-combustible, developed by the Organization, should be conducted. Adhesives used in the construction of the specimen are not required to be non-combustible; however, they are recommended to have low flame-spread characteristics.

3.2.4 Thickness

The thickness of each material and combination of materials should be measured by using a suitable gauge or callipers.

The thickness of a sprayed insulation material should be measured using a suitable probe at positions adjacent to each of the unexposed-face thermocouples referred to in 7.5.1.1 and 7.5.1.2.

3.2.5 Density

The density of each material should be determined from measurement of the weight and the dimensions.

The density of mineral wool or any similar compressible material should be related to the nominal thickness.

3.2.6 Moisture content

Specimens of each material, measuring minimum 60 mm × 60 mm × thickness of the material, should be weighed (initial conditioned weight W_1) and then heated in a ventilated oven at a temperature of $105 \pm 2^\circ\text{C}$ for 24 h and reweighed when cooled (W_2). However, gypsum-based, cementitious and similar materials should be dried at a temperature of $55 \pm 5^\circ\text{C}$ to constant weight (W_2).

The moisture content ($W_1 - W_2$) of each specimen should be calculated as a percentage of the dry weight (W_2).

3.2.7 Binder content

After the percentage moisture contents have been calculated as specified above, the specimens should be further heated in an oven at a temperature of $550 \pm 20^\circ\text{C}$ for 24 h and again weighed (W_3). The binder content ($W_2 - W_3$) should be calculated as a percentage of the dry weight (W_2).

4 CONDITIONING OF THE TEST SPECIMENS

4.1 General

The test specimen should not be tested until it has reached an air-dry condition. This condition is defined as an equilibrium (constant weight) with an ambient atmosphere of 50% relative humidity at 23°C .

Accelerated conditioning is permissible provided the method does not alter the properties of component materials. In general, high-temperature conditioning should be below temperatures critical for the materials.

4.2 Verification

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 should be so constructed as to represent the loss of water vapour from the specimen by having similar thicknesses and exposed faces. They should have minimum linear dimensions of 300 mm by 300 mm and a minimum mass of 100 g. Constant weight should be considered to be reached when two successive weighing operations, carried out at an 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.

4.3 Encapsulated materials

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 should be made with the applicant for the test to ensure that this is so.

5 MOUNTING OF THE TEST SPECIMENS

5.1 Restraint and support frames

All test specimens should 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 should have a density between 1600 kg/m³ and 2400 kg/m³. The concrete or masonry lining to a steel frame should have a thickness of at least 50 mm.

The rigidity of the restraint frames should 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 should be conducted in the direction of the bulkhead or deck stiffeners, and the increase of the internal dimension should not exceed 2 mm.

For frames which are to be used to evaluate "A" class divisions which incorporate "B" class ceilings or linings, the frames should be provided with at least four viewing and access openings, notionally one to each quarter of the test specimen. These openings should facilitate access to the cavity for the determination of the integrity of the ceiling or lining during the test on the deck or bulkhead. The access/viewing openings should normally be sealed with mineral wool insulation slabs except when viewing or accessing to the ceiling or lining is needed.

5.2 "A" class divisions

The structural core to an "A" class division should be fixed into the restraint frame and sealed around its perimeter as shown in figure 3. 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 an "A" class division 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 should 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, should the perimeter edges be protected from direct exposure to the heating conditions.

5.3 "B" and "F" class divisions

For a "B" or "F" class bulkhead or lining, the specimen should be supported at the top and secured on the vertical sides and at the bottom in a manner representative of the conditions in service. The support provided at the top of a bulkhead or lining should allow for the appropriate expansion or clearance to be used as in practice. At the vertical edges lateral expansion towards the vertical edges of the restraint frame should be prevented by ensuring a tight fit of the specimen within the frame which may be achieved by inserting a rigid packing between the vertical edges and the frame. If provision for movement at the edges of a bulkhead or lining is made for a particular construction in service, the specimen should simulate these conditions.

For a "B" or "F" class ceiling, expansion of the ceiling members should be prevented at the perimeter edges since the specimen is intended to simulate a part of a ceiling removed from a much greater area. Expansion should be prevented by ensuring a tight fit of the specimen within the frame which may be achieved by inserting a rigid packing between the ends or edges of ceiling members and the restraint frame. Only if the ceiling is being tested at full size in one or more directions is it allowed to incorporate the expansion allowance at the perimeter edges in the appropriate direction or directions.

6 EXAMINATION OF THE TEST SPECIMENS

6.1 Conformity

The laboratory should verify the conformity of the test specimen with the drawings and method of assembly provided by the applicant (see section 2), and any area of discrepancy should 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 test. When it is necessary to rely on information provided by the applicant then this should be clearly stated in the test report. The laboratory should nevertheless ensure that it fully appreciates the design of the test specimen and should be confident that it is able to accurately record the constructional details in the test report.

6.2 Door clearances

Following mounting of the door and immediately prior to test, the laboratory should measure the actual clearances between the door leaf and the door frame, and additionally for a double leaf door between the adjacent door leaves. The clearances should be measured for each door leaf at two positions along the top and bottom edges and at three positions along each vertical edge.

6.3 Door operation

Similarly, immediately prior to test, the laboratory should check the operability of the door by opening the door leaf by a distance of at least 300 mm. The door leaf should then be closed, either automatically, if such a closing device is provided, or manually. The door may be latched for the test but should not be locked, and no devices for latching or locking should be included which are not normally incorporated in practice.

7 INSTRUMENTATION

7.1 General

The furnace, the instrumentation of the furnace and the instrumentation of the test specimen should generally be in accordance with the International Standard ISO 834: Part 1, except where amended by this section. The details given in the following paragraphs are supplementary to, an elaboration of, or a deviation from the ISO requirements.

7.2 Furnace temperature thermocouples

7.2.1 Design

The furnace temperature should be measured by thermocouples as shown in figure 4. They may be either thermocouples of bare-wire design or sheathed thermocouples having an equivalent response time to that of bare-wire thermocouples. The bare-wire thermocouples should have a wire diameter of between 0.75 and 1.00 mm and a welded or crimped junction. At least 25 mm of wire should project from the insulation. Bare-wire thermocouples should be checked at least after every 20 h of use, and stainless-steel-sheathed thermocouples should be checked at least after every 50 h of use, to establish their accuracy and sensitivity. If any doubt exists as to their serviceability, they should be replaced.

7.2.2 Number

At least six furnace thermocouples should be provided for the specimens given in section 2. For specimens larger than specified in section 2, additional thermocouples should be provided in the proportion one per 1.5 m² of the specimen area. In the case of a door assembly, *specimen area* refers to the entire bulkhead construction with the door fitted.

7.2.3 Positioning

The thermocouples employed to measure the temperature of the furnace should 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 should be 100 mm from the face of the specimen and they should be maintained at a distance of 50 mm to 150 mm during the test. The method of support should 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 should not be used. The hot junctions of the thermocouples should not be located at positions within the furnace where they are subject to direct flame impingement.

7.2.4 Connection

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

7.3 Furnace pressure sensors

The mean value of the furnace pressure should be measured using one of the designs of sensing heads described in figure 5.

7.4 Unexposed-face temperature thermocouples

7.4.1 Design

The temperature of the unexposed surface should be measured by means of disc thermocouples of the type shown in figure 6. Thermocouple wires, 0.5 mm in diameter, should be soldered to a 0.2 mm thick by 12 mm diameter copper disc. Each thermocouple should be covered with a 30 mm square \times 2.0 ± 0.5 mm thick non-combustible insulating pad. The pad material should have a density of 900 ± 100 kg/m³.

7.4.2 Connection

Connection to the recording instrument should be by wires of similar or appropriate compensating type.

7.4.3 Preparation of surfaces to receive thermocouples

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

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

7.4.4 Fixing of thermocouples

Steel – The insulating pad with the thermocouple fitted should 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 should 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 should be replaced.

Mineral wool – The thermocouples with insulating pads fitted should 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 should be made using a “contact adhesive”. The nature of the adhesive necessitates a drying time before mating surfaces are put together, thus obviating the need for external pressure.

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

Vermiculite/cement type spray – The technique specified for wet fibrous spray should be employed.

Boards of fibrous or mineral aggregate composition – The bonding technique for steel should be used.

In all cases of adhesive binding the adhesive should be applied in a thin film sufficient to give an adequate bond and there should 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”.

For “A” and “B” class divisions the insulation performance of a construction should be given by that part of the construction which is manufactured from non-combustible materials only. However, if a material or panel is only produced with a superimposed finish, or if the Administration considers that the addition of a superimposed finish may be detrimental to the performance of the division, the Administration may allow, or may require, the finish to be incorporated during the test. In these cases the superimposed finish should be removed locally over as small an area as possible to allow fixing of the thermocouples to the non-combustible part, e.g. a deck provided with overlaid non-combustible insulation (a floating floor) should have any combustible top surface finish removed locally to the thermocouples to allow them to be fixed to the insulation material.

7.5 Positioning of thermocouples on the specimen

7.5.1 “A” class divisions, excluding doors

The surface temperatures on the unexposed face of the test specimen should be measured by thermocouples located as shown in figures 7 and 8:

- .1 five thermocouples, one at the centre of the test specimen and one at the centre of each of the four quarters, all positioned at least 100 mm away from the nearest part of any joints and/or at least 100 mm away from the welds to any stiffeners;
- .2 two thermocouples, one placed over each of the central stiffeners and for a bulkhead at 0.75 height of the specimen and for a deck at mid-length of the deck;
- .3 two thermocouples, each placed over a vertical (longitudinal) joint, if any, in the insulation system and positioned for a bulkhead at 0.75 height of the specimen and for a deck at mid-length of the deck;
- .4 when a construction has two differently orientated joint details, for example normal to each other, then two thermocouples additional to those already described in 7.5.1.3 above should be used, one on each of two intersections;
- .5 when a construction has two different types of joint detail, then two thermocouples should be used for each type of joint;
- .6 additional thermocouples, at the discretion of the testing laboratory or Administration, may 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; and
- .7 the thermocouples specified in 7.5.1.4 to 7.5.1.6 above for measurements on bulkheads, e.g. over different joint types or over joint intersections, should, where possible, be positioned in the upper half of the specimen.

7.5.2 "B" and "F" class divisions, excluding doors

The surface temperatures on the unexposed face of the test specimen should be measured by thermocouples located as shown in figure 9:

- .1 five thermocouples, one at the centre of the test specimen and one at the centre of each of the four quarters, all positioned at least 100 mm away from the nearest part of any joints;
- .2 two thermocouples, each placed over a vertical (longitudinal) joint, if any, in the division/insulation system and positioned for a bulkhead at 0.75 height of the specimen and for a deck/ceiling at mid-length of the deck/ceiling; and
- .3 additional thermocouples, as required by 7.5.1.4 to 7.5.1.7 above.

7.5.3 "A", "B" and "F" class doors

The surface temperatures on the unexposed face of the test specimen should be measured by:

- .1 five thermocouples, one at the centre of the door leaf and one at the centre of each of the four quarters of the door leaf, all positioned at least 100 mm away from the edge of the door leaf, from any stiffeners, from any door furniture and from any special features or specific constructional details;
- .2 if the door leaf incorporates stiffeners, two additional thermocouples, one placed over each of two stiffeners in the central portion of the door;
- .3 additional thermocouples, at the discretion of the testing laboratory or Administration, may be fixed over special features or specific constructional details if it is considered that temperatures higher than those measured by the thermocouples listed above may result. Any additional thermocouples fixed to the door frame, or to any part of the door leaf, which is closer than a distance of 100 mm from the gap between the edge of the door leaf and the frame should not be used for the purpose of classification of the test specimen, and if provided are for information only;
- .4 the thermocouples specified in 7.5.3.2 and 7.5.3.3 above should, where possible, be positioned in the upper half of the specimen; and
- .5 when testing double-leaf door assemblies, the requirements should be applied to each door leaf separately.

7.6 Structural core temperature thermocouples

When testing a specimen with a structural core other than steel, thermocouples should be fixed to the core material in positions corresponding to the surface thermocouples mentioned in 7.5.1.1.

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

7.7 Cotton-wool pads and gap gauges

7.7.1 Cotton-wool pads

The cotton-wool pad employed in the measurement of integrity should consist of new, undyed and soft cotton fibres, 20 mm thick × 100 mm square, and should weigh between 3 g and 4 g. It should be conditioned prior to use by drying in an oven at $100 \pm 5^\circ\text{C}$ for at least 30 min. After drying, it should be allowed to cool to ambient temperature within a desiccator, where it may be stored until needed to be used. For use it should be mounted in a wire frame, as shown in figure 10, provided with a handle.

7.7.2 Gap gauges

Two types of gap gauge, as shown in figure 11, should be available for the measurement of integrity. They should be made of stainless steel of the diameter specified to an accuracy of ± 0.5 mm. They should be provided with appropriate handles.

8 METHOD OF TEST

8.1 General

The test should be carried out generally in accordance with the International Standard ISO 834: Part 1, except where amended by this section. The procedures given in the following paragraphs are supplementary to, an elaboration of, or a deviation from the ISO requirements.

8.2 Commencement of test

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

At the time of the test, the initial average internal temperature and unexposed surface temperature of the specimen should be $20 \pm 10^\circ\text{C}$ and should be within 5°C of the initial ambient temperature.

8.3 Furnace control

8.3.1 Furnace temperature

8.3.1.1 The average temperature of the furnace as derived from the furnace thermocouples specified in 7.2 should be monitored and controlled such that it follows the relationship (i.e. the standard heating curve)

$$T = 345 \log_{10}(8t + 1) + 20$$

where:

T is the average furnace temperature ($^\circ\text{C}$)

t is the time (minutes)

8.3.1.2 The following points are defined by the above relationship:

- at the end of the first 5 min 576°C
- at the end of the first 10 min 679°C
- at the end of the first 15 min 738°C
- at the end of the first 30 min 841°C
- at the end of the first 60 min 945°C

8.3.1.3 The per cent deviation 'd' 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 should be within:

$\pm 15\%$	from $t = 0$ to $t = 10$	(i)
$\pm 15 - 0.5(t - 10)\%$	from $10 < t \leq 30$	(ii)
$\pm 5 - 0.083(t - 30)\%$	from $30 < t \leq 60$	(iii)
$\pm 2.5\%$	from $t = 60$ and above	(iv)

where:

$$d = (A - A_s) \times 1/A_s \times 100, \text{ and}$$

A is the area under the actual average furnace time–temperature curve

A_s is the area under the standard time–temperature curve

All areas should be computed by the same method, i.e. by the summation of areas at intervals not exceeding 1 min for (i), 2 min for (ii), and 5 min for (iii) and (iv).

8.3.1.4 At any time after the first 10 min of test, the temperature recorded by any thermocouple should not differ from the corresponding temperature of the standard time–temperature curve by more than $\pm 100^\circ\text{C}$.

8.3.2 *Furnace pressure*

8.3.2.1 A linear pressure gradient exists over the height of a furnace, and although the gradient will vary 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 should be the nominal mean value, disregarding rapid fluctuations of pressure associated with turbulence, etc., and should be established relative to the pressure outside the furnace at the same height. It should be monitored and controlled continuously and by 5 min from the commencement of the test should be achieved within ± 5 Pa and by 10 min from the commencement of the test should be achieved and maintained within ± 3 Pa.

8.3.2.2 For vertically orientated specimens the furnace should 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 should not be greater than 20 Pa, and the height of the neutral pressure axis should be adjusted accordingly.

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

8.4 **Measurements and observations on the test specimen**

8.4.1 *Temperature*

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

8.4.1.2 When calculating temperature rise on the unexposed surface of the test specimen, this should be done on an individual thermocouple-by-thermocouple basis. The average temperature rise of the unexposed surface should be calculated as the average of the rises recorded by the individual thermocouples used to determine the average temperature.

8.4.1.3 For “A” class divisions, excluding doors, the average temperature rise on the unexposed face of the specimen should be calculated from the thermocouples specified in 7.5.1.1 only.

8.4.1.4 For “B” and “F” class divisions, excluding doors, the average temperature rise on the unexposed face of the specimen should be calculated from the thermocouples specified in 7.5.2.1 only.

8.4.1.5 For “A”, “B” and “F” class doors, the average temperature rise on the unexposed face of the specimen should be calculated from the thermocouples specified in 7.5.3.1 only. For a double-leaf door, all ten thermocouples used on both door leaves should be used for this calculation.

8.4.2 *Flaming on unexposed face*

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

8.4.3 *Cotton-wool pad*

8.4.3.1 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.

8.4.3.2 A cotton-wool pad is employed by placing the frame within which it is mounted against the surface of the test specimen, adjacent to the opening or flaming under examination, for a period of 30 s, or until ignition (defined as glowing or flaming) of the cotton-wool pad occurs (if this happens before the elapse of the 30 s period). Small adjustments in position may be made so as to achieve the maximum effect from the hot gases. A cotton-wool pad should be used only once.

Where there are irregularities in the surface of the test specimen in the area of the opening, care should be taken to ensure that the legs of the support frame are placed so that clearance between the pad and any part of the test specimen surface is maintained during the measurements.

The cotton-wool pad should be applied freely and not necessarily parallel to the surface of the specimen, and not always such that the crack or opening is central to the pad. The pad should be positioned in the flow of hot gases but should never be positioned such that any part of the pad is closer than approximately 25 mm from any point of the test specimen. For example, to adequately evaluate the hot gas leakage around a door it may be necessary to use the pad both parallel and normal to the face of the door or possibly at an oblique angle within the confines of the door frame.

The operator may make 'screening tests' to evaluate the integrity of the test specimen. Such screening may involve selective short duration applications of the cotton pad to areas of potential failure and/or the movement of a single pad over and around such areas. Charring of the pad may provide an indication of imminent failure, but an unused pad should be employed in the prescribed manner for an integrity failure to be confirmed.

8.4.4 *Gap gauges*

8.4.4.1 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.

8.4.4.2 The gap gauges should be used at intervals which will be determined by the apparent rate of the specimen deterioration. Two gap gauges should be employed, in turn, and without undue force to determine:

- whether the 6 mm gap gauge can be passed through the specimen such that the gauge projects into the furnace, and can be moved a distance of 150 mm along the gap, or
- whether the 25 mm gap gauge can be passed through the specimen such that the gauge projects into the surface.

Any small interruption to the passage of the gauge that would have little or no effect upon the transmission of hot gases through the opening should not be taken into account, e.g. small fastening across a construction joint that has opened up due to distortion.

8.4.5 *Deformation*

The deflection of an "A", "B" or "F" class test specimen, and additionally in the case of a door the maximum displacement of each corner of the door leaf relative to the door frame, should be recorded during the test. These deflections and displacements should be measured with an accuracy of ± 2 mm.

8.4.6 *General behaviour*

Observations should 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 should be made. If quantities of smoke are emitted from the unexposed face this should be noted in the report. However, the test is not designed to indicate the possible extent of hazard due to these factors.

8.5 Duration of testing

8.5.1 "A" class divisions

For all "A" class divisions, including those with doors, the test should continue for minimum 60 min.

When the specimen is of an "A" class division, with a structural steel core which is imperforate (e.g. without door), and where insulation is provided to the exposed face only (i.e. the structural steel core is the unexposed face of the construction), it is permitted to terminate the test prior to 60 min once the unexposed-face temperature-rise limits have been exceeded.

8.5.2 "B" and "F" class divisions

For all "B" and "F" class divisions, including those with doors, the test should continue for minimum 30 min.

9 PERFORMANCE CRITERIA

9.1 Insulation

9.1.1 "A" class divisions, including "A" class doors

The average unexposed-face temperature rise as determined in accordance with 8.4.1 should not be more than 140°C, and the temperature rise recorded by any of the individual unexposed-face thermocouples should not be more than 180°C during the periods given below for each classification:

class "A-60"	60 min
class "A-30"	30 min
class "A-15"	15 min
class "A-0"	0 min

9.1.2 "B" and "F" class divisions, including "B" and "F" class doors

The average unexposed-face temperature rise as determined in accordance with 8.4.1 should not be more than 140°C, and the temperature rise recorded by any of the individual unexposed-face thermocouples should not be more than 225°C during the periods given below for each classification:

class "B-30"	30 min
class "B-15"	15 min
class "B-0"	0 min
class "F-30"	30 min
class "F-15"	15 min
class "F-0"	0 min

9.2 Integrity

For all "A", "B" and "F" class divisions, including "A", "B" and "F" class doors, the following requirements should be satisfied for the minimum test duration relevant to the classification (see 8.5).

Flaming: there should be no flaming on the unexposed face

Cotton-wool pad: there should be no ignition, i.e. flaming or glowing, of the cotton-wool pad when applied in accordance with 8.4.3 or when used to assist evaluation of flaming (see 8.4.2)

Gap gauges: it should not be possible to enter the gap gauges into any opening in the specimen in the manner described in 8.4.4.

9.3 Structural core temperature

In the case of load-bearing divisions of aluminium alloy, the average temperature of the structural core obtained by the thermocouples described in 7.6 should not rise more than 200°C above its initial temperature at any time during the minimum test duration relevant to the classification (see 8.5). Where the structural core is of a material other than steel or aluminium alloy the Administration should decide the rise in temperature which should not be exceeded during the test duration.

10 TEST REPORT

The test report should include all important information relevant to the test specimen and the fire test, including the following specific items:

- .1 The name of the testing laboratory and the test date.
- .2 The name of the applicant for the test.
- .3 The name of the manufacturer of the test specimen and of the products and components used in the construction, together with identification marks and trade names.
- .4 The constructional details of the test specimen, including description and drawing and principal details of components. All the details requested in section 2 should be given. The description and the drawings which are included in the test report should, 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 should be authenticated by the laboratory and at least one copy of the authenticated drawing(s) should be retained by the laboratory; in this case reference to the applicant's drawing(s) should be given in the report together with a statement indicating the method of endorsing the drawings.
- .5 All the 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 binder content of the insulation material(s) as determined by the test laboratory.
- .6 A statement that the test has been conducted in accordance with the requirements of this IMO resolution, and, if any deviations have been made to the prescribed procedures (including any special requirements of the Administration), a clear statement of the deviations.
- .7 The name of the representative of the Administration present at the test; when a test is not witnessed by a representative of the Administration a note to this effect should be made in the report in the following form:
"The ... (name of the Administration) . . . was notified of the intention to conduct the test detailed in this report and did not consider it necessary to send a representative to witness it".
- .8 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 should be included which clearly illustrates the positions of the various thermocouples and identifies them relative to the temperature-time data.
- .9 The average and the maximum temperature rises and the average core temperature rise, when applicable, recorded at the end of the period of time appropriate to the insulation performance criteria for the relevant classification (see 9.1 and 9.3) or, if the test is terminated due to the insulation criteria having been exceeded, the times at which limiting temperatures were exceeded.

- .10 The maximum deflection of an "A", "B" and "F" class specimen or the maximum deflection at the centre of an "A", "B" or "F" class door and the maximum displacement of each corner of the door leaf relative to the door frame.
- .11 Observations of significant behaviour of the test specimen during the test and photographs, if any.
- .12 The classification attained by the test specimen should be expressed in the form of "class A-60 deck", i.e. including the qualification on orientation of the division.

The result should be presented in the test report in the following manner, which includes proviso regarding non-combustibility, under the heading "Classification":

"A deck constructed as described in this report may be regarded as a

Class A-60 Deck

according to IMO resolution A.754(18) if all the materials of the construction (except adhesives) are non-combustible.

Approval of the construction may be obtained only on application to the appropriate Administration."

Appendix

Testing of windows, fire dampers, pipe penetrations and cable transits

Introduction

This appendix covers the testing of windows, fire dampers, pipe penetrations and cable transits, all of which may be incorporated within "A" class divisions.

Irrespective of the fact that this appendix is written only for "A" class divisions, the prescriptions given can be used by analogy when testing windows, fire dampers, pipe and duct penetrations and cable transits incorporated in "B" class divisions, where appropriate.

The testing and reporting of these components should be generally in accordance with the requirements given in IMO resolution A.754(18). Where additional interpretation, adaption and/or supplementary requirements may be necessary, these are detailed in this appendix.

Since it is not possible to introduce the distortions which are experienced by the structural core during tests corresponding to procedures given in the resolution, into specimens of smaller scale, all the tests of the components covered by this appendix should be undertaken with those components installed in full-size dimensioned structural cores as specified in the resolution.

A.I – WINDOWS

1 General

The term *window* is taken to include windows, sidescuttles and any other glazed opening provided for light transmission or vision purposes in "A" class bulkheads. Windows in "A" class doors are considered to be part of the door and they should be tested within the appropriate door.

The approach adopted for testing windows should generally follow the requirements for testing "A" class doors where relevant and appropriate.

2 Nature of test specimens

2.1 Dimensions

The test should be conducted on the window of the maximum size (in terms of both the width and the height) for which approval is sought.

2.2 Design

The bulkhead which includes the window should be insulated to class A-60 on the stiffened face, which should be the face exposed to the heating conditions of the test. This is considered to be most typical of the use of windows on board ships, not necessarily being the worst way round. There may be special applications of windows where the Administration considers it appropriate to test the window with the insulation of the bulkhead to the unexposed face of the structural core, or within bulkheads other than class A-60.

The window should be positioned within the bulkhead, shown in figure 1 of the resolution, at that height which is intended for practical application. When this is not known, the window should be positioned with the top of its frame as close as possible, but not closer than 300 mm, to the top of the bulkhead.

3 Instrumentation

When a window is required by the Administration to be of a classification other than class A-0, thermocouples should be fixed to the window pane as specified for the leaf of a door. In addition, thermocouples should be provided to the window frame, one at mid-length of each perimeter edge. When windows are fitted with transoms and/or mullions, five thermocouples should be fixed to each window pane as specified for the leaf of a door, and, in addition to the thermocouples fixed to the window frame, a single thermocouple should be fixed at mid-length of each transom or mullion member.

4 Method of test

4.1 Temperature

For the calculation of the average temperature rise on the unexposed face, only those thermocouples fixed to the face of the window pane(s) should be used.

4.2 Cotton-wool pad and gap gauges

For windows which are to be of a classification of A-0 the cotton-wool pad test need not be used to evaluate the integrity of a window since radiation through the window pane could be sufficient to cause ignition of the cotton-wool pad. In such cases cracks or openings in windows should not be such as to allow the gap gauges to enter in the manner described in 8.4.4 of the recommendation. The cotton-wool pad has to be used for windows required to have a classification other than A-0.

5 Hose-stream test

5.1 General

This procedure is an optional requirement and may be requested by some Administrations for windows used in specific areas of a ship. The window is subjected to the impact, erosion and cooling effects of a hose stream.

5.2 Method of test

The hose-stream test should be applied to the exposed face of the specimen immediately, but at least within not more than 1½ min following the termination of the heating period.

The water stream is delivered through a standard fire hose and discharged through a 19 mm nozzle of tapered smooth-bore pattern without shoulder at the orifice. The nozzle orifice should be 6 m from the centre and normal to the exposed face of the specimen.

The water pressure at the nozzle should be 310 kPa when measured with the water flow in progress.

The duration of application of the hose stream to the surface of the specimen should be 0.65 min for each square metre of the exposed area of the specimen. The stream should be directed firstly at the centre and then at all parts of the exposed face, changes in direction being made slowly.

5.3 Performance criteria

The specimen is considered to have satisfied the criteria of the hose-stream test if no openings develop during the application of the stream which allow water to pass to the unexposed face.

A.II – FIRE DAMPERS

1 General

“A” class divisions may have to be pierced for the passage of ventilation ducting, and arrangements should be made to ensure that the effectiveness of the division in relation to the criterion for integrity, as specified in 9.2 of the recommendation, is not impaired. Provisions should also be made to ensure that, should a fire be initiated within, or gain access to, ventilation ductwork, such a fire does not pass through the division within the ductwork.

To provide for both these requirements, fire dampers are provided within or fixed to spigots or coamings which are welded to the structural core and are insulated to the same standard as the division.

2 Nature of test specimens

2.1 Dimensions

The maximum and minimum sizes (in terms of both the width and the height, or the diameter) of each type of fire damper for which approval is sought should be tested in both vertical and horizontal orientation.

2.2 Design

2.2.1 A bulkhead which includes the damper should be constructed in accordance with 2.1.1 of the recommendation and should be insulated to class A-60 on the stiffened face, which should be the face which is not exposed to the heating conditions of the test. A deck which includes the damper should be constructed in accordance with 2.2.1 of the recommendation and should be insulated to class A-60 on the stiffened face, which should be the face which is exposed to the heating conditions of the test.

2.2.2 Fire dampers should be incorporated into or fixed to coamings or spigots, which should be welded or bolted into the structural core. The coaming or spigot including the damper should have a length of 900 mm (450 mm on each side of the structural core) and a thickness as follows:

<i>Width* or diameter of the duct</i>	<i>Minimum thickness of coaming or spigot</i>
Up to and including 300 mm	3 mm
760 mm and over	5 mm

For widths or diameters of ducts in excess of 300 mm but less than 760 mm, the thickness of the coaming or spigot should be obtained by interpolation.

The coaming or spigot should be insulated as shown in figure A1.

* *Width* means the greater of the two cross-sectional dimensions.

2.2.3 The coamings or spigots (including insulation) should be positioned only in the top half of a bulkhead but should be no closer than 200 mm from the edges of a bulkhead or a deck. Where more than one damper is to be tested simultaneously in a division, the separation between adjacent coamings or spigots (including insulation) should not be less than 200 mm. When more than one damper is included in a bulkhead, the top edges of all dampers should be, as far as possible, at the same height.

2.2.4 The fire dampers should be positioned on the exposed face of the bulkhead or deck, at a distance of at least 225 mm from the structural core, with their operative controls also on that side of the division.

2.2.5 Fire dampers which are operated automatically should be in the open position at the start of the test.

3 Instrumentation

3.1 Positioning of thermocouples on the specimen

For each fire damper, two thermocouples should be fixed to the unexposed face at each of the following locations:

- on the surface of the insulation provided to the coaming or spigot at a distance of 25 mm from the unexposed surface of the division; and
- on the surface of the coaming or spigot at a distance of 25 mm from where the coaming or spigot emerges from its insulation.

For fire dampers in bulkheads, for each of the positions indicated above, one of the thermocouples should be fixed on the top surface of the coaming or spigot and the other thermocouple should be fixed on the bottom surface of the coaming or spigot.

4 Method of test

It will not always be possible to utilize the cotton-wool-pad test to evaluate the integrity of a fire damper since radiation through the damper could be sufficient to cause ignition of the cotton-wool pad. In such cases, cracks or openings in fire dampers should not be such as to allow the gap gauges to enter in the manner described in 8.4.4 of the recommendation.

The performance of fire dampers may be related to their ability to satisfy both the insulation and the integrity criteria or may be related only to the requirements for integrity, depending on the requirements of the Administration.

A.III – PIPE AND DUCT PENETRATIONS

1 General

“A” class divisions may have to be provided with apertures to allow them to be penetrated by service pipes and ducts, and it is necessary to reinstate the insulation and/or integrity performance of the division at the position where it has been penetrated.

Administrations may have different requirements relating to the need to classify pipe and/or duct penetrations, e.g. related to the pipes’ diameter and their direct attachment or not to the structural core.

This section refers from hereon to pipe penetrations but may be read as equally applicable to duct penetrations.

2 Nature of test specimens

2.1 Dimensions

The maximum and minimum sizes (in terms of both the width and the height, or diameter) of each type of pipe penetration for which approval is sought should be tested in both vertical and horizontal orientation.

2.2 Design

2.2.1 A bulkhead which includes the pipe penetration should be constructed in accordance with 2.1.1 of the recommendation and should be insulated to class A-60 on the stiffened face, which should be the face which is not exposed to the heating conditions of the test. A deck which includes the pipe penetration should be constructed in accordance with 2.2.1 of the recommendation and should be insulated to class A-60 on the stiffened face, which should be the face which is exposed to the heating conditions of the test.

2.2.2 The pipe penetrations should be positioned only in the top half of a bulkhead but should not be closer than 200 mm from the edges of a bulkhead or a deck. Where more than one pipe penetration is to be tested simultaneously in a division, the separation between adjacent penetrations should not be less than 200 mm. Both measurements should relate to the distance to the nearest part of the penetration system, including any insulation which is part of the system.

2.2.3 Each pipe passing through a penetration should project 500 ± 50 mm beyond the exposed end of the penetration and 500 ± 50 mm beyond the unexposed end of the penetration. The exposed end of the pipe should be blanked off, using an appropriate methodology to ensure that any fire penetration into the pipe does not occur via the end of the pipe in advance of it occurring through the exposed perimeter of the pipe.

2.2.4 Each pipe should be firmly supported and fixed independent of the bulkhead or deck on the unexposed side of the test specimen, e.g. by a framework mounted from the restraint frame. The support and fixing of the pipe should restrain it from movement during the test.

3 Instrumentation

3.1 Positioning of thermocouples on the specimen

For each pipe penetration, two thermocouples should be fixed on the unexposed face at each of the following locations:

- on the surface of the pipe at a distance of 25 mm from the centre of the thermocouples to the position where the pipe emerges from the penetration seal;
- on the pipe penetration at a distance of 25 mm from the centre of the thermocouples to the face of the insulation on the unexposed side of the test specimen; and
- on the surface of any insulation or filling material used between the pipe and any coaming or spigot fixed to the division (provided that the gap between pipe or any such coaming or spigot is greater than 30 mm), or on the surface of any collar or shroud used between the pipe and the division (e.g. vapour barrier).

For pipe penetrations in bulkheads, for each of the positions indicated above, one of the thermocouples should be fixed directly above the centre of the pipe and the other thermocouple should be fixed directly below the centre of the pipe.

Additional thermocouples may be required to be fitted, dependent upon the complexity of the pipe penetration.

4 Performance criteria

4.1 General

The performance of pipe penetrations may be related to their ability to satisfy both the insulation and the integrity criteria or may be related only to the requirements for integrity, depending on the requirements of the Administration.

4.2 Insulation

Since the pipe penetration is a local weakness in the division it should be capable of preventing a temperature rise at any point on the surface not exceeding 180°C above the initial temperature. The average temperature rise is not relevant.

A.IV – CABLE TRANSITS

1 General

“A” class divisions may have to be provided with apertures to allow them to be penetrated by cables, and it is necessary to reinstate the insulation and integrity performance of the division at the position where it has been penetrated. A cable transit consists of a metal frame, box or coaming, a sealant system or material and the cables, and it may be uninsulated, partially insulated or fully insulated.

2 Nature of test specimens

2.1 Dimensions

The maximum and minimum sizes (in terms of both the height and the width) of each type of cable transit for which approval is sought should be tested in both vertical and horizontal orientation.

2.2 Design

2.2.1 A bulkhead which includes the cable transit should be constructed in accordance with 2.1.1 of the recommendation and should be insulated to class A-60 on the stiffened face, which should be the face which is not exposed to the heating conditions of the test. A deck which includes the cable transit should be constructed in accordance with 2.2.1 of the recommendation and should be insulated to class A-60 on the stiffened face, which should be the face which is exposed to the heating conditions of the test.

2.2.2 The cable transits should be positioned only in the top half of a bulkhead but should not be closer than 200 mm from the edges of a bulkhead or a deck. Where more than one cable transit is to be tested simultaneously in a division, the separation between adjacent transits should not be less than 200 mm. Both measurements should relate to the distance to the nearest part of the transit system, including any insulation which is part of the system.

2.2.3 Notwithstanding the above, the distance between transits should be sufficient to ensure that the transits do not influence each other during the test, except that this requirement does not apply to multi-transits which are intended to be positioned adjacent to one another.

2.2.4 The cables should project 500 ± 50 mm beyond the transit on the exposed side of the division and 500 ± 50 mm on the unexposed side.

2.2.5 Cable transits should be welded or bolted into the bulkhead or deck. The cables and sealing compounds or blocks should be incorporated into the transits with the bulkhead and deck panels placed respectively in vertical and horizontal positions. Any insulation should be applied to the panels and transits with the panels in the same respective positions.

2.2.6 The transit(s) should be tested incorporating a range of different types of cables (e.g. in terms of number and type of conductor, type of sheathing, type of insulation material, size) and should provide an assembly which represents a practical situation which may be found on ships. An individual Administration may have its own specification for a “standard” configuration of penetrating cables which it may use as a basis of its approvals.

The test results obtained from a given configuration are generally valid for the tested types of cables of size equal to or smaller than tested.

2.2.7 No more than 40% of the inside cross-sectional area of each transit should be occupied by cables and the distances between adjacent cables and between the cables and the inside of the transit should be the minimum which is allowable for the actual penetration sealing system.

3 Instrumentation

3.1 Positioning of thermocouples on the specimen

For each uninsulated cable transit, thermocouples should be fixed on the unexposed face at each of the following locations:

- at two positions on the surface of the outer perimeter of the frame, box or coaming at a distance of 25 mm from the unexposed surface of the division;
- at two positions at the end of the transit, on the face of the sealant system or material at a distance of 25 mm from a cable; and
- on the surface of each type of cable included in the cable transit, at a distance of 25 mm from the face of the sealant system or material. In case of a group or bunch of cables the group should be treated as a single cable. In case of horizontal cables the thermocouples should be mounted on the uppermost surface of the cables.

For those thermocouples placed on the outer perimeter of the frame, box or coaming, one thermocouple should be fixed on each of two opposite faces, which in the case of bulkheads should be the top and bottom faces.

For each partially insulated or fully insulated cable transit, thermocouples should be fixed on the unexposed face at equivalent positions to those specified for an uninsulated transit as illustrated in figure A2.

Additional thermocouples may be required to be fixed, dependent upon the complexity of the cable transit.

When fixing thermocouples to the unexposed surface of the cables, the copper disc and the insulating pad should be formed over the surface to provide good contact with the surface of the cable. The copper disc and the pad should be retained in position by some mechanical means, e.g. wiring or spring clips, such that they do not become detached during the test. The mechanical retention should not provide any significant heat-sink effect to the unexposed face of the thermocouple.

4 Performance criteria

4.1 General

The performance of cable transits may be related to their ability to satisfy both the requirements for insulation and integrity or may be related only to the requirements for integrity, depending on the requirements of the Administration.

4.2 Insulation

Since the cable transit is a local weakness in the division it should be capable of preventing a temperature rise at any point on the surface not exceeding 180°C above the initial temperature. The average temperature rise is not relevant.

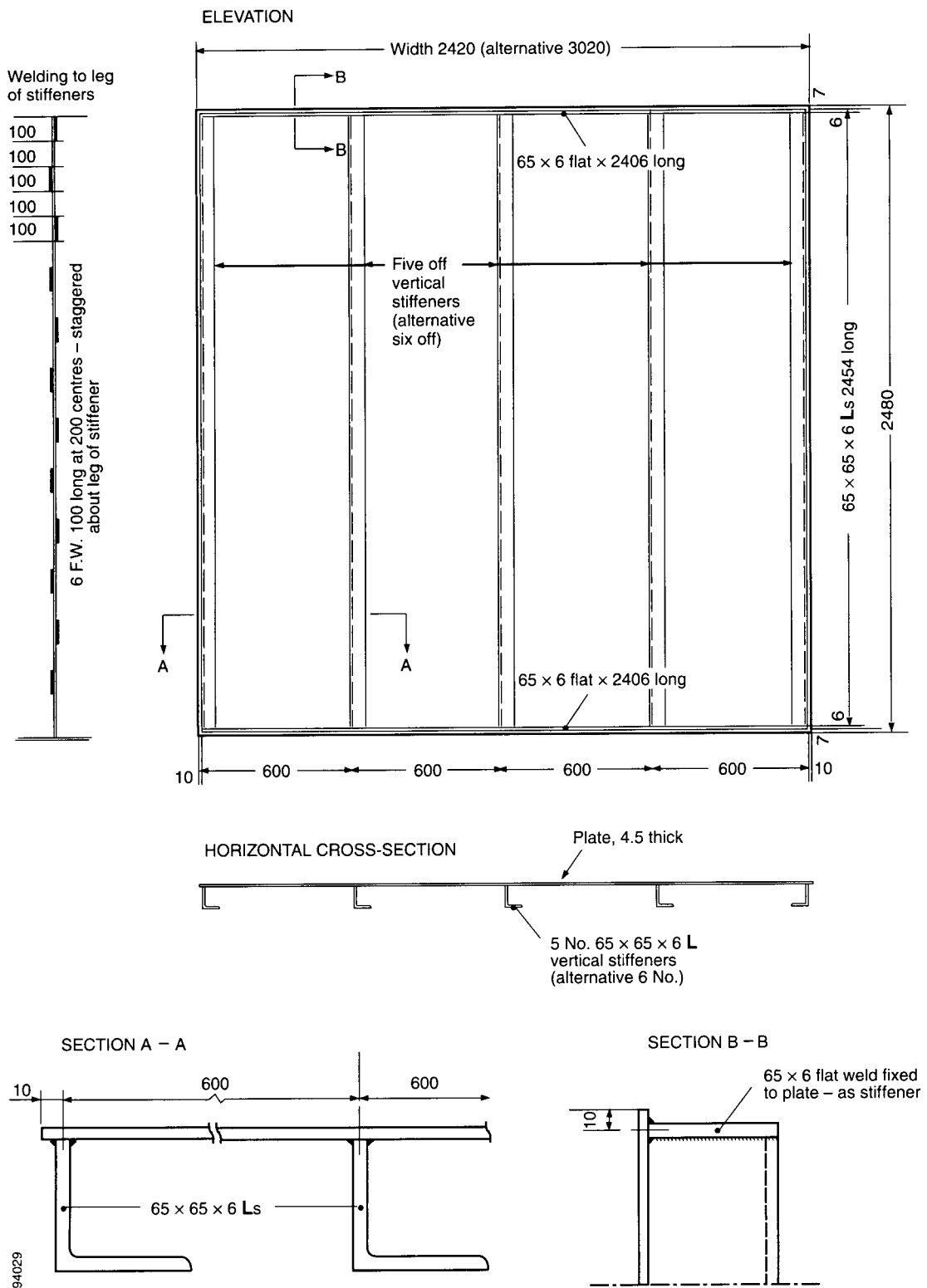


Figure 1 - Structural steel core for 'A' class bulkhead and 'B' class lining

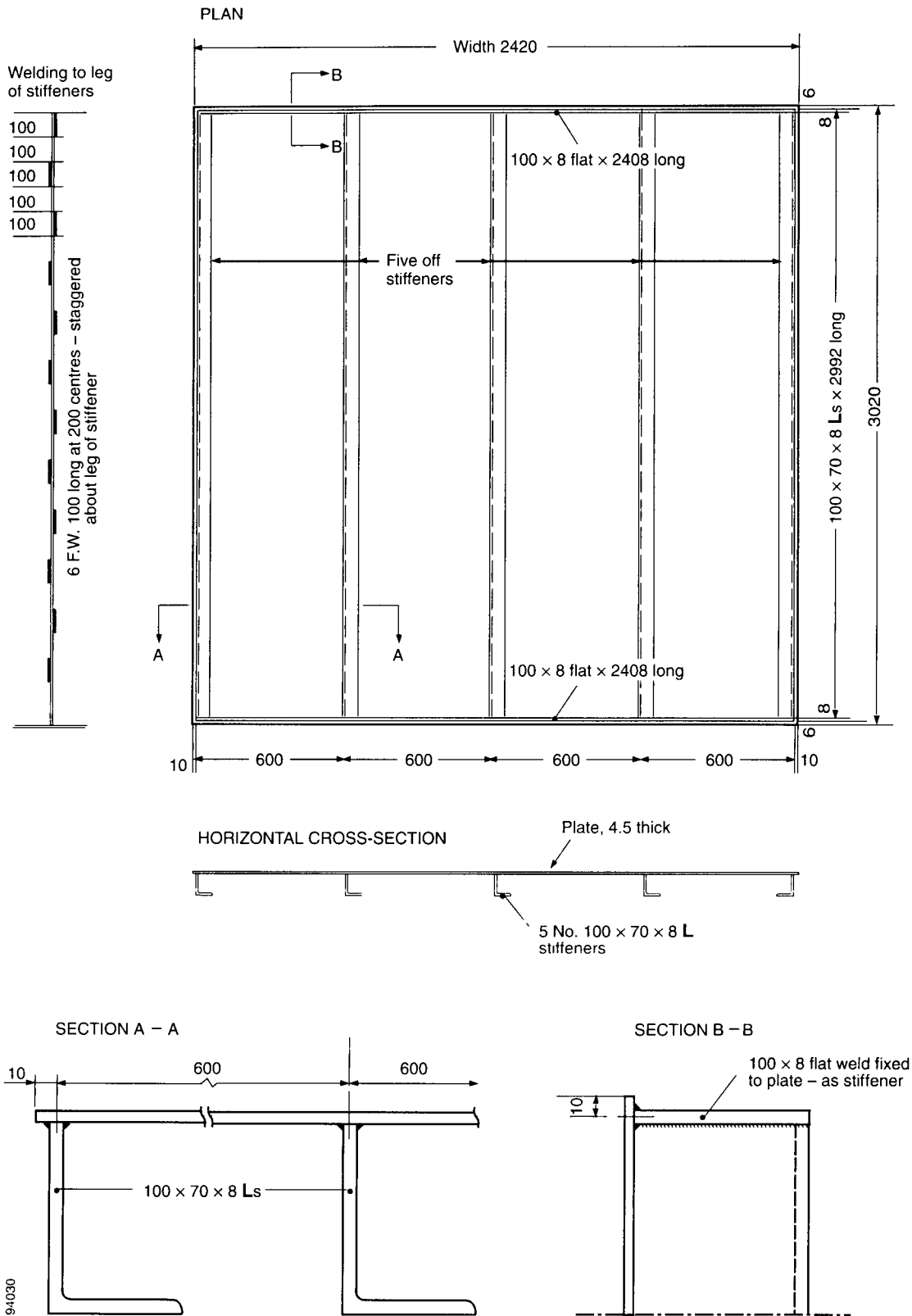
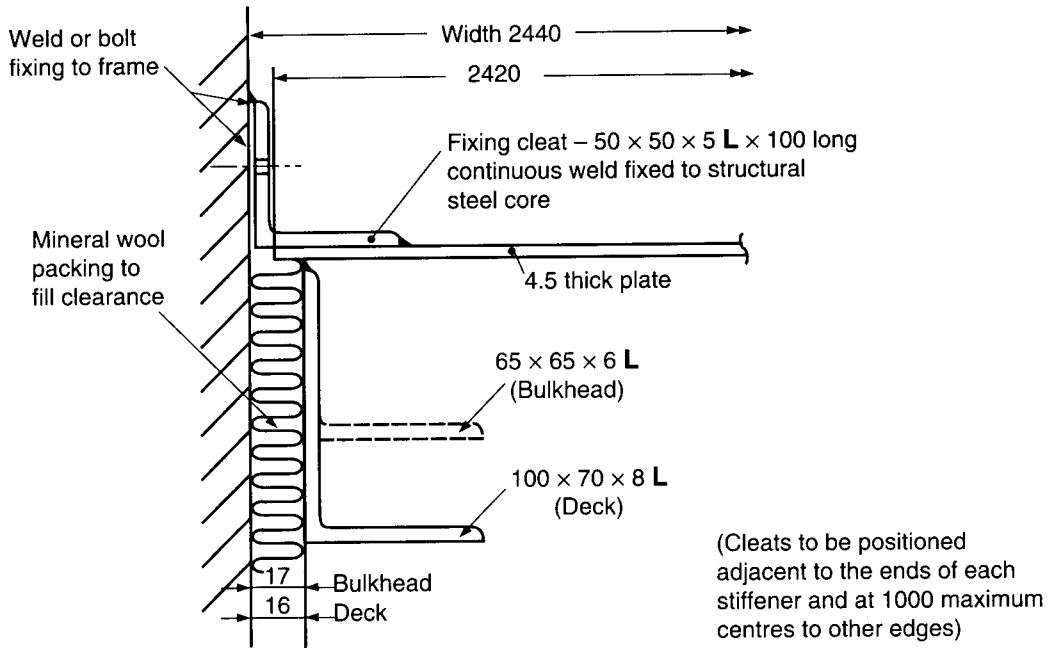
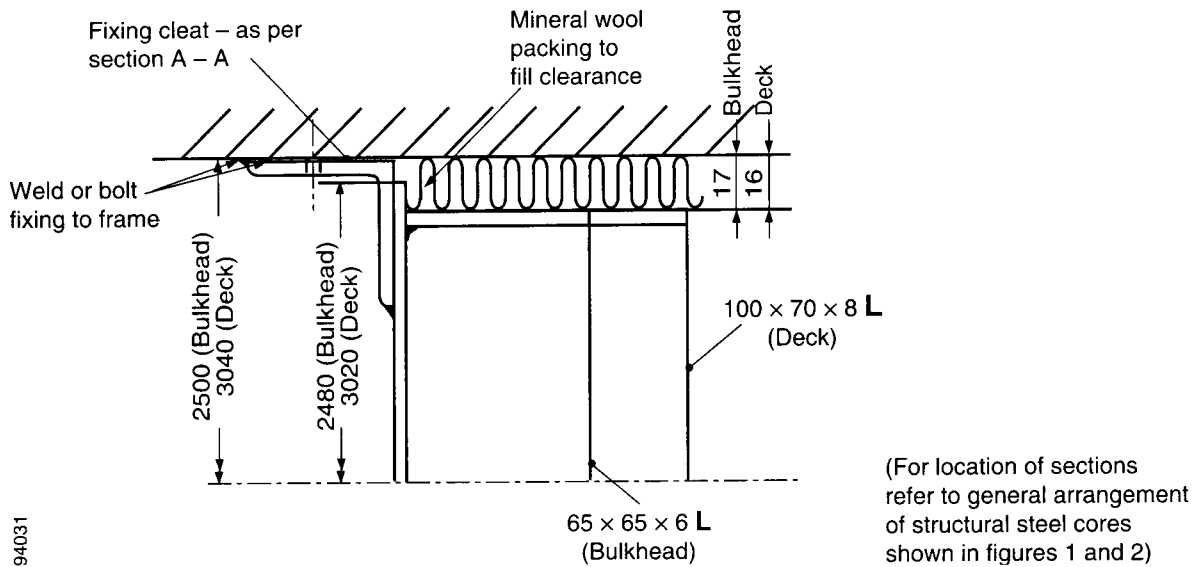


Figure 2 - Structural steel core for 'A' class deck and 'B' class ceiling

SECTION A – A (see figures 1 and 2)



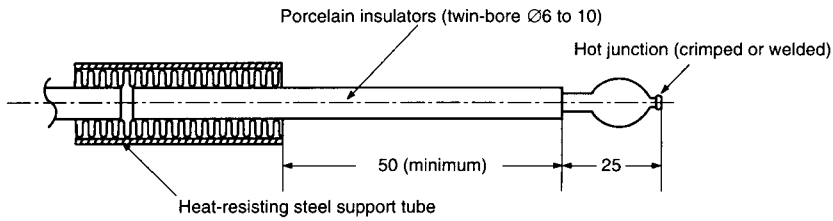
SECTION B – B (see figures 1 and 2)



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Figure 3 – Connection between restraint frame and structural steel core

Bare wire thermocouple assembly



Stainless-steel-sheathed thermocouple assembly

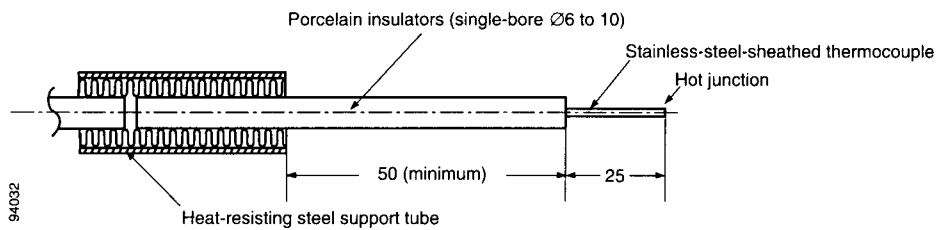
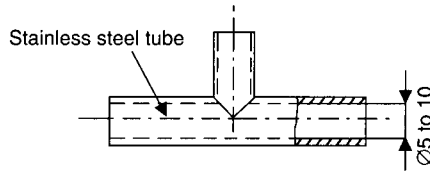


Figure 4 - Furnace thermocouple assembly

Type 1 - 'T' shaped sensor



Note: Tee branches shall be horizontally oriented

Type 2 - tube sensor

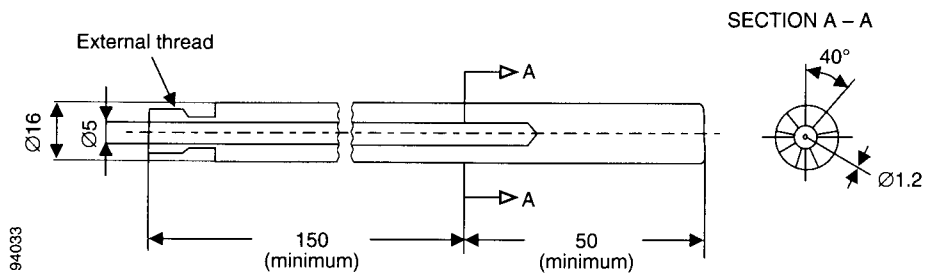
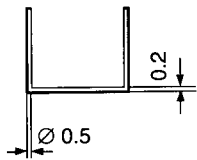
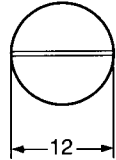


Figure 5 - Pressure-sensing heads

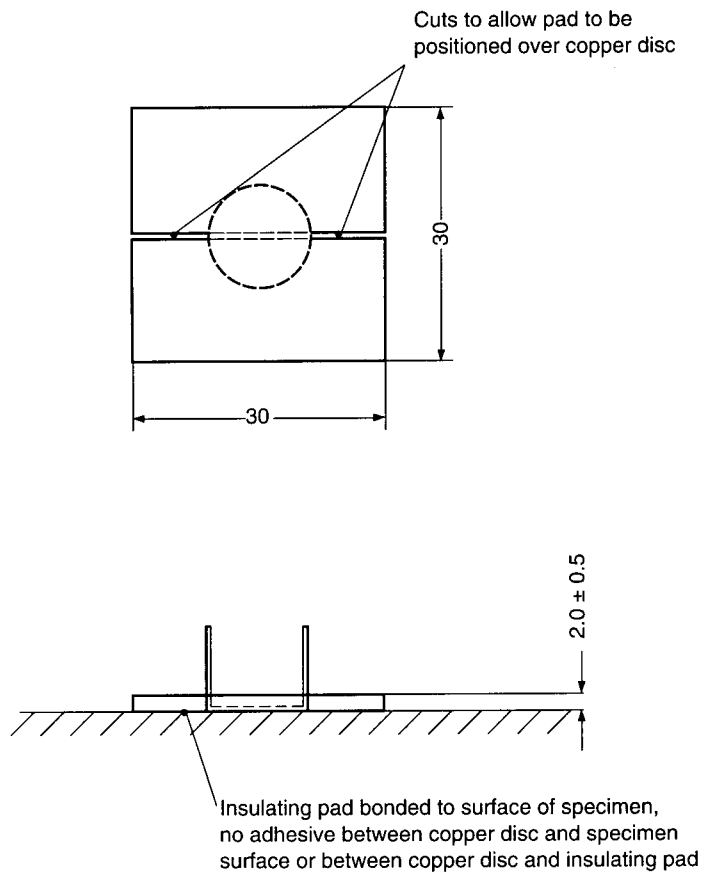
Copper disc measuring junction



When making the junction of the thermocouple wires to the copper disc, a minimum amount of solder shall be used for the purpose. Any surplus solder shall be removed.

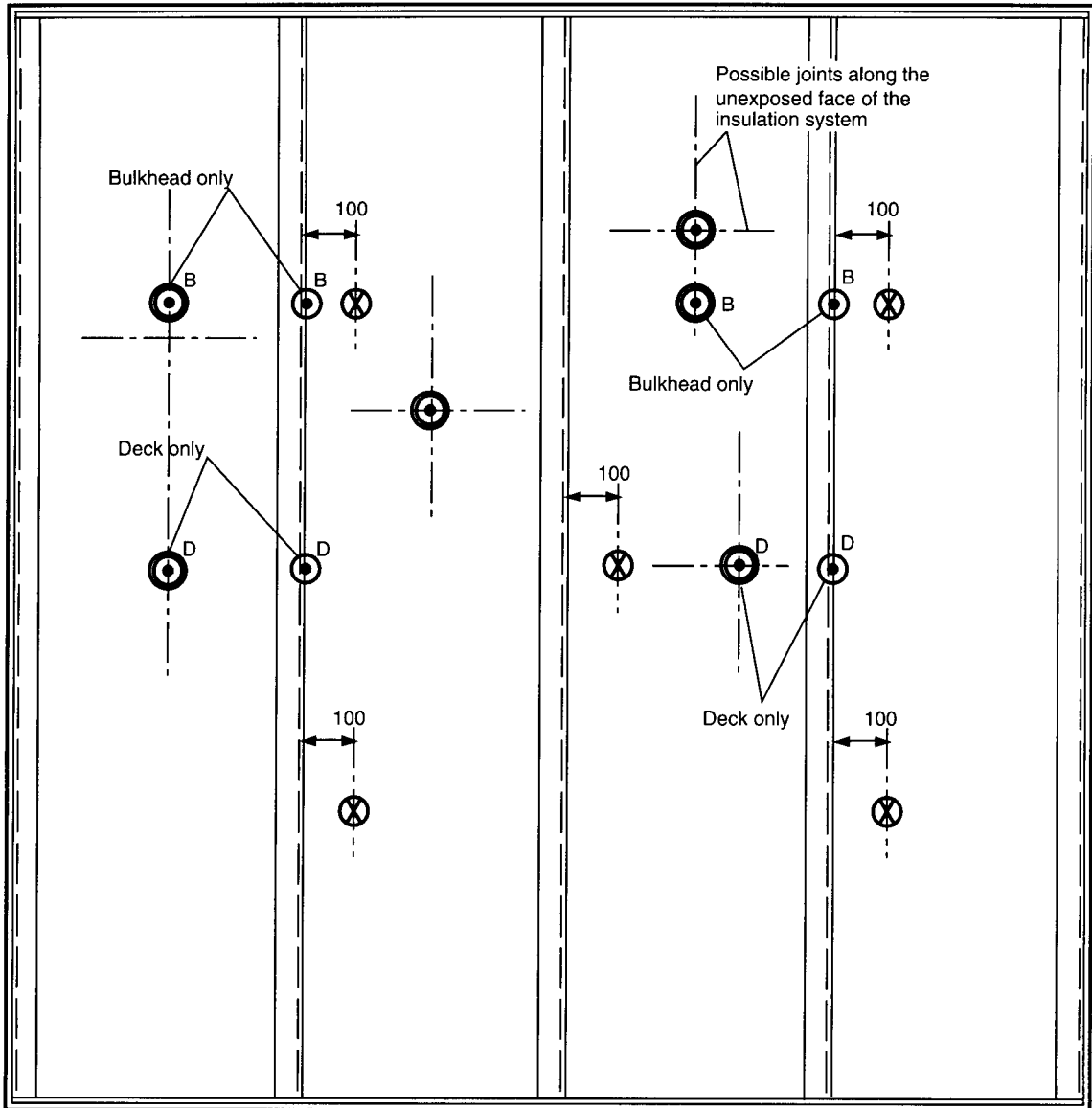


Copper disc and insulating pad



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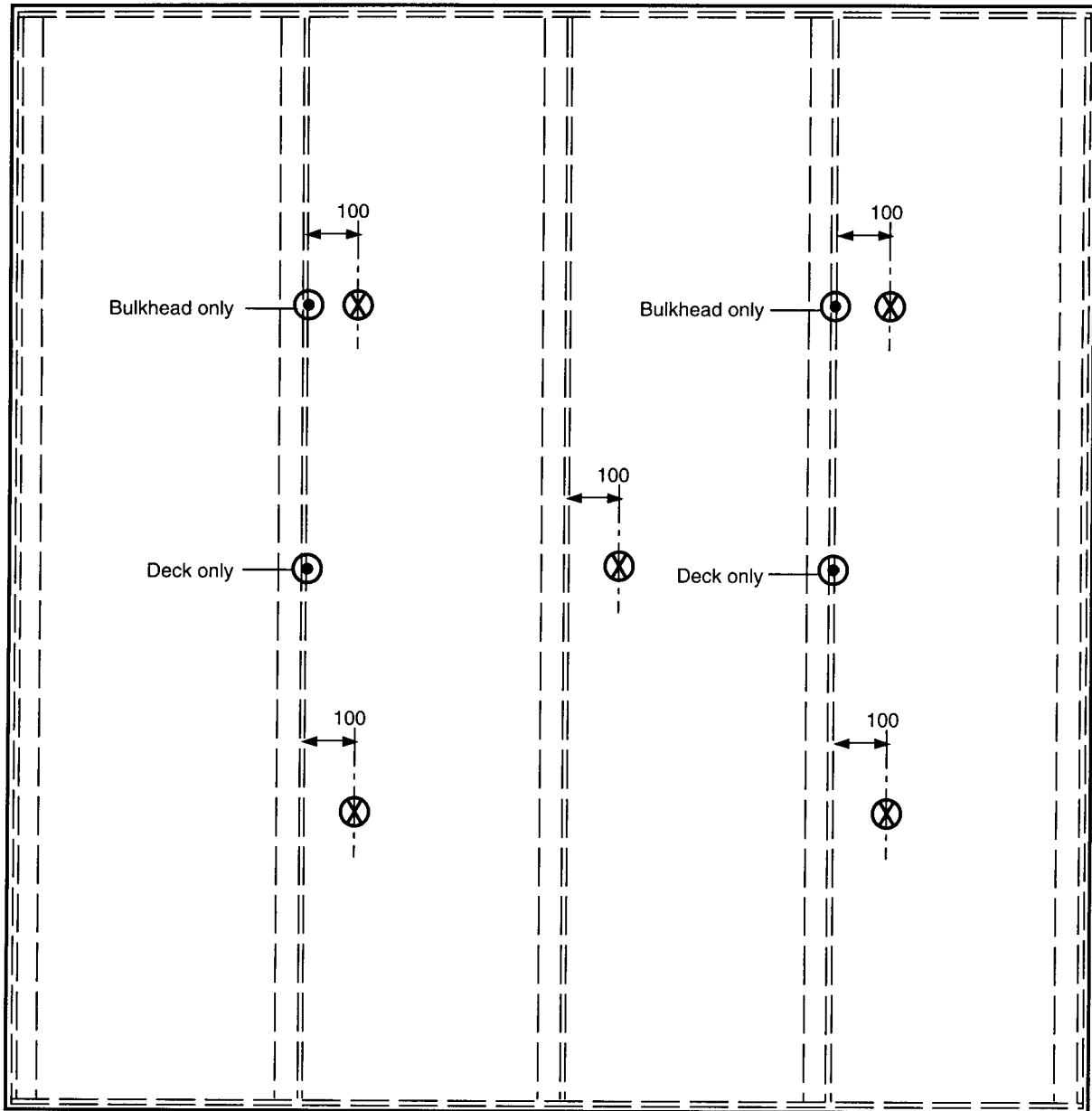
Figure 6 - Unexposed-surface thermocouple junction and insulating pad



- ⊗ Thermocouples used for maximum temperature rise and in calculating average temperature rise.
- ⊙ Thermocouples used for maximum temperature rise.
- ⊕ Thermocouples used for maximum temperature rise (Not applicable if insulation system is without joints).
- B: Thermocouples used for bulkhead tests only.
- D: Thermocouples used for deck tests only.

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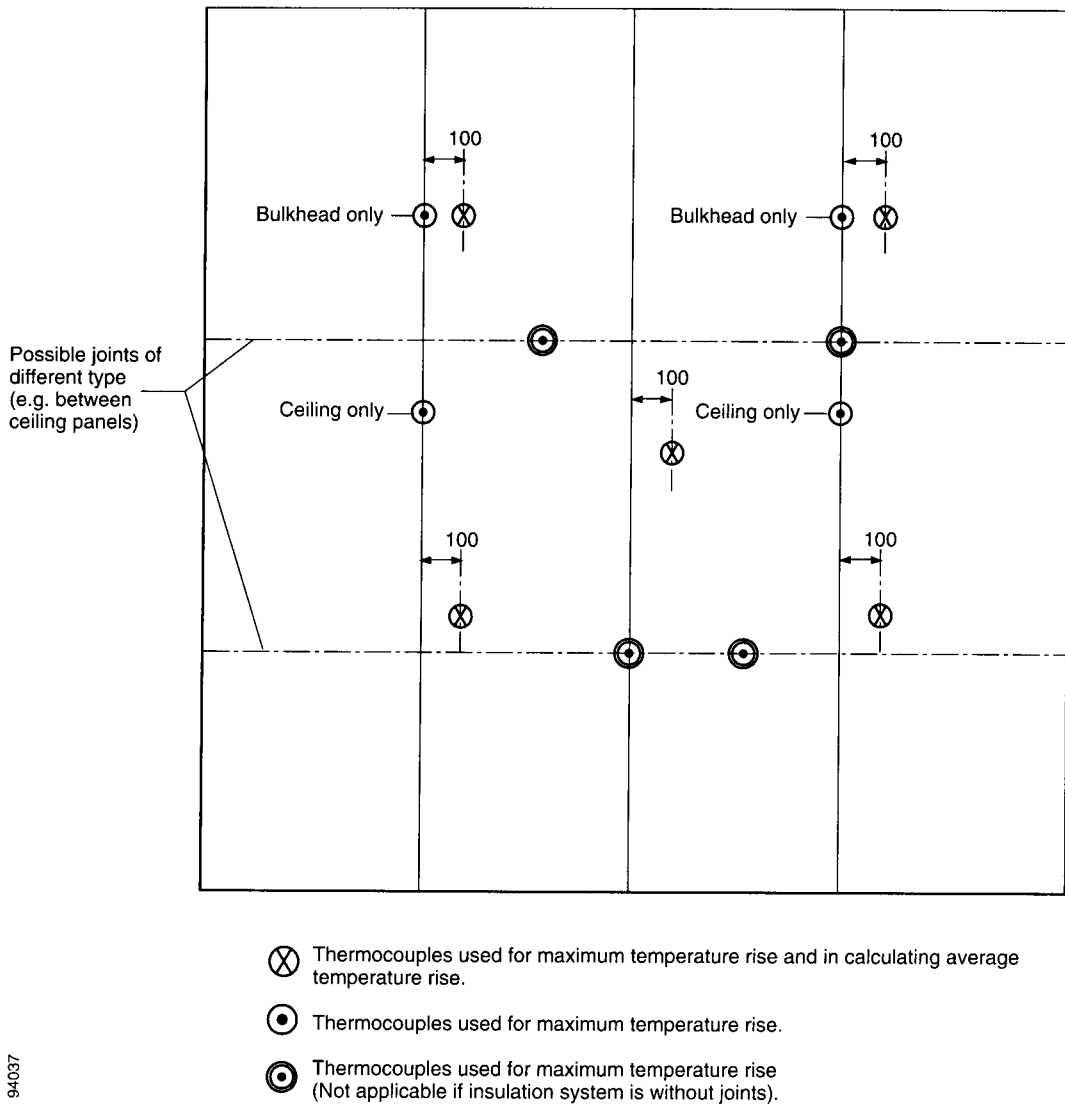
Figure 7 - Position of unexposed-face thermocouples for 'A' class division: insulated face to the laboratory



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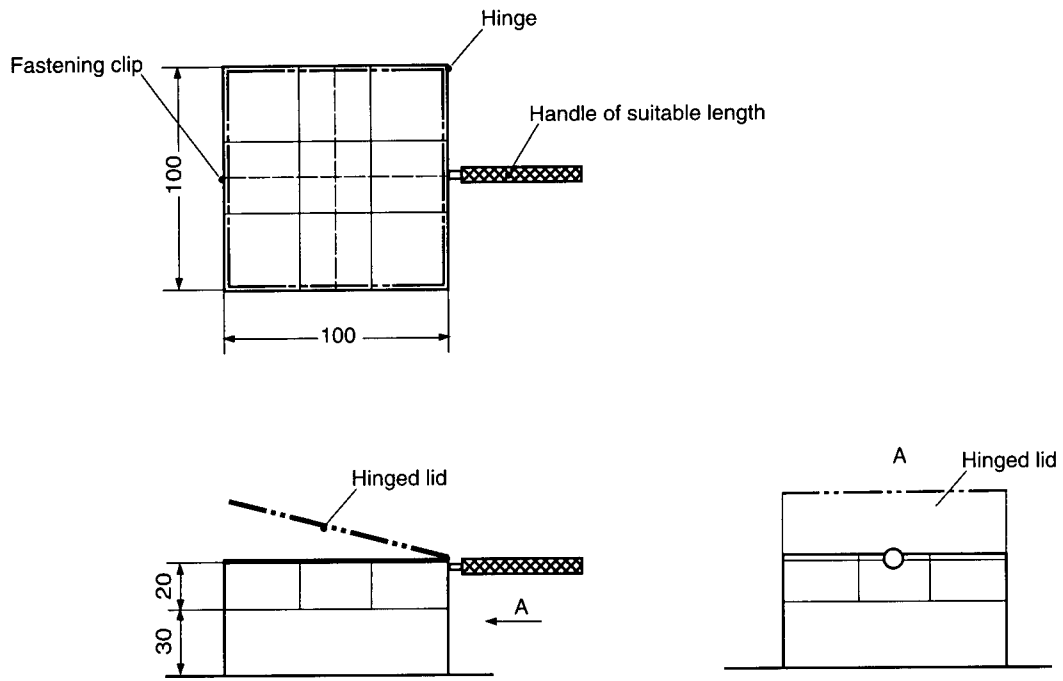
- ⊗ Thermocouples used for maximum temperature rise and in calculating average temperature rise.
- Thermocouples used for maximum temperature rise.

Figure 8 - Position of unexposed-face thermocouples for 'A' class division: flat face of structural steel core to the laboratory



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Figure 9 - Position of unexposed-face thermocouples for 'B' and 'F' class divisions



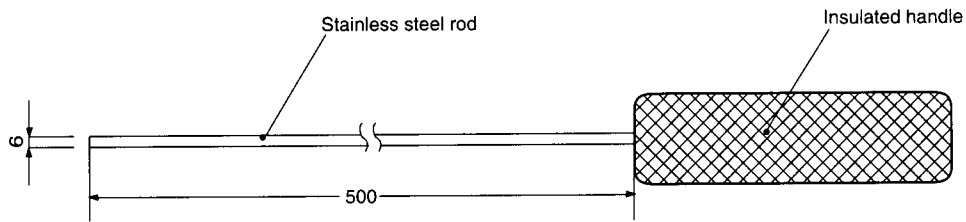
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Material list:

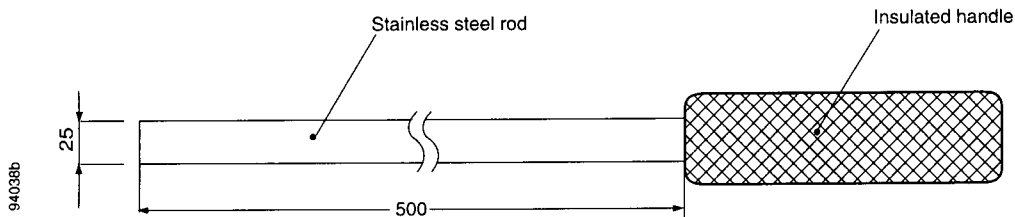
1. Main framework manufactured from $\varnothing 1.5$ wire
2. Supporting wire $\varnothing 0.5$ for cotton pad

Figure 10 - Cotton pad holder

The 6 mm diameter gap gauge



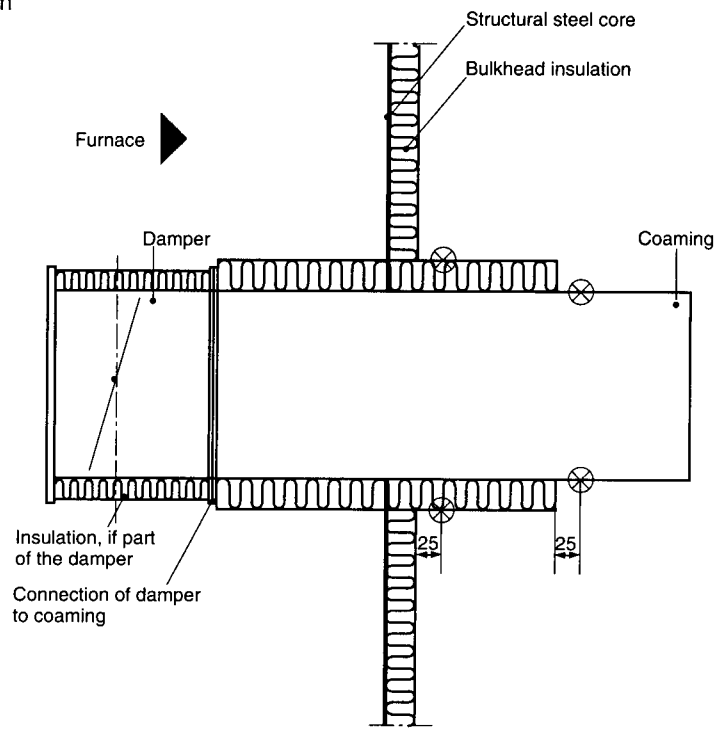
The 25 mm diameter gap gauge



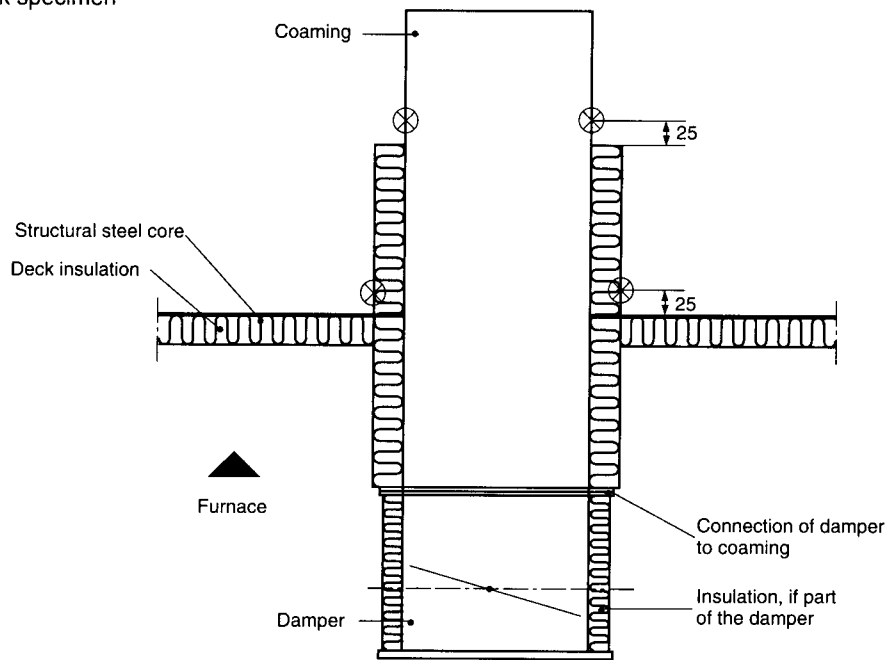
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Figure 11 - Gap gauges

Bulkhead specimen



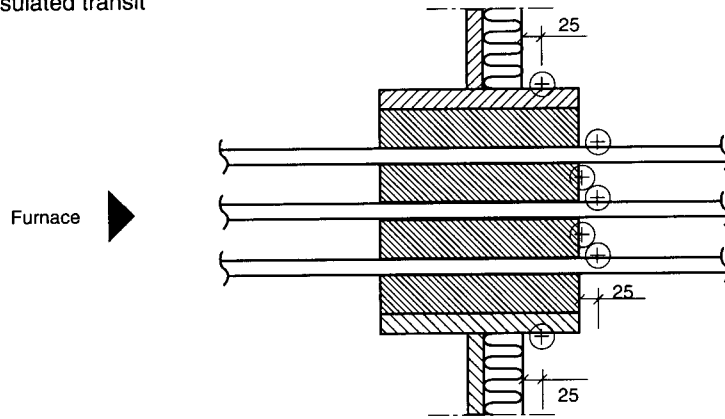
Deck specimen



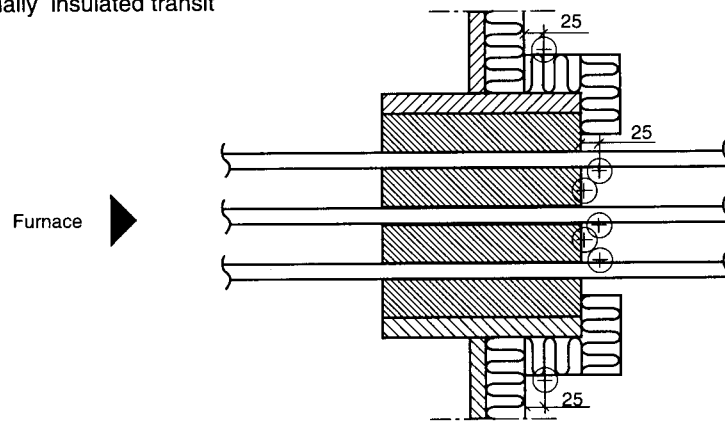
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Figure A1 – Fire dampers: insulation on test specimens and position of unexposed-face thermocouples

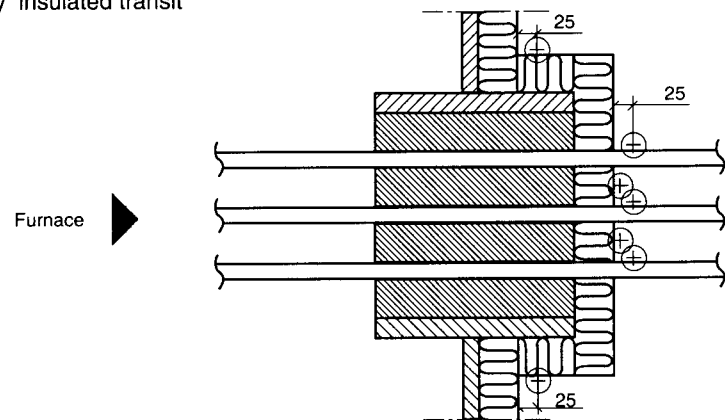
Uninsulated transit



Partially insulated transit



Fully insulated transit



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Figure A2 - Cable transits; position of unexposed-face thermocouples (shown for bulkhead)