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RESOLUTION A.123(V)

Adopted on 25 October 1967

RECOMMENDATION ON FIXED FIRE EXTINGUISHING SYSTEMS FOR SPECIAL CATEGORY SPACES [1]

A fixed fire extinguishing system for special category spaces should be at least as effective in controlling a flowing petrol fire as a fixed pressure water-spraying system complying with the following:

(a) The nozzles should be of an approved full bore type. They should be arranged so as to secure an effective distribution of water in the spaces which are to be protected. For this purpose, the system should be such as will provide water application at a rate of at least 3.5 litres per square metre per minute (0.07 gallons per square foot per minute) for spaces with a deck height not exceeding 2.5 metres (8.2 feet) and a capacity of at least 5 litres per square metre per minute (0.1 gallons per square foot per minute) for spaces with a deck height of 2.5 metres (8.2 feet) or more.

(b) The water pressure should be sufficient to secure an even distribution of water.

(c) The system should normally cover the full breadth of the vehicle deck and may be divided into sections provided they are of at least 20 metres (66 feet) in length, except that in ships where the vehicle deck space is subdivided with longitudinal ”A” Class divisions forming boundaries of staircases, etc., the breadth of the sections may be reduced accordingly.

(d) The distribution valves for the system should be situated in an easily accessible position adjacent to but outside the space to be protected which will not readily be cut off by a fire within the space. Direct access to the distribution valves from the vehicle deck space and from outside that space should be provided. Adequate ventilation should be fitted in the space containing the distribution valves.

(e) The water supply to the system should be provided by a pump or pumps other than the ship's required fire pumps which should additionally be connected to the system by a lockable non-return valve which will prevent a back-flow from the system into the fire main.

(f) The principal pump or pumps should be capable of providing simultaneously at all times a sufficient supply of water at the required pressure to all nozzles in the vehicle deck or in at least two sections thereof.

(g) The principal pump or pumps should be capable of being brought into operation by remote control (which may be

---

[1] ”Special category spaces" are those enclosed spaces above or below the bulkhead deck intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access.

manually actuated) from the position at which the distribution valves are situated.

RESOLUTION A.229(VII)

Adopted on 12 October 1971

MERCHANT SHIP SEARCH AND RESCUE MANUAL (MERSAR)

The Assembly,

Noting Article 16(i) of the Convention on the Inter-Governmental Maritime Consultative Organization concerning the functions of the Assembly with regard to maritime safety,

Having considered the Merchant Ship Search and Rescue Manual (MERSAR) prepared by the Maritime Safety Committee and communicated to all concerned (MSC/Circ.63 and 73),

Having noted that the Committee recommended Member Governments to put the Manual into effect forthwith by giving it wide distribution and encouraging vessels under their flag to adhere to it as necessary so that experience could be gained,

Having also noted with approval that the Committee has included in its long-term programme the formulation of an international agreement on a Search and Rescue System,

Decides:

(a) to adopt the Manual, and

(b) to endorse the Committee's recommendation for putting it into effect,

Requests the Maritime Safety Committee to:

(a) take the necessary action for keeping the Manual up to date and amended as appropriate, and

(b) consider in due course the status of the Manual in the context of the agreement on a Search and Rescue System.

RESOLUTION A.265(VIII)

Adopted on 20 November 1973

REGULATIONS ON SUBDIVISION AND STABILITY OF PASSENGER SHIPS AS AN EQUIVALENT TO PART B OF CHAPTER II OF THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1960

1. The Regulations hereunder constitute an equivalent to and a total alternative to the requirements of Part B of Chapter II of the International Convention for the Safety of Life at Sea, 1960 for passenger ships.

2. In applying these equivalent Regulations the following should be observed for other Parts of Chapter II of that Convention:

PART A - Regulation l (d) and Regulation 2 are not applicable.
PARTS C, F AND H - In Regulations 25(a), 37(b), 68(a), 94(1), 96(b), 99(a), (b) and (c) and 108 the term "bulkhead deck" is to be replaced by the term "relevant bulkhead deck" as defined in Regulation 1(e) of the equivalent Regulations.

3. The following references to Regulations relate solely to the Regulations of this Equivalent.

Regulation 1

Definitions

For the purpose of these Regulations, unless expressly provided otherwise:

(a) **(i)** A "subdivision loadline" is a waterline used in determining the subdivision of the ship; and

(ii) the "deepest subdivision loadline" is the waterline which corresponds to the greatest draught permitted by the subdivision requirements which are applicable.

(b) the "subdivision length of the ship" (L_s) is the extreme moulded length of that part of the ship below, the immersion limit line.

(c) "midlength" is the midpoint of the subdivision length of the ship (L_s).

(d) **(i)** the "breadth" (B_1) is the extreme moulded breadth of the ship at midlength at or below the deepest subdivision loadline;

(ii) the "breadth" (B_2) is the extreme moulded breadth of the ship at midlength at the relevant bulkhead deck.

(e) The "relevant bulkhead deck" is the uppermost deck which, together with the watertight bulkheads bounding the extent of flooding under consideration and the shell of the ship, defines the limit of watertight integrity in the flooded condition.

(f) The "immersion limit line" at any point in L_s is defined by the highest relevant bulkhead deck at side at that point.

(g) The "draught" (d_i) is the vertical distance from the moulded base line at midlength to the waterline in question.

(i) The "subdivision draught" (d_s) is the draught up to the subdivision loadline in question.

(ii) The "lightest service draught" (d_o) is the service draught corresponding to the lightest anticipated loading and associated tankage, including, however, such ballast as may be necessary for stability and/or immersion.

(iii) Intermediate draughts between d_s and d_o are:

$$d_1 = d_s - {}^2/_3\,(d_s - d_o)$$
$$d_2 = d_s - {}^1/_3\,(d_s - d_o)$$
$$d_3 = d_s - {}^1/_6\,(d_s - d_o)$$

(h) The "effective mean damage freeboard" (F_1) is equal to the projected area of that part of the ship taken in the upright position between the relevant bulkhead deck and the damage waterline and between ${}^1/_3L_s$ forward and abaft the midlength divided by ${}^2/_3L_s$. In making this calculation no part of the area which is more than $0.2B_2$ above the damage waterline shall be included. However, if there are stairways or other openings in the bulkhead deck through which serious downflooding could occur F_1 shall be taken as not more than ${}^1/_3(B_2$ tang $\theta_f)$, where θ_f is the angle at which such openings would be immersed.

(i) The "permeability" (μ) of a space is the proportion of the immersed volume of that space which can be occupied by water.

Regulation 2

Subdivision Index

(a) To provide for buoyancy and stability after collision or other damage, ships shall have sufficient intact stability and be as efficiently subdivided as is possible having regard to the nature of the service for which they are intended.

(b) The subdivision of a ship is considered sufficient if:

(i) the stability of the ship in damaged condition meets the requirements of Regulation 5; and

(ii) the attained Subdivision Index A according to Regulations 6 and 7 is not less than the required Subdivision Index R calculated in accordance with paragraph (c) of this Regulation.

(c) The degree of subdivision is determined by the required Subdivision Index R, as follows:

$$R = 1 - \frac{1000}{1.22L_S + N + 1500} \quad (\textit{in feet})$$

$$\ldots\ldots\ldots\ldots\ldots(\mathrm{I})$$

$$R = 1 - \frac{1000}{4L_S + N + 1500} \quad (\textit{in metres})$$

Where:

N = $N_1 + 2N_2$
N_1 = number of persons for whom life-boats are provided.
N_2 = number of persons (including officers and crew) that the ship is permitted to carry in excess of N_1.

(d) Where the conditions of service are such that compliance with paragraph (b) of this Regulation on the basis of $N = N_1 + 2N_2$ is impracticable and where the Administration considers that a suitably reduced degree of hazard exists, a lesser value of N may be taken but in no case less than $N = N_1 + N_2$.

Regulation 3

Special Rules concerning Subdivision

(a) In ships 330 feet (or 100 metres) in length and upwards the watertight transverse bulkhead next abaft the forepeak bulkhead shall be located so that the s-value, as defined in Regulation 6(a), for a combination of the forepeak and adjacent compartment, calculated by formulae (VIII) and (IX) shall not be less than 1.0. However, in no case shall the distance between the forepeak bulkhead and the next bulkhead be less than the longitudinal extent of damage specified in Regulation 5(b)(i).

(b) A watertight transverse bulkhead may be recessed provided that all parts of the recess lie inboard of vertical surfaces on both sides of the ship, situated at a distance of $0.2B_1$ from the ship's side, and measured at right angles to the centreline at the level of the subdivision loadline. Any part of a recess which lies outside these limits shall be dealt with as a step, as provided in Regulation 5(b)(i).

Regulation 4

Permeability

(a) For the purpose of the subdivision and damage stability calculations of Regulations 5, 6 and 7 the permeability of each space or part of a space subject to flooding either during any intermediate stage or in the final stage of flooding shall be as follows:

Spaces	*Permeability* (μ)
Appropriated as accommodation for passengers and crew, or other spaces not specifically herein designated	0.95
Appropriated for machinery…………….	0.85
Normally occupied by stores……………	0.60
Intended for consumable liquids………..	0.00 or 0.95[2]

(b) The permeability μ of any space appropriated for cargo shall be assumed to vary with the draught before damage in such a way that for any initial draught d_i the permeability μ_i of any cargo space shall be taken as:

$$\mu_i = 1.000 - \frac{1.2(d_i - d_o)}{d_s} - \frac{0.05(d_s - d_i)}{(d_s - d_o)}$$

but not more than 0.95 nor less than 0.60.

(c) If the ship's arrangement or service are such that the use of other permeabilities resulting in more severe requirements is logical the use of other permeabilities may be required by the Administration.

Regulation 5

Subdivision and Damage Stability

(a) Sufficient intact stability shall be provided in all service conditions so as to enable the ship to comply with the provisions of this Regulation. Before certification of the ship the Administration shall be satisfied that the required intact stability can practicably be obtained in service.

(b) **(i)** All ships shall be so designed as to comply with the provisions of this Regulation in the event of flooding due to one side damage with a penetration of $0.2B_1$ from the ship's side at right angles to the centreline at the level of the subdivision loadline and a longitudinal extent of 9.8 feet (3.00 metres) + $0.03L_s$, or 36 feet (11 metres) whichever is the less, occurring anywhere in the ship's length, but not including a transverse bulkhead. However, where a bulkhead is stepped it shall be assumed as subject to damage.

(ii) Ships for which N is more than 600 shall additionally be able to comply with this Regulation in the event of flooding, due

[2] Whichever results in the more severe requirement.

to side damage including transverse bulkheads occurring anywhere within a length equal to ($\frac{N}{600}$ - 1.00)L_s, measured from the forward terminal of L_s, where N is as defined in Regulation 2(c) and (d). The value of ($\frac{N}{600}$ - 1.00) shall not be more than one.

(iii) In any calculation required under this paragraph the damage shall be assumed to extend from the base line upwards without limit. However, if flooding due to a lesser extent of damage either vertically, transversely or longitudinally results in a higher necessary intact metacentric height, such a lesser extent of damage shall be assumed. In all cases, however, only one breach in the hull and only one free surface need be assumed. For the purpose of assessing heel prior to, equalization the bulkheads and deck bounding refrigerated spaces and other decks or inner divisions which in the opinion of the Administration are likely to remain sufficiently watertight after damage, shall be regarded as limiting flooding. Otherwise, flooding shall be assumed as limited only by undamaged watertight structural divisions.

(c) **(i)** In the final stage of flooding:

(1) there shall be a positive metacentric height, GM, calculated by the constant displacement method and for the ship in upright condition, of at least

$GM = 0.003 \frac{B_2^2(N_1 + N_2)}{\Delta F_1}$ or

$GM = 0.049 \frac{B_2}{F_1}$ (in feet)

$GM = 0.015 \frac{B_2}{F_1}$ (in metres) or

GM = 2 inches (0.05 m) whichever is the greater

Where: Δ = displacement of the ship in the undamaged condition (in long tons or metric tons respectively);

(2) the angle of heel in the case of one compartment flooding shall not exceed 7 degrees. For the simultaneous flooding of two or more adjacent compartments a heel of 12 degrees may be permitted unless the Administration considers a lesser heel necessary to ensure an adequate amount and range of residual stability;

(3) except in way of the flooded compartment or compartments no part of the relevant bulkhead deck at side shall be immersed.

(ii) Unsymmetrical flooding shall be kept to a minimum consistent with efficient arrangements. If any equalizing arrangements are necessary to ensure that the angle of heel in the final stage of flooding does not exceed the limits specified in sub-paragraphs (i)(2) and (3) of this paragraph, these arrangements shall, where practicable, be self-acting. However, if controls are necessary, they shall be operable from above the highest relevant bulkhead deck. All such arrangements shall be acceptable to the Administration.

(iii) The Administration shall be satisfied that stability prior to equalization is sufficient. However, in no case shall the maximum heel before equalization exceed 20 degrees nor shall it result in progressive flooding. Additionally, the time for equalization of cross-connected spaces to at least the limits specified in sub-paragraphs (i)(2) and (3) of this paragraph shall not exceed ten minutes.

(iv) The Administration shall be satisfied that the residual stability is sufficient during intermediate flooding and that progressive flooding will not take place. Calculations relative thereto shall be in accordance with the provisions of sub-paragraph (b)(iii) of this Regulation, respecting the assumed extent of damage and resulting extent of flooding. Heel during intermediate flooding due either to negative metacentric height alone or in combination with unsymmetrical flooding shall not exceed 20 degrees.

(d) Damage stability calculations performed in compliance with this Regulation shall be such as to take account of the form and the design characteristics of the ship and the arrangements, configuration and probable contents of the compartments considered to be flooded. In making calculations for heel prior to equalization and for equalization time, the flooding of that portion of the ship opened to the sea shall be assumed to be completed prior to commencement of equalization. For each initial draught condition the ship shall be at the most unfavourable intact service trim anticipated at that draught having regard to the influence of the trim on the freeboard in the flooded condition.

(e) The intact metacentric height, and corresponding vertical centre of gravity, necessary to provide compliance with the requirements specified in paragraphs (b) and (c) of this Regulation shall be determined for the operating range of draughts between d_s and d_o. If (d_s-d_o) does not exceed 0.1 d_s, damage stability calculations may be made only for d_s and d_o, and the intermediate values may be obtained by linear interpolation. If (d_s –d_o) exceeds 0.1 d_s, damage stability calculations shall also be made for at least one additional intermediate draught. However, in all cases where there are vertical discontinuities in permeabilities or in free surfaces which may result in discontinuities in the necessary intact metacentric height, damage stability calculations shall be made for the corresponding draughts in order to define such discontinuities.

Regulation 6

Attained Subdivision Index A

(a) **(i)** In addition to complying with Regulation 5 the attained Subdivision Index A shall be determined for the ship by formula (II):

$A = \Sigma$ aps………………………..(II)

Where:
"a" accounts for the probability of damage as related to the position of the compartment in the ship's length,

"p" evaluates the effect of the variation in longitudinal extent of damage on the probability that only the compartment or group of compartments under consideration may be flooded, and

"s" evaluates the effect of freeboard, stability and heel in the final flooded condition for the compartment or groups of compartment under consideration.

(ii) The summation indicated by formula (II) is taken over the ship's length for each compartment taken singly. To the extent that the related buoyancy and stability in the final condition of flooding are such that "s" is more than zero, the summation is also taken for all possible pairs of adjacent compartments, and may be taken for all possible groups of a higher number of adjacent compartments if it is found that such inclusion contributes to the value of the attained Subdivision Index A.

(iii) Wherever wing compartments are fitted and where the assumed damage used in the damage stability calculations according to Regulation 5 forming the basis for the "s" calculation does not result in flooding of the associated inboard spaces, "p" shall be multiplied by "r" as determined in Regulation 7(b).

(b) The factor "a" in formula (II) shall be determined for each compartment and for each group of compartments by formula (III):

$A = 0.4 [1 + \zeta_1 + \zeta_2 + \zeta_{12}]$……………..(III)

Where:

$\zeta_1 = \frac{X_1}{L_s}$ if X_1 is equal to or less than 0 $5L_s$

and otherwise

$\zeta_1 = 0.5$

$\zeta_2 = \frac{X_2}{L_s}$ if X_2 is equal to or less than $0.5L_s$

and otherwise

$\zeta_2 = 0.5$

$\zeta_{12} = \frac{X_1 + X_2}{L_s}$ if $X_1 + X_2$ is equal to or less than L_s

and otherwise

$\zeta_{12} = 1.0$

and where:

X_1 = the distance from the aft terminal of L_s to the aft end of the considered compartment or group of adjacent compartments.

X_2 = the distance from the aft terminal of L_s to the forward end of the considered compartment or group of adjacent compartments.

For the purposes of this paragraph and of paragraph (c) of this Regulation, with respect to the length of any compartment or groups of compartments under consideration, where one or both of the limiting bulkheads have steps, the forward and after ends of the considered compartment or group of compartments shall be taken at the portions of the bulkheads which are nearest to each other.

(c) The factor "p" in formula (II) shall be determined for each compartment and for each group of compartments by formulae (IV) - (VII).

(i) In general, "p" shall be.

$$P = W\left[4.46\left(\frac{\ell}{\lambda}\right)^2 - 6.20\left(\frac{\ell}{\lambda}\right)^3\right] \quad \text{for } \frac{\ell}{\lambda} \text{ equal to 0.24 or less} \qquad)$$

and otherwise,)(IV)

$$p = W\left[1.072\frac{\ell}{\lambda} - 0.086\right] \qquad)$$

Where:

ℓ = the Length of compartment or group of compartments as defined in paragraph (b) of this Regulation.

W = 1.0 and $\lambda = L_s$ for L_s = 655 feet (200 metres) or less and otherwise

$$W = \frac{602.5}{L_s - 52.5} \text{ and } \lambda = 655 \text{ (for } L_s \text{ in feet)}$$

$$W = \frac{184}{L_s - 16} \text{ and } \lambda = 200 \text{ (for } L_s \text{ in metres).}$$

(ii) To evaluate "p" for compartments taken singly, formulae (IV) are applied directly.

(iii) To evaluate the "p" values attributable to groups of compartments, the following supplementary nomenclature and formulae apply:

ℓ_1, ℓ_2, ℓ_3, ℓ_4, etc. are the lengths of compartments taken singly

ℓ_{12}, ℓ_{23}, ℓ_{34}, etc. are the lengths of pairs of adjacent compartments

ℓ_{123}, ℓ_{234}, etc. are the lengths of groups of three adjacent compartments

ℓ_{1234}, etc. is the length of a group of four adjacent compartments

P_1, P_2, P_3, P_4, etc. are p calculated by formulae (IV) using ℓ_1, ℓ_2, ℓ_3, ℓ_4, etc. as ℓ.

P_{12}, P_{23}, P_{34}, etc. are p calculated using ℓ_{12}, ℓ_{23}, ℓ_{34}, etc. as ℓ.

P_{123}, P_{234}, etc. are p calculated using ℓ_{123}, ℓ_{234}, etc. as ℓ.

P_{1234}, etc. is p calculated using ℓ_{1234}, etc. as ℓ.

For compartments taken by pairs,

$$\left.\begin{array}{l} P = P_{12} - P_1 - P_2 \text{ or} \\ P = P_{23} - P_2 - P_3\text{, etc.} \end{array}\right) \ldots\ldots \text{(V)}$$

For compartments taken by groups of three,

$$\left.\begin{array}{l} P = P_{123} - P_{12} - P_{23} + P_2\text{, or} \\ P = P_{234} - P_{23} - P_{34} + P_3\text{, etc.} \end{array}\right) \ldots\ldots \text{(VI)}$$

For compartments taken by groups of four,

$$P = P_{1234} - P_{123} - P_{234} + P_{23}\text{, etc.} \ \ldots\ldots \text{(VII)}$$

(d) The factor "s" in formula (II) shall be determined for the final stage of flooding for each compartment and for each group of compartments by formulae (VIII) and (IX).

(i) In general for any condition of flooding from any initial draught d_i, s_i shall be:

)

$$
\left.
\begin{aligned}
s_i &= 2.70\left[\left(\frac{F_1}{B_2} - \frac{\tan\theta}{2}\right)(GM_R - MM_S)\right]^{1/2} \quad \text{(in feet)} \\
s_i &= 4.9\left[\left(\frac{F_1}{B_2} - \frac{\tan\theta}{2}\right)(GM_R - MM_S)\right]^{1/2} \quad \text{(in metres)}
\end{aligned}
\right\} \quad \text{(VIII)}
$$

but not more than 1.0

Where:

θ = the angle of heel due to unsymmetrical flooding in the final condition after cross-flooding, if any:

GM_R = the highest required intact metacentric height at the relative draught, as determined Regulation 5 (e) or if a higher metacentric height is to be specified in the instructions to the Master, that value may be used:

MM_S = the reduction in the height of the metacentre as a result of flooding, calculated for the ship in the upright position in the final stage of flooding.

(ii) For each compartment and for each group of compartments, "s" is taken as:

$s = 0.45s_1 + 0.33s_2 + 0.22s_3$ . . . . (IX)

Where:

$s_1 = s_i$ calculated for the ship at initial draught d_1
$s_2 = s_i$ “ “ “ “ “ “ “ d_2
$s_3 = s_i$ “ “ “ “ “ “ “ d_3
d_1, d_2 and d_3 as defined in Regulation 1(g)(iii).

Values of GM_R for the draughts d_1, d_2 and d_3 are determined from the plot of GM_R versus draught to be furnished to the Master of the ship in accordance with Regulation 8. Values of MM_S, θ and F_1 for these draughts are determined from plots of damaged condition vertical metacentre, trim, draught and heel versus undamaged draught, determined in accordance with Regulation 5(e).

(iii) Provided a positive contribution to the attained Subdivision Index A is obtained thereby, the flooding of combinations of adjacent compartments in excess of those required for compliance with Regulation 5(b)(i) and (ii) may be included in the calculations. However, s_i shall be taken as zero for any case of flooding which results

(1) during intermediate flooding or prior to equalization in an angle of heel in excess of 20 degrees or which immerses any opening through which downflooding might take place, or

(2) for the final stage of flooding, except in way of the flooded compartment or compartments, in immersion of the relevant bulkhead deck at side, or heel in excess of 12 degrees, or (GM_R - MM_S) less than 2 inches (0.05 metre).

Regulation 7

Combined Longitudinal and Transverse Subdivision

(a) Regulation 6 is predicated upon the condition that transverse bulkheads ordinarily extend from side to side. However, an Administration may also accept a combination of transverse and longitudinal watertight bulkheads wherein some of the transverse watertight bulkheads extend inboard only to longitudinal watertight bulkheads, provided that:

- **(i)** A horizontal watertight division located not less than 0.1 B_1 above the base line is fitted in the centre space between the longitudinal bulkheads, and the space below the horizontal division is subdivided by watertight bulkheads in line with the watertight transverse bulkheads in the wings or by equivalent means.
- **(ii)** Compliance with the provisions of Regulation 5 is demonstrated.
- **(iii)** The Subdivision Index A, calculated according to paragraphs (b) and (c) of this Regulation is not less than the required Subdivision Index R.

(b) To calculate the contribution of the wing compartments to the attained Subdivision Index A:

- **(i)** "a" is calculated as in Regulation 6(b) using the distances from the aft terminal of L_S to the transverse bulkheads bounding the considered wing compartment or group of compartments.
- **(ii)** "p" is obtained by multiplying the values obtained by application of formulae (IV) of Regulation 6(c) by the reduction factor "r" according to formulae (X), which represents the probability that the inboard spaces will not be flooded.

(1) Where ℓ/L_S is equal to or more than 0.2 b/B_1

$$r = \frac{b}{B_1}\left[2.8 + 0.08/(\ell / L_S + 0.02)\right] \quad)$$

if b/B_1 is equal to or less than 0.2, and) (X)

$$r = 0.016/(\ell/L_s + 0.02) + b/B_1 + 0.36 \quad)$$

if b/B_1 is greater than 0.2.)

(2) Where ℓ/L_S is less than 0.2 b/B_1, r shall be determined by linear interpolation between 1.0 for $\ell/L_S = 0$ and the r-value calculated by formulae (X) for $\ell/L_S = 0.2\ b/B_1$.

In formulae (X) the terms have the following meaning:

ℓ = the distance between the longitudinal limits used for the calculation of "a" and "p" as defined in Regulation 6(b) and (c).

b = the mean transverse distance measured at right angles to the centreline at the subdivision loadline between the shell and a plane through the outermost portion of and parallel to that part of the longitudinal bulkhead which extends between the longitudinal limits used in calculating "a".

(iii) "s" is calculated as in Regulation 6(d), treating the inboard spaces as not floodable, i.e.$\mu = 0$.

(c) If the attained Subdivision Index A obtained by application of the procedures in paragraph (b) of this Regulation is less than the required Subdivision Index R, the additional contribution to the attained Subdivision Index A attributable to flooding of spaces inboard of the longitudinal bulkheads together with the outboard spaces may be included. For the purposes of this contribution:

(i) "a" is calculated as in sub-paragraph (b)(i) of this Regulation except that the distances from the aft terminal of L_s. are taken to each transverse bulkhead bounding either a wing or an inboard compartment or group thereof.

(ii) "p" is obtained by multiplying the values obtained by application of formulae (IV) through (VII) of Regulation 6(c) by (1 - r).

(iii) "s" is calculated as in Regulation 6(d). In so doing, the assumed extent of flooding of both wing and inboard spaces shall be that which would result from an assumed longitudinal extent of damage coincidental with the longitudinal limits used in calculating "a" and "p" and extending in to the ship's centreline.

Regulation 8

Stability Information

(a) **(i)** Every passenger ship shall be inclined upon its completion and the elements of its stability determined.

(ii) Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information shall be provided. If necessary the ship shall be re-inclined.

(b) The Master of the ship shall be supplied with such reliable information as is necessary to enable him by rapid and simple means to obtain accurate guidance as to the stability of the ship under varying conditions of service which information shall include:

(i) a curve of minimum operational metacentric height versus draught which assures compliance with the requirements of Regulations 5, 6 and 7, as well as a corresponding curve of the maximum allowable vertical centre of gravity versus draught, or with the tabular equivalents of these curves;

(ii) tables containing draught limits and their corresponding trim limits within which the requirements of Regulations 5, 6 and 7 can be met;

(iii) instructions concerning the operation of cross-flooding arrangements; and

(iv) all other data and aids which might be necessary to maintain the required stability after damage.

(c) There shall be permanently exhibited, for the guidance of the officer in charge of the ship, plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding. In addition booklets, containing the aforementioned information shall be made available to the officers of the ship.

(d) All information called for by this Regulation shall be subject to approval by the Administration.

Regulation 9

Ballasting

When ballasting with water is necessary, the water ballast should not in general be carried in tanks intended for oil fuel. In ships in which it is not practicable to avoid putting water in oil fuel tanks, oily-water separator equipment to the satisfaction of the Administration shall be fitted, or other alternative means acceptable to the Administration shall be provided for disposing of the oily-water ballast.

Regulation 10

Peak and Machinery Space Bulkheads, Shaft Tunnels, etc.

(a) **(i)** A ship shall have a forepeak or collision bulkhead, which shall be watertight up to the relevant bulkhead deck. This bulkhead shall be fitted not less than $0.05L_s$ and not more than 9.8 feet (or 3.0 metres) + $0.05L_S$ abaft the forward terminal of the deepest subdivision loadline.

(ii) If a ship has a long forward superstructure and the residual freeboard at the forward terminal of L_S after flooding of the foremost compartment is less than the summer freeboard required amidships according to the International Convention on Load Lines, 1966 the collision bulkhead shall be collision bulkhead shall be extended weathertight to the deck next above the relevant bulkhead deck. The extension need not be fitted directly over the bulkhead below, provided it is at least $0.05L_S$ abaft the forward terminal of the deepest subdivision loadline and the part of the relevant bulkhead deck which forms the step is made effectively weathertight.

(b) An afterpeak bulkhead and bulkheads dividing the machinery space from the cargo and passenger spaces forward and aft shall also be fitted and made watertight up to the relevant bulkhead deck. The afterpeak bulkhead may, however, be stepped below the relevant bulkhead deck, provided the degree of safety of the ship as regards subdivision is not thereby diminished.

(c) In all cases stern tubes shall be enclosed in watertight spaces of moderate volume. The stern gland shall be situated in a watertight shaft tunnel or other watertight space separate from the stern tube compartment and of such volume that, if flooded by leakage through the stern gland, the relevant bulkhead deck will not be submerged.

Regulation 11

Double Bottoms

(a) A double bottom shall be fitted extending from the forepeak bulkhead to the afterpeak bulkhead as far as this is practicable and compatible with the design and proper working of the ship.

(i) In ships 165 feet (or 50 metres) and under 200 feet (or 61 metres) in length a double bottom shall be fitted at least from the machinery space to the forepeak bulkhead, or as near thereto as practicable.

(ii) In ships 200 feet (or 61 metres) and under 249 feet (or 76 metres) in length a double bottom shall be fitted at least outside the machinery space, and shall extend to the fore and after peak bulkheads, or as near thereto as practicable.

(iii) In ships 249 feet (or 76 metres) in length and upwards a double bottom shall be fitted amidships, and shall extend to the fore and after peak bulkheads, or as near thereto as practicable.

(b) Where a double bottom is required to be fitted its depth shall be to the satisfaction of the Administration and the inner bottom shall be continued out to the ship's sides in such a manner as to protect the bottom to the turn of the bilge. Such protection will be deemed satisfactory if the line of intersection of the outer edge of the margin plate with the bilge plating is not lower at any part than a horizontal plane passing through the point of intersection with the frame line amidships of a transverse diagonal line inclined at 25 degrees to the base line and cutting it at a point $0.5B_1$ from the middle line.

(c) Small wells constructed in the double bottom in connection with drainage arrangements of holds, etc., shall not extend downwards more than necessary. The depth of the well shall in no case be more than the depth less 18 inches (or 457 millimetres) of the double bottom at the centreline, nor shall the well extend below the horizontal plane referred to in paragraph (b) of this Regulation. A well extending to the outer bottom is, however, permitted at the after end of the shaft tunnel of screw ships. Other wells (e.g. for lubricating oil under main engines) may be permitted by the Administration if satisfied that the arrangements give protection equivalent to that afforded by a double bottom complying with this Regulation.

(d) A double bottom need not be fitted in way of watertight compartments of moderate size used exclusively for the carriage of liquids, provided the safety of the ship, in the event of bottom or side damage, is not, in the opinion of the Administration, thereby impaired.

Regulation 12

Assigning, Marking and Recording of Subdivision Loadlines

(a) In order that the required degree of subdivision shall be maintained, a loadline corresponding to the approved subdivision draught shall be assigned and marked on the ship's sides. A ship having spaces which are specially adapted for the accommodation of passengers and the carriage of cargo alternatively may, if the owners desire, have one or more additional loadlines assigned and marked to correspond with the subdivision draughts which the Administration may approve for the alternative service conditions.

(b) The subdivision loadlines assigned and marked shall be recorded in the Passenger Ship Safety Certificate, and shall be distinguished by the notation C.1 for the principal passenger condition, and C.2, C.3, etc., for the alternative conditions.

(c) The freeboard corresponding to each of these loadlines shall be measured at the same position and from the same deck line as the freeboards determined in accordance with the International Convention on Load Lines, 1966.

(d) The freeboard corresponding to each approved subdivision loadline and the conditions of service for which it is approved, shall be clearly indicated on the Passenger Ship Safety Certificate.

(e) In no case shall any subdivision loadline mark be placed above the deepest loadline in salt water as determined by the strength of the ship and/or the International Convention on Load Lines, 1966.

(f) Whatever may be the position of the subdivision loadline marks, a ship shall in no case be loaded so as to submerge the loadline mark appropriate to the season and locality as determined in accordance with the International Convention on Load Lines, 1966.

(g) A ship shall in no case be so loaded that when she is in salt water the subdivision loadline mark appropriate to the particular voyage and condition of service is submerged.

Regulation 13

Construction and Initial Testing of Watertight Bulkheads, etc.

(a) Each watertight subdivision bulkhead whether transverse or longitudinal shall be constructed in such a manner that it shall be capable of supporting, with a proper margin of resistance, the pressure due to the maximum head of water which it might have to sustain in the event of damage to the ship, but at least the pressure due to a head of water up to the immersion limit line. The construction of these bulkheads shall be to the satisfaction of the Administration.

(b) **(i)** Steps and recesses in bulkheads shall be watertight and as strong as the bulkhead at the place where each occurs.

(ii) Where frames or beams pass through a watertight deck or bulkhead such deck or bulkhead shall be made structurally watertight without the use of wood or cement.

(c) Testing main compartments by filling them with water is not compulsory. When testing by filling with water is not carried out, a hose test is compulsory; this test shall be carried out in the most advanced stage of the fitting out of the ship. In any case, a thorough inspection of the watertight bulkheads shall be carried out.

(d) The forepeak, double bottoms (including duct keels) and inner skins shall be tested with water to a head corresponding to the requirements of paragraph (a) of this Regulation.

(e) Tanks which are intended to hold liquids, and which form part of the subdivision of the ship, shall be tested for tightness with water to a head up to the deepest subdivision loadline or to a head corresponding to two-thirds of the depth from the top of the keel to the immersion limit line in way of the tanks, whichever is the greater; provided that in no case shall the test head be less than 3 feet (or 0.92 metre) above the top of the tank.

(f) The tests referred to in paragraphs (d) and (e) of this Regulation are for the purpose of ensuring that the subdivision structural arrangements are watertight and are not to be regarded as a test of the fitness of any compartment for the storage of oil fuel or for other special purposes for which a test of a superior character may be required depending on the height to which the liquid has access in the tank or its connections.

Regulation 14

Openings in Watertight Bulkheads

(a) The number of openings in watertight bulkheads shall be reduced to the minimum compatible with the design and proper working of the ship; satisfactory means shall be provided for closing these openings.

(b) **(i)** Where pipes, scuppers, electric cables, etc. are carried through watertight subdivision bulkheads, arrangements shall be made to ensure the integrity of the watertightness of the bulkheads.

(ii) Valves and cocks not forming part of a piping system shall not be permitted in watertight subdivision bulkheads.

(iii) Lead or other heat sensitive materials shall not be used in systems which penetrate watertight subdivision bulkheads, where deterioration of such systems in the event of fire would impair the watertight integrity of the bulkheads.

(c) **(i)** No doors, manholes, or access openings are permitted:

(1) in the collision bulkhead below the relevant bulkhead deck;

(2) in watertight transverse bulkheads dividing a cargo space from an adjoining cargo space, except as provided in paragraph (k) of this Regulation.

(ii) Except as provided in sub-paragraph (iii) of this paragraph, the collision bulkhead may be pierced below the relevant bulkhead deck by not more than one pipe for dealing with fluid in the forepeak tank, provided that the pipe is fitted with a screwdown valve capable of being operated from above the immersion limit line, the valve chest being secured inside the forepeak to the collision bulkhead.

(iii) If the forepeak is divided to hold two different kinds of liquids the Administration may allow the collision bulkhead to be pierced below the relevant bulkhead deck by two pipes, each of which is fitted as required by sub-paragraph (ii) of this paragraph, provided the Administration is satisfied that there is no practical alternative to the fitting of such a second pipe and that, having regard to the additional subdivision provided in the forepeak, the safety of the ship is maintained.

(d) Within spaces containing the main and auxiliary propelling machinery including boilers serving the needs of propulsion not more than one door apart from the doors to shaft tunnels may be fitted in each main transverse bulkhead. Where two or more shafts are fitted the tunnels shall be connected by an intercommunicating passage. There shall be only one door between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors shall be of the sliding type and shall be located so as to have their sills as high as practicable, The hand gear for operating these doors shall be situated above the immersion limit line and outside the spaces containing the machinery if this is consistent with a satisfactory arrangement of the necessary gearing.

(e) **(i)** Watertight doors shall be sliding doors or hinged doors or doors of an equivalent type. Plate doors secured only by bolts and doors required to be closed by dropping or by the action of a dropping weight are not permitted.

(ii) Sliding doors may be either:
hand operated only, or power operated as well as hand operated.

(iii) Authorized watertight doors may therefore be divided into three Classes:
Class 1 - hinged doors;
Class 2 - hand operated sliding doors;
Class 3 - sliding doors which are power operated as well as hand operated.

(iv) The means of operation of any watertight door whether power operated or not shall be capable of closing the door with the ship listed to 15 degrees either way.

(v) In all classes of watertight doors indicators shall be fitted which show, at all operating stations from which the doors are not visible, whether the doors are open or closed. If any of the watertight doors, of whatever Class, is not fitted so as to enable it to be closed from a central control station, it shall be provided with a mechanical, electrical, telephonic, or any other suitable direct means of communication, enabling the officer of the watch promptly to contact the person who is responsible for closing the door in question, under previous orders.

(f) Hinged doors (Class 1) shall be fitted with quick action closing devices, such as catches, workable from each side of the bulkhead.

(g) Hand operated sliding doors (Class 2) may have a horizontal or vertical motion. It shall be possible to operate the mechanism at the door itself from either side, and in addition, from an accessible position above the immersion limit line, with an all round crank motion, or some other movement providing the same guarantee of safety and of an approved type. Departures from the requirement of operation on both sides may be allowed, if this requirement is impossible owing to the layout of the spaces. When operating a hand gear, the time necessary for the complete closure of the door with the ship upright shall not exceed 90 seconds.

(h) **(i)** Power operated sliding doors (Class 3) may have a vertical or horizontal motion. If a door is required to be power operated from a central control, the gearing shall be so arranged that the door can be operated by power also at the door itself from both sides. The arrangement shall be such that the door will close automatically if opened by local control after being closed from the central control, and also such that any door can be kept closed by local systems which will prevent the door from being opened from the upper control. Local control handles in connection with the power gear shall be provided each side of the bulkhead and shall be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the closing mechanism in operation accidentally. Power operated sliding doors shall be provided with hand gear workable at the door itself on either side and from an accessible position above the immersion limit line, with an all round crank motion or some other movement providing the same guarantee of safety and of an approved type. Provision shall be made to give warnings by sound signal that the door has begun to close and will continue to move until it is completely closed. The door shall take a sufficient time to close to ensure safety.

(ii) There shall be at least two independent power sources capable of opening and closing all the doors under control, each of them capable of operating all the doors simultaneously. The two power sources shall be controlled from the central station on the bridge provided with all the necessary indicators for checking that each of the two power sources is capable of giving the required service satisfactorily.

(iii) In the case of hydraulic operation, each power source shall consist of a pump capable of closing all doors in not more than 60 seconds. In addition, there shall be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closed-open-closed. The fluid used shall be one which does not freeze at any of the temperatures liable to be encountered by the ship during its service.

(i) **(i)** Hinged watertight doors (Class 1) in passenger, crew and working spaces are only permitted above a deck the underside of which, at its lowest point at side, is at least 7 feet (or 2.13 metres) above the deepest subdivision loadline.

(ii) Watertight doors, the sills of which are above the deepest subdivision loadline and below the line specified in subparagraph (i) of this paragraph shall be sliding doors and may be hand operated (Class 2), except in ships where N is

1200 or more in which all such doors shall be power operated. When trunkways in connection with refrigerated cargo and ventilation or forced draught ducts are carried through more than one main watertight subdivision bulkhead, the doors at such openings shall be operated by power.

(j) Watertight doors which may sometimes be opened at sea, and the sills of which are below the deepest subdivision loadline, shall be sliding doors. The following rules shall apply:

(1) when the number of such doors (excluding doors at entrances to shaft tunnels) exceeds five, all of these doors and those at the entrance to shaft tunnels or ventilation or forced draught ducts, shall be power operated (Class 3) and shall be capable of being simultaneously closed from a central station situated on the bridge;

(2) when the number of such doors (excluding doors at entrances to shaft tunnels) is greater than one, but does not exceed five,

(a) where the ship has no passenger spaces below the immersion limit line, all the above-mentioned doors may be hand operated (Class 2);

(b) where the ship has passenger spaces below the immersion limit line all the above-mentioned doors shall be power operated (Class 3) and shall be capable of being simultaneously closed from a central station situated on the bridge;

(3) in any ship where there are only two such watertight doors and they are into or within the space containing machinery, the Administration may allow these two doors to be hand operated only (Class 2).

(k) **(i)** If the Administration is satisfied that such doors are essential, watertight doors of satisfactory construction may be fitted in watertight bulkheads dividing cargo between deck spaces. Such doors may be hinged, rolling or sliding doors but shall not be remotely controlled. They shall be fitted at the highest level and as far from the shell plating as practicable, but in no case shall the outboard vertical edges be situated at a distance from the shell plating which is less than $0.2B_1$, such distance being measured at right angles to the centreline of the ship at the level of the deepest subdivision loadline.

(ii) Such doors shall be closed before the voyage commences and shall be kept closed during navigation, and the time of opening such doors in port and of closing them before the ship leaves port shall be entered in the log book. Should any of the doors be accessible during the voyage, they shall be fitted with a device which prevents unauthorized opening.

When it is proposed to fit such doors, the number and arrangements shall receive the special consideration of the Administration.

(l) Portable plates on bulkheads shall not be permitted except in machinery spaces. Such plates shall always be in place before the ship leaves port, and shall not be removed during navigation except in case of urgent necessity. The necessary precautions shall be taken in replacing them to ensure that the joints shall be watertight.

(m) All watertight doors shall be kept closed during navigation except when necessarily opened for the working of the ship, and shall always be ready to be immediately closed.

(n) **(i)** Where trunkways or tunnels for piping, or for any other purpose are carried through main transverse watertight bulkheads, they shall be watertight and in accordance with the requirements of Regulation 17. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, shall be through a trunk extending watertight to a height sufficient to permit access above the relevant bulkhead deck. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels shall not extend through the first subdivision bulkhead abaft the collision bulkhead.

(ii) Where it is proposed to fit tunnels or trunkways for forced draught, piercing main transverse water-tight bulkheads, these shall receive the special consideration of the Administration.

Regulation 15

Openings in the Shell Plating below the Immersion Limit Line

(a) The number of openings shall be reduced to the minimum compatible with the design and proper working of the ship

(b) The arrangement and efficiency of the means for closing any opening in the shell plating shall be consistent with its intended purpose and the position in which it is fitted and generally to the satisfaction of the Administration.

(c) **(i)** If in a between deck the sills of any sidescuttles are below a line drawn parallel to the immersion limit line at side and having its lowest point $0.025B_1$ above the deepest subdivision loadline, all sidescuttles in that between deck shall be of the non-opening type.

(ii) All sidescuttles, the sills of which are below the immersion limit line, other than those required to be of a non-opening type by sub-paragraph (i) of this paragraph, shall be of such construction as will effectively prevent any person opening them without the consent of the Master of the ship.

(iii) **(1)** Where in a between deck the sills of any of the sidescuttles referred to in sub-paragraph (ii) of this paragraph are below a line drawn parallel to the immersion limit line, and having its lowest point 4½ feet (or 1.37 metres) + $0.025B_1$ above the water when the ship departs from any port, all the sidescuttles in that between deck shall be closed watertight and locked before the ship leaves port, and they shall not be opened before the ship arrives at the next port. In the application of this sub-paragraph the appropriate allowance for fresh water may be made when applicable.

(2) The time of opening such sidescuttles in port and of closing and locking them before the ship leaves port shall be entered in such log book as may be prescribed by the Administration.

(d) Efficient hinged inside deadlights arranged so that they can be easily and effectively closed and secured watertight shall be fitted to all sidescuttles except that abaft $0.125L_S$ from the forward terminal of L_S and above a line drawn parallel to the immersion limit line and having its lowest point at a height of 12 feet (or 3.66 metres) + $0.025B_1$ above the deepest subdivision loadline the deadlights may be portable in passenger accommodation other than that for steerage passengers, unless the deadlights are required by the International Convention on Load Lines, 1966 to be permanently attached in their proper positions. Such portable deadlights shall be stowed adjacent to the sidescuttles they serve.

(e) Sidescuttles and their deadlights, which will not be accessible during navigation, shall be closed and secured before the ship leaves port.

(f) **(i)** No sidescuttles shall be fitted in any spaces which are appropriated exclusively to the carriage of cargo.

(ii) Sidescuttles may, however, be fitted in spaces appropriated alternatively to the carriage of cargo or passengers, but they shall be of such construction as will effectively prevent any person opening them or their deadlights without the consent of the Master of the ship.

(iii) If cargo is carried in such spaces, the sidescuttles and their deadlights shall be closed watertight and locked before the cargo is shipped and such closing and locking shall be recorded in such log book as may be prescribed by the Administration.

(g) Automatic ventilating sidescuttles shall not be fitted in the shell plating below the immersion limit line without the special sanction of the Administration.

(h) The number of scuppers, sanitary discharges and other similar openings in the shell plating shall be reduced to the minimum either by making each discharge serve for as many as possible of the sanitary and other pipes, or in any other satisfactory manner.

(i) **(i)** All inlets and discharges in the shell plating shall be fitted with efficient and accessible arrangements for preventing the accidental admission of water into the ship. Lead or other heat sensitive materials shall not be used for pipes fitted outboard of shell valves in inlets or discharges, or any other application where the deterioration of such pipes in the event of fire would give rise to danger of flooding.

(ii) **(1)** Except as provided in sub-paragraph (iii) of this paragraph, each separate discharge led through the shell plating from spaces below the immersion limit line shall be provided either with one automatic non-return valve fitted with a positive means of closing it from above the immersion limit line or, alternatively, with two automatic non-return valves without such means, the upper of which is so situated above the deepest subdivision loadline as to be always accessible for examination under service conditions, and is of a type which is normally closed.

(2) Where a valve with positive means of closing is fitted, the operating position above the immersion limit line shall always be readily accessible, and means shall be provided for indicating whether the valve is open or closed.

(iii) Main and auxiliary sea inlets and discharges in connection with machinery shall be fitted with readily accessible cocks or valves between the pipes and shell plating or between the pipes and fabricated boxes attached to the shell plating.

(j) **(i)** Gangway, cargo and bunkering station ports fitted below the immersion limit line shall be of sufficient strength. They shall be effectively closed and secured watertight before the ship leaves port, and shall be kept closed during navigation.

(ii) Such ports shall be in no case fitted so as to have their lowest point below the deepest subdivision loadline.

(k) **(i)** The inboard opening of each rubbish-shoot, etc., shall be fitted with an efficient cover.

(ii) If the inboard opening is situated below the immersion limit line the cover shall be watertight, and in addition an automatic non-return valve shall be fitted in the shoot in an easily accessible position above the deepest subdivision loadline. When the shoot is not in use both the cover and the valve shall be kept closed and secured.

Regulation 16

Construction and Initial Tests of Watertight Doors, Sidescuttles, etc.

(a) **(i)** The design, materials and construction of all watertight doors, sidescuttles, gangway, cargo and other ports, valves, pipes, and rubbish-shoots referred to in these Regulations shall be to the satisfaction of the Administration.

(ii) The frames of vertical watertight doors shall have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

(iii) All cocks and valves for sea inlets and discharges below the immersion limit line and all fittings outboard of such cocks and valves shall be made of steel, bronze or other approved ductile material. Ordinary cast iron or similar materials shall not be used.

(b) Each watertight door shall be tested by water pressure to a head up to the immersion limit line. The test shall be made before the ship is put in service, either before or after the door is fitted.

Regulation 17

Construction and Initial Tests of Watertight Decks, Trunks, etc.

(a) Watertight decks, trunks, tunnels, duct keels and ventilators shall be of the same strength as watertight bulkheads at corresponding levels. The means used for making them watertight, and the arrangements adopted for closing openings in them, shall be to the satisfaction of the Administration. Watertight ventilators and trunks shall be carried at least up to the immersion limit line.

(b) After completion, a hose or flooding test shall be applied to watertight decks and a hose test to watertight trunks, tunnels and ventilators.

Regulation 18

Watertight Integrity above the relevant Bulkhead Deck

(a) The Administration may require that all reasonable and practicable measures shall be taken to limit the entry and spread of water above the relevant bulkhead deck. Such measures may include partial bulkheads or webs. When partial watertight bulkheads and webs are fitted on the relevant bulkhead deck, above or in the immediate vicinity of main subdivision bulkheads, they shall have watertight shell and relevant bulkhead deck connections so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the partial watertight bulkhead does not line up with the bulkhead below, the relevant bulkhead deck between shall be made effectively watertight.

(b) The deck at the immersion limit line or a deck above it shall be weathertight in the sense that in ordinary sea conditions water will not penetrate in a downward direction. All openings in the exposed weather deck shall have coamings of ample height and strength and shall be provided with efficient means for expeditiously closing them weathertight. Freeing ports, open rails and/or scuppers shall be fitted as necessary for rapidly clearing the weather deck of water under all weather conditions.

(c) Sidescuttles, gangway, cargo and other ports and other means for closing openings in the shell plating above the immersion limit line shall be of efficient design and construction and of sufficient strength having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision loadline.

(d) Efficient inside deadlights, arranged so that they can be easily and effectively closed and secured watertight, shall be provided for all sidescuttles to spaces below the first deck above the immersion limit line.

Regulation 19

Bilge Pumping Arrangements

(a) Ships shall be provided with an efficient bilge pumping plant capable of pumping from and draining any watertight compartment which is neither a permanent oil compartment nor a permanent water compartment under all practicable conditions after a casualty whether the ship is upright or listed. For this purpose wing suctions will generally be necessary except in narrow compartments at the ends of the ship, where one suction may be sufficient. In compartments of unusual form, additional suctions may be required. Arrangements shall be made whereby water in the compartment may find its way to the suction pipes. Where in relation to particular compartments the Administration is satisfied that the provision of drainage may be undesirable, it may allow such provision to be dispensed with if calculations made in accordance with the conditions laid down in Regulation 5 and assumed for the purposes of Regulations 6 and 7 show that the safety of the ship will not be impaired. Efficient means shall be provided for draining water from insulated holds.

(b) **(i)** Ships shall have at least three power pumps connected to the bilge main, one of which may be attached to the propelling unit. Where R is more than 0.50, one additional independent power pump shall be provided.

(ii) The requirements are summarized in the following table:

Required Subdivision Index R	Less than 0.50	and over 0.50

Main engine pump (may be replaced by one independent pump) … ... … …	1	1
Independent pumps … … … … …	2	3

(iii) Sanitary, ballast and general service pumps may be accepted as independent power bilge pumps if fitted with the necessary connections to the bilge pumping system.

(c) Where practicable, the power bilge pumps shall be placed in separate watertight compartments so arranged or situated that these compartments will not readily be flooded by the same damage. If the engines and boilers are in two or more watertight compartments, the pumps available for bilge service shall be distributed throughout these compartments as far as is possible.

(d) On ships 330 feet (or 100 metres) or more in length or having R more than 0.50, the arrangements shall be such that at least one power pump shall be available for use in all ordinary circumstances in which a ship may be flooded at sea. This requirement will be satisfied if:

(i) one of the required pumps is an emergency pump of a reliable submersible type having a source of power situated above the relevant bulkhead deck; or

(ii) the pumps and their sources of power are so disposed throughout the length of the ship that under any condition of flooding which the ship is required to withstand, at least one pump in an undamaged compartment will be available.

(e) With the exception of additional pumps which may be provided for peak compartments only, each required bilge pump shall be arranged to draw water from any space required to be drained by paragraph (a) of this Regulation.

(f) Each power bilge pump shall be capable of giving a speed of water through the required main bilge pipe of not less than 400 feet (or 122 metres) per minute. Independent power bilge pumps situated in machinery spaces shall have direct suctions from these spaces, except that not more than two such suctions shall be required in any one space. Where two or more such suctions are provided there shall be at least one on the port side and one on the starboard side. The Administration may require independent power bilge pumps situated in other spaces to have separate direct suctions. Direct suctions shall be suitably arranged and those in a machinery space shall be of a diameter not less than that required for the bilge main.

(g) **(i)** In addition to the direct bilge suction or suctions required by paragraph (f) of this Regulation there shall be in the machinery space a direct suction from the main circulating pump leading to the drainage level of the machinery space and fitted with a non-return valve. The diameter of this direct suction pipe shall be at least two-thirds of the diameter of the pump inlet in the case of steamships, and of the same diameter as the pump inlet in the case of motorships.

(ii) Where in the opinion of the Administration the main circulating pump is not suitable for this purpose, a direct emergency bilge suction shall be led from the largest available independent power driven pump to the drainage level of the machinery space; the suction shall be of the same diameter as the main inlet of the pump used. The capacity of the pump so connected shall exceed that of a required bilge pump by an amount satisfactory to the Administration.

(iii) The spindles of the sea inlet and direct suction valves shall extend well above the engine room platform.

(h) **(i)** All pipes from the pumps which are required for draining cargo or machinery spaces shall be entirely distinct from pipes which may be used for filling or emptying spaces where water or oil is carried.

(ii) All bilge pipes used in or under fuel storage tanks or in boiler or machinery spaces, including spaces in which oil–settling tanks or oil fuel pumping units are situated, shall be of steel or other approved material.

(i) The diameter of the bilge main shall be calculated according to the following formulae provided that the actual internal diameter of the bilge main may be of the nearest standard size acceptable to the Administration.

$$d \text{ (in inches)} = \sqrt{\frac{L_S(B_1 + D_S)}{2{,}500}} + 1$$

or

$$d \text{ (in millimetres)} = 1.68\sqrt{L_S(B_1 + D_S)} + 25$$

where d = internal diameter of the bilge main (in inches or in millimetres respectively)

L_S and B_1 in feet or metres respectively

D_S = moulded depth of ship to immersion limit line at midlength (in feet or metres respectively).

The diameter of the bilge branch pipes shall be determined by rules to be made by the Administration.

(j) The arrangement of the bilge and ballast pumping system shall be such as to prevent the possibility of water passing from the sea and from water ballast spaces into the cargo and machinery spaces, or from one compartment to another. Special provision shall be made to prevent any deep tank having bilge and ballast connections being inadvertently run up from the sea when containing cargo, or pumped out through a bilge pipe when containing water ballast.

(k) Provision shall be made to prevent the compartment served by any bilge suction pipe being flooded in the event of the pipe being severed, or otherwise damaged by collision or grounding in any other compartment. For this purpose, where the pipe is at any part situated nearer the side of the ship than $0.2B_1$ (measured at right angles to the centreline at the level of the deepest subdivision loadline), or in a duct keel, a non-return valve shall be fitted to the pipe in the compartment containing the open end.

(l) All the distribution boxes, cocks and valves in connection with the bilge pumping arrangements shall be in positions which are accessible at all times under ordinary circumstances. They shall be so arranged that, in the event of flooding, one of the bilge pumps may be operative on any compartment; in addition, damage to a pump or its pipe connecting to the bilge main outboard of a line drawn at $0.2B_1$, shall not put the bilge system out of action. If there is only one system of pipes common to all the pumps, the necessary cocks or valves for controlling the bilge suctions must be capable of being operated from above the immersion limit line. Where in addition to the main bilge pumping system an emergency bilge pumping system is provided, it shall be independent of the main system and so arranged that a pump is capable of operating on any compartment under flooding conditions; in that case only the cocks and valves necessary for the operation of the emergency system need be capable of being operated from above the immersion limit line.

(m) All cocks and valves mentioned in paragraph (1) of this Regulation which can be operated from above the immersion limit line shall have their controls at their place of operation clearly marked and provided with means to indicate whether they are open or closed.

Regulation 20

Marking, Periodical Operation and Inspection of Watertight Doors, etc.

(a) Drills for the operating of watertight doors, sidescuttles, valves and closing mechanisms of scuppers, and rubbish-shoots shall take place weekly. In ships in which the voyage exceeds one week in duration a complete drill shall be held before leaving port, and others thereafter at least once a week during the voyage. In all ships all watertight power doors and hinged doors, in main transverse bulkheads, in use at sea, shall be operated daily.

(b) **(i)** The watertight doors and all mechanisms and indicators connected therewith, all valves the closing of which is necessary to make a compartment watertight, and all valves the operation of which is necessary for damage control cross connections, shall be periodically inspected at sea at least once a week.

(ii) Such valves, doors and mechanisms shall be suitably marked to ensure that they may be properly used to provide maximum safety.

Regulation 21

Entries in Log

(a) Hinged doors, portable plates, sidescuttles, gangway, cargo and other ports and other openings, which are required by these Regulations to be kept closed during navigation, shall be closed before the ship leaves port. The time of closing and the time of opening (if permissible under these Regulations) shall be recorded in such log book as may be prescribed by the Administration.

(b) A record of all drills and inspections required by Regulation 20 shall be entered in the logbook with an explicit record of any defects which may be disclosed.

RESOLUTION A.468(XII)
Adopted on 19 November 1981

CODE ON NOISE LEVELS ON BOARD SHIPS

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PREAMBLE

1 The Code on Noise Levels on Board Ship (hereinafter referred to as the Code) has been developed to provide guidance to Administrations on principles of noise control on board ships in general. Its purpose is to stimulate and promote noise control at a national level within the framework of internationally agreed guidelines.

2 Guidance to Administrations on maximum noise levels and noise exposure limits should be considered as the main objectives of the Code.

3 The recommendations on procedures and programmes should be regarded as an attempt to establish international uniformity rather than to set strict rules to be followed.

4 The Code has been developed having regard to conventional passenger and cargo ships. While certain types and sizes of ships have been excluded from application, it should be recognized that full application to ships which differ appreciably from the conventional types of ships regarding design or operations might need specific consideration.

5 The Code is not intended for direct incorporation by reference or reproduction in national legislation although it could provide a basis for such legislation.

6 The Organization adopted a recommendation on methods of measuring noise levels at listening posts with resolution A.343(IX). This recommendation related to interference by shipborne noise with the proper reception of external audible navigation signals and although the methods of measuring noise levels in accordance with resolution A.343(IX) and with the Code are different, these documents are considered compatible inasmuch as the Code is concerned primarily with the effect of noise on health and comfort.

CHAPTER 1 - GENERAL

1.1 Scope

1.1.1 The Code is designed to provide standards to prevent the occurrence of potentially hazardous noise levels on board ships and to provide standards for an acceptable environment for seafarers.

1.1.2 Recommendations are made for:

- **.1** protecting the seafarer from the risk of noise-induced hearing loss under conditions where at present it is not feasible to limit the noise to a level which is not potentially harmful;
- **.2** measurement of noise levels and exposure;
- .3 limits on acceptable maximum noise levels for all spaces to which seafarers normally have access.

1.2 Purpose

1.2.1 The purpose of the Code is to limit noise levels and to reduce exposure to noise, in order to:

- **.1** provide for safe working conditions by giving consideration to the need for speech communication and for hearing audible alarms, and to an environment where clear-headed decisions can be made in control stations, navigation and radio spaces and manned machinery spaces;
- **.2** protect the seafarer from excessive noise levels which may give rise to a noise-induced hearing loss;
- **.3** provide the seafarer with an acceptable degree of comfort in rest, recreation and other spaces and also provide conditions for recuperation from the effects of exposure to high noise levels.

1.3 Application

1.3.1 The Code applies to new ships of 1,600 tons gross tonnage and over.

1.3.2 The provisions relating to potentially hazardous noise levels contained in the Code should also apply to existing ships of 1,600 tons gross tonnage and over, as far as reasonable and practicable, to the satisfaction of the Administration.

1.3.3 The Code should apply to new ships of less than 1,600 tons gross tonnage, as far as reasonable and practicable, to the satisfaction of the Administration.

1.3.4 The Code does not apply to:
dynamically supported craft;
fishing vessels;
pipe-laying barges;
crane barges;
mobile offshore drilling units;
pleasure yachts not engaged in trade;
ships of war and troopships;
ships not propelled by mechanical means.

1.3.5 For ships designed for and employed on voyages of short duration, or on other services involving short periods of operation of the ship, sections 4.2.3 and 4.2.4 may be applied only with the ship in the port condition, provided that the periods under such conditions are adequate for seafarers' rest and recreation.

1.3.6 The Code applies to ships in service, i.e. in port or at sea with seafarers on board.

1.3.7 The Code is not intended to apply to passenger cabins and other passenger spaces except in so far as they are work spaces and are covered by the provisions of the Code.

1.4 Definitions

For the purpose of the Code the following definitions apply. Additional definitions are given elsewhere in the Code.

1.4.1 *Accommodation spaces:* Cabins, offices (for carrying out ship's business), hospitals, mess rooms, recreation rooms (such as lounges, smoke rooms, cinemas, libraries and hobbies and games rooms) and open recreation areas to be used by seafarers.

1.4.2 *Auxiliary machinery:* Machinery other than main propelling machinery that is in service when the ship is in normal service, e.g. auxiliary diesel engines, turbo-generators, hydraulic motors and pumps, compressors, boiler ventilation fans, gear pumps.

1.4.3 *A-weighted sound pressure level or noise level:* The quantity measured by a sound level meter in which the frequency response is weighted according to the A-weighting curve (see lEC publication 651).

1.4.4 *Continuously manned spaces:* Spaces in which the continuous or prolonged presence of seafarers is necessary for normal operational periods.

1.4.5 *Crane barge:* A vessel with permanently installed cranes designed principally for lifting operations.

1.4.6 *Duty stations:* Those spaces in which the main navigating equipment, the ship's radio or the emergency source of power are located or where the fire recording or fire control equipment is centralized and also those spaces used for galleys, main pantries, stores (except isolated pantries and lockers), mail and specie rooms, workshops other than those forming part of the machinery spaces and similar such spaces.

1.4.7 *Dynamically supported craft:* A craft which is operable on or above water and which has characteristics different from those of conventional displacement ships. Within the aforementioned generality, a craft which complies with either of the following characteristics:

.1 the weight, or a significant part thereof, is balanced in one mode of operation by other than hydrostatic forces;

.2 the craft is able to operate at speeds such that the function $\frac{v}{\sqrt{gL}}$ is equal to or greater than 0,9, where "v" is the maximum speed, "L" is the water-line length and "g" is the acceleration due to gravity, all in consistent units.

1.4.8 *Ear protector:* A device worn to reduce the level of noise heard by the wearer.

1.4.9 *Effective sound level $L_{ef(X)}(H)$:* A notional continuous sound level which is calculated from the various A-weighted sound levels and duration at these levels with an XdB exchange rate. The exchange rate is the number of dB decrease in noise level which would allow doubling of exposure time. $L_{ef(3)}(H)$ is equal to $L_{eq}(H)$. In instances of fluctuating noise and intermittent exposures 5dB is often used for X. "H" represents the time period concerned expressed in hours.

1.4.10 *Equivalent continuous sound level $L_{eq}(H)$:* A notional level which would in the course of a given time period (H) cause the same A-weighted sound energy to be received as that due to the actual sound over the period. "H" represents the time period concerned expressed in hours.

$$L_{eq} = 10 \log_{10} \quad \frac{1}{T}\int_{O}^{T}\frac{(Pa(t))^2}{P_O{}^2}\cdot dt$$

where: T = measurement time

$Pa^{(t)}$ = A-weighted instantaneous sound pressure
P_O = 20 x 10^{-6} pascal (the reference level).

1.4.11 *Fishing vessel:* A vessel used commercially for catching fish, whales, seals, walrus or other living resources of the sea.

1.4.12 *Fluctuating noise:* Noise which is varying in level rising and falling. For the purpose of this Code it may be taken to mean fluctuations in excess of the steady noise as defined in 1.4.31 and excludes impulse noise as defined in 1.4.14.

1.4.13 *Hearing loss:* Hearing loss is evaluated in relation to a reference auditory threshold defined conventionally in ISO Standard 389 (1975). The hearing loss corresponds to the difference between the auditory threshold of the subject being examined and the reference auditory threshold. ISO Standard 1999 (1975)[3] takes an average loss of 25 dB calculated at frequencies 500, 1,000 and 2,000 Hz.

1.4.14 *Impulse noise:* Noise of less than one second's duration which occurs as an isolated event, or as one of a series of events with a repetition rate of less than 15 times per second.

1.4.15 *Integrating sound level meter:* A sound level meter designed or adapted to measure the level of the mean squared time averaged A-weighted sound pressure.

1.4.16 *ISO noise rating (NR) number:* The number found by plotting the octave band spectrum on the NR curves given in ISO Standard R 1996-1967 and selecting the highest noise rating curve to which the spectrum is tangent.

1.4.17 *Machinery spaces:* All spaces containing propulsion machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery and similar spaces, and trunks to such spaces.

1.4.18 *Mobile offshore drilling unit:* A vessel capable of engaging in drilling operations for the exploration for, or exploitation of, resources beneath the sea-bed, such as liquid or gaseous hydrocarbons, sulphur or salt.

1.4.19 *Navigating bridge wings:* Those parts of the ship's navigating bridge extending towards the ship's sides.

1.4.20 *Noise:* For the purpose of the Code all sound which can result in hearing impairment, or which can be harmful to health or be otherwise dangerous.

1.4.21 *Noise induced hearing loss:* A hearing loss, originating in the nerve cells within the cochlea, attributable to the effects of sound.

1.4.22 *Noise level:* See A-weighted sound pressure level (1.4.3).

[3] This Standard is at present (January 1981) being revised.

1.4.23 *Normal service shaft speed:* The shaft speed specified for the ship's acceptance on initial delivery, or after being modified, as applicable.

1.4.24 *Occasional exposures:* Those exposures typically occurring once per week, or less frequently.

1.4.25 *Passenger:* Any person on board other than the master and members of the crew or other persons employed or engaged in any capacity on board a ship on the business of that ship.

1.4.26 *Pipe-laying barge:* A vessel specifically constructed for, or used in conjunction with, operations associated with the laying of submarine pipelines.

1.4.27 *Port condition:* The condition in which all machinery solely required for propulsion is stopped.

1.4.28 *Potentially hazardous noise levels:* Those levels at and above which persons exposed to them without protection are at risk of sustaining a noise induced hearing loss.

1.4.29 *Sound:* Energy that is transmitted by pressure waves in air or other materials and is the objective cause of the sensation of hearing.

1.4.30 *Sound pressure level:* A measure of sound level, L, on a logarithmic scale given by:

$$L = 20 \log_{10} \frac{(p)}{(P_O)} \cdot dB$$

where: p = rms value of measured sound pressure between 20 Hz and 20 kHz

P_O = 20×10^{-6} pascal (the reference level).

1.4.31 *Steady noise:* A sound where the level fluctuates through a total range of less than 5 dB(A) as measured on the "slow" response of a sound level meter in one minute.

1.4.32 *Voyages of short duration:* Voyages where the ship is not generally underway for periods long enough for seafarers to require sleep, or long off-duty periods, during the voyages.

CHAPTER 2 - MEASUREMENT

2.1 General

On completion of the construction of the ship, or as soon as practicable thereafter, measurement of noise levels in all spaces specified in Chapter 4 should take place under the operating conditions specified in 2.2 and 2.3 and should be suitably recorded as required by 4.3.

2.2 Operating conditions at sea

2.2.1 Measurements should be taken with the ship in the loaded or ballast condition.

2.2.2 The main propulsion machinery should be run at normal design service shaft speed. Controllable pitch and Voith-Schneider propellers, if any, should be in the normal seagoing position.

2.2.3 All auxiliary machinery, navigation instruments, radio and radar sets, etc., normally, or likely to be, in use at any one time should operate throughout the measurement period.

2.2.4 Measurements in spaces containing emergency diesel engine-driven generators, fire pumps or other emergency equipment that would normally be run only in emergency, or for test purposes, should be taken with the equipment operating. Adjoining spaces need not be measured with such equipment operating, however, unless it is likely that the equipment will be operated for periods other than those mentioned above.

2.2.5 Mechanical ventilation and air-conditioning equipment should be in normal operation, taking into account that the capacity should be in accordance with the design conditions.

2.2.6 Doors and windows should in general be closed but they should be open in spaces where this is the normal condition, for instance in the navigating bridge where the door on the lee side is normally open.

2.2.7 Spaces should be furnished with all necessary equipment. Measurements without soft furnishings may be made but no allowance should be made for their absence.

2.2.8 Ships fitted with bow thrusters, stabilizers, etc., may be subject to high noise levels when in operation. Measurements should be taken at positions around such machinery when in operation and in adjacent accommodation spaces and duty stations.

2.3 Operating conditions in port

2.3.1 Measurements as specified in 2.3.2, 2.3.3 and 2.3.4 should be taken with the ship in port condition.

2.3.2 Measurements should be taken with the ship's cargo handling equipment in operation, in those areas and accommodation spaces affected by its operation. Noise originating from sources external to the ship should be discounted as indicated in 2.4.3.

2.3.3 Where the ship is a vehicle carrier and noise during loading and discharging originates from vehicles, the noise level in the cargo spaces and the duration of the exposure should be measured. This exposure should be considered in conjunction with Chapter 5.

2.3.4 It will be necessary to take measurements in machinery spaces with the auxiliary machinery operating in the port condition if the provisions of 5.3.1 in respect of ear protection are to be met in lieu of the provisions of 4.2.1.1 during maintenance, overhaul or similar port conditions.

2.4 Environmental conditions

2.4.1 The depth of water under the ship's keel and the presence of large reflecting surfaces in the ship's vicinity may affect the readings obtained, and should, therefore, be noted in the noise survey report.

2.4.2 The meteorological conditions such as wind and rain, as well as sea state, should be such that they do not influence the measurements. Wind force 4 and sea state 3 should not be exceeded. If this cannot be achieved, the actual conditions should be reported.

2.4.3 Care should be taken to see that noise from extraneous sound sources, such as people, construction and repair work, does not influence the noise level on board the ship at the positions of measurement. If necessary, readings may be corrected for steady state background noise according to the energy summation principle.

2.5 Safe measurement conditions

With the meter set to "fast response" spot checks should be made at positions of high noise level to ensure the safety of a person taking measurements.

2.6 Measurement procedures

2.6.1 During noise level measurement, only seafarers necessary for the operation of the ship and persons taking the measurements should be present in the space concerned.

2.6.2 Sound pressure level readings should be taken in decibels using an A-weighting filter (dB(A)) and if necessary also in octave bands between

31.5 and 8,000 Hz, in order to determine the ISO noise rating (NR) number, as required by Chapter 4.

2.6.3 The meter should be set to "slow" response and the readings made only to the nearest decibel. A measuring time of at least 5 seconds should be allowed. If a meter fluctuates in level within a range of no more than 5 dB(A) maximum to minimum, an estimate of the level should be made by averaging the excursions of the needle by eye.

2.6.4 If the range fluctuations are in excess of 5 dB(A), or the sound is cyclic, irregular or intermittent in operation an integrating meter should be used set to A-weighting. Integration should be made over a period of at least 30 seconds.

2.6.5 Exposure measurement

In addition to the steady state and fluctuating noise level measurements, the noise exposure of seafarers may be measured as allowed by 4.1.2, if necessary.

2.7 Calibration

The sound level meter should be calibrated with the calibrator referred to in 3.2.2 before and after measurements are taken.

2.8 Measurement positions

2.8.1 *Points of measurement*

If not otherwise stated, measurements should be performed with the microphone at a height of between 1.2 m and 1.6 m from the deck. The distance between two measurement points should be at least 2 m, and in large spaces not containing machinery, measurements should be taken at intervals not greater than 7 m throughout the space including positions of maximum noise level. In large cargo holds no more than three measurements need be taken. In no case should measurements be taken closer than 0.5 m from the boundaries of a space. The microphone positions should be as specified in 2.8.2 to 2.8.8.

2.8.2 *Accommodation spaces*

One measurement should be made in the middle of the space. The microphone should be moved slowly horizontally and/or vertically over a distance of 1 m and the mean reading recorded. Additional measurements should be performed at other points if appreciable differences, i.e. greater than 10 dB(A), in the level of sound inside the room occur, especially near the head positions of a sitting or lying person.

2.8.3 *Machinery spaces*

2.8.3.1 Measurements should be made at the principal working and control stations of the seafarers in the machinery spaces and in the adjacent control rooms, if any, special attention being paid to telephone locations and to positions where voice communication and audible signals are important.

2.8.3.2 Readings should not normally be taken, closer than 1 m from operating machinery, or from decks, bulkheads or other large surfaces, or from air inlets. Where this is not possible, measurement should be taken at a position midway between the machinery and adjacent reflecting surface.

2.8.3.3 Measurements from machinery which constitutes a sound source should be taken at 1 m from the machinery. Measurement should be made at a height of 1.2 m to 1.6 m above the deck, platform or walkway as follows:

.1 at a distance of 1 m from, and at intervals not greater than 3 m around, all sources such as:
- main turbines or engines at each level
- main gearing
- turbo-blowers
- purifiers
- electrical alternators and generators
- boiler firing platform
- forced and/or induced draught fans
- compressors
- cargo pumps (including their driving motors or turbines)

(in order to avoid an unnecessarily large and impractical number of measurements and recordings in the case of large engines and of machinery spaces where the measured sound pressure level in dB(A) at the intervals above does not vary significantly, it will not be necessary to record each position. Full measurement at representative positions and at the positions of maximum sound pressure level should, however, be made and recorded, subject to at least four measurements being recorded at each level.);

.2 at local control stations, e.g. the main manoeuvring or emergency manoeuvring stand on the main engine and the machinery control rooms;

.3 at all other locations not specified in .1 and .2 which would normally be visited during routine inspection, adjustment and maintenance;

.4 at points on all normally used access routes, unless covered by positions already specified above, at intervals not greater than 10 m;

.5 in rooms within the machinery space, e.g. workshops.
(in order to restrict the number of measurements and recordings, the number of recordings can be reduced as in .1, subject to a total of at least four measurements (including those specified in this paragraph) being recorded at each machinery space level up to upper deck.)

2.8.4 ***Duty stations***

The noise level should be measured at all points where the work is carried out. Additional measurements should be performed in spaces containing duty stations if variations in noise level are thought to occur in the vicinity of the duty stations.

2.8.5 ***Normally unoccupied spaces***

2.8.5.1 In addition to the spaces referred to in 2.8.2 to 2.8.4, measurements should be made in all locations with unusually high noise levels where seafarers may be exposed, even for relatively short periods, and at intermittently used machinery locations, for example cargo discharge pumps.

2.8.5.2 In order to restrict the number of measurements and recordings, noise levels need not be measured for normally unoccupied spaces, holds, deck areas and other spaces which are remote from sources of noise and where a preliminary survey shows that the noise levels are well below the limit specified in Chapter 4.

2.8.6 ***Open deck***

Measurements should be taken in any areas provided for the purpose of recreation and additionally where a preliminary survey indicates that the limits specified in 5.3.1 may be exceeded.

2.8.7 ***Intake and exhaust openings***

When measuring noise levels at the intake and exhaust of engines and near ventilation, air-conditioning and cooler systems, the microphone should, where possible, be placed outside the gas stream at a distance of 1 m from the edge of the intake or exhaust opening and at a 30° angle away from the direction of the gas stream and as far as possible from reflecting surfaces.

2.8.8 ***Navigating bridge wings***

Measurements should be taken on both navigating bridge wings but should only be taken when the navigating bridge wing to be measured is on the lee side of the ship.

CHAPTER 3 - MEASURING EQUIPMENT

3.1 Equipment specifications

3.1.1 ***Sound level meters***

Measurement of sound pressure levels should be carried out using precision grade sound level meters, industrial grade sound level meters, and integrating sound level meters subject to the requirements of paragraph 3.1.4. Such meters should be manufactured to the IEC Publication 651(1979)[4] type 0, 1 or 2 standards as applicable, or to an equivalent standard acceptable to the Administration.

3.1.2 *Octave filter set*

When used alone, or in conjunction with a sound level meter, as appropriate, an octave filter set should conform to IEC Publication 225(1966)[5] or an equivalent standard acceptable to the Administration:

3.1.3 *Measurement microphones*

Microphones should be of the random incidence type and should meet the standards of IEC Publication 179(1973), IEC Publication 651(1979) types I and II or an equivalent standard acceptable to the Administration.

3.1.4 *Selection of equipment*

The main difference between the grades is in the tolerance band which is allowed on the A-weighting filter networks. The tolerances allowed are wider at low and high frequencies than at mid-frequencies. In consequence, for sound emitted by typical medium sized machines the accuracy of measurement with a precision grade meter is about ± 1 dB(A) and with an industrial grade meter about ± 3 dB(A). The industrial grade meter will tend to give lower readings than the precision grade. It is recommended that where noise levels are likely to be close to the limits given in the Code precision grade instruments should be used, and in any cases of dispute readings should be taken with a precision grade instrument.

3.2 Use of equipment

3.2.1 *Measuring fluctuating noise*

When measuring fluctuating noise an integrating sound level meter should be used.

3.2.2 *Calibration*

A suitable calibrator, approved by the manufacturer of the particular sound level meter, should be used. Calibrators for use with precision grade sound level meters should be accurate to within ± 0.3 dB(A), and for use with industrial grade meters accurate to within ± 0.5 dB(A).

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[4] Recommendation for sound level meters.

[5] Octave, half octave and third octave band-pass filters intended for the analysis of sounds and vibrations.

3.2.3 *Check of measuring instrument and calibrator*

The sound level measuring instrument and calibrator should be returned to the manufacturer or other competent organization capable of providing a calibration check traceable to a national standard laboratory at intervals not exceeding two years.

3.2.4 *Microphone windscreen*

A microphone wind screen should be used when taking readings outside, e.g. on navigating bridge wings or on deck, and below deck where there is any substantial air movement. The wind screen should not affect the measurement level of similar sounds by more than 0.5 dB(A) in "no wind" conditions.

3.2.5 *Measuring equipment for use in gas dangerous spaces*

Measuring equipment should not be used in areas where flammable gas/air mixtures may be present, unless such equipment has been certified intrinsically safe for such purposes.

3.2.6 *Industrial grade instruments*

In any situations where an industrial grade meter is used a factor of 3 dB(A) should be added to the readings to allow for the reduced accuracy of this type of instrument.

CHAPTER 4 - MAXIMUM ACCEPTABLE SOUND PRESSURE LEVELS

4.1 General

4.1.1 The limits specified in this section should be regarded as maximum levels and not as desirable levels. Where reasonably practicable, it is desirable for the noise level to be lower than the maximum levels specified.

4.1.2 The limit specified for any work space may be assessed by steady, fluctuating, equivalent continuous or effective sound level measurement for the space. Where the equivalent continuous or effective sound level is used, it should include all the measurement locations required in Chapter 2, Where the 24 hour equivalent continuous or effective sound level is used as the basis for compliance with the Code, the limit for this level given in Chapter 5 should apply.

4.1.3 Personnel entering spaces with noise levels greater than 85 dB(A) should be required to wear ear protectors (see Chapter 5). The limit of 110 dB(A) given in 4.2.1.2 assumes that ear protectors giving protection meeting the requirements for ear muffs in Chapter 7 are worn.

4.1.4 Limits are specified in terms of A-weighted sound pressure levels (see 1.4.3 and 1.4.22).

4.1.5 In accommodation spaces where the dB(A) limits are exceeded and where there is a subjectively annoying low frequency sound or obvious tonal components the ISO noise rating (NR) number should also be determined. The limits specified may be considered as satisfied if the ISO noise rating (NR) number does not numerically exceed the specified A-weighted value minus 5.

4.1.6 In machinery spaces specified in 4.2.1.2, in which the operation of any equipment or machinery or part of machinery results in an emission of subjectively high frequency sound and in which the sound level of 105 dB(A) is exceeded, the ISO noise rating (NR) number should be determined. When NR 105 is exceeded the acceptability of this level should be determined by the Administration.

4.2 Noise level limits

Limits for noise levels are specified for various spaces as follows:

4.2.1 ***Work spaces*** (see 5.1)

		dB(A)
.1	Machinery spaces (continuously manned)[6]	90
.2	Machinery spaces (not continuously manned)[4]	110
.3	Machinery control rooms	75
.4	Workshops	85
.5	Non-specified work spaces[4]	90

[6] Ear protectors should be worn when the noise level is above 85 dB(A) (see 4.1.3).

4.2.2	***Navigation spaces***	dB(A)
.1	Navigating bridge and chartrooms	65
.2	Listening post, including navigating bridge[7] wings and windows	70
.3	Radio rooms (with radio equipment operating but not producing audio signals)	60
.4	Radar rooms	65

4.2.3	***Accommodation spaces***	dB(A)
.1	Cabins and hospitals	60
.2	Mess rooms	65
.3	Recreation rooms	65
.4	Open recreation areas	75
.5	Offices	65

4.2.4	***Service spaces***	dB(A)
.1	Galleys, without food processing equipment operating	75
.2	Serveries and pantries	75

4.2.5	***Normally unoccupied spaces***[8]	dB(A)
	Spaces not specified (see 5.1)	90

4.3 Survey report

4.3.1 A noise survey report should be made for each ship. The report should comprise information on the noise levels in the various spaces on board. The report should show the reading at each specified measuring point. The points should be marked on a general arrangement plan, or on accommodation drawings attached to the report, or should otherwise be identified.

4.3.2 A model format for noise survey reports is set out in Appendix 1.

4.3.3 The following particulars should be mentioned in the noise survey report:

- **.1** Hull number, name, gross tonnage, main dimensions and type of ship.
- **.2** The leading particulars of the ship's machinery.
- **.3** Names of the builder and owner of the ship.
- **.4** Date and time of the measurements.
- **.5** The type of voyage, the meteorological conditions, sea state and the ship's position during the measurements.
- **.6** The underkeel clearance during the measurements.
- **.7** The main operating conditions as required by 2.2 and 2.3, including those items on the main machinery line which were operating and the operating condition.

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[7] Reference is made to resolution A.343(IX) which also applies.
[8] Ear protectors should be worn when the noise level is above 85 dB(A) (see 4.1.3).

.8 The name and address of those carrying out the measurements.
.9 The make, type and serial number of instrumentation used.
.10 Details and date of calibration of instruments.
.11 A list of the main noise abatement measures applied aboard the ship.
.12 Other particulars of interest, including exceptions to the standard laid down in this Code.

4.3.4 Where the ship does not comply with Chapter 4 and where the use of ear protectors is required, a copy of the noise survey report should be carried on board.

CHAPTER 5 - NOISE EXPOSURE LIMITS

5.1 General

The noise level limits as set out in Chapter 4 are designed to ensure that, if they are complied with, seafarers will not be exposed to an $L_{eq}(24)$ exceeding 80 dB(A), i.e. within each day or 24 hour period the equivalent continuous noise exposure would not exceed 80 dB(A). In spaces with sound pressure levels exceeding 85 dB(A), it will be necessary to use suitable ear protection, or to apply time limits for exposure, as set out in this section, to ensure that an equivalent level of protection is maintained. Consideration should be given to the instruction of seafarers on these aspects, as recorded in Appendix 2.

5.2 Hearing conservation and use of ear protectors

In order to comply with the exposure criteria of this section, the use of ear protectors complying with Chapter 7 is permitted. In some instances when ear protectors are required for compliance with the Code, a hearing conservation programme and other measures may be implemented by the Administration.

5.3 Limits of exposure of seafarers to high noise levels

Seafarers should not be exposed to noise in excess of the levels and durations shown in figure 5.1 and described in 5.3.1 to 5.3.5.

5.3.1 *Maximum exposure without protection (zone E, fig. 5. 1)*

For exposures of less than 8 hours, seafarers without ear protection should not be exposed to noise levels exceeding 85 dB(A). When seafarers remain for more than 8 hours in spaces with a high noise level, an $L_{eq}(24)$ of 80 dB(A) should not be exceeded. Consequently, for at least a third of each 24 hours each seafarer should be subject to an environment with a noise level not exceeding 75 dB(A).

5.3.2 *Maximum exposure with protection (zone A, fig. 5. 1)*

No seafarer even wearing ear protectors should be exposed to levels exceeding 120 dB(A) or to an $L_{eq}(24)$ exceeding 105 dB(A).

5.3.3 *Daily exposure (zone D, fig.5. 1)*

If seafarers routinely work (daily exposure) in spaces with noise levels within zone D ear protectors should be worn and a hearing conservation programme may be considered.

5.3.4 *Occasional exposure (zone 8, fig.5. 1)*

Only occasional exposures should be allowed in zone B and both ear muffs and ear plugs should be used unless the exposure duration is restricted to not more than 10 minutes when only ear muffs or plugs are required.

5.3.5 *Occasional exposure (zone C, fig.5. 1)*

In zone C only occasional exposures should be allowed and ear muffs or plugs should be required.

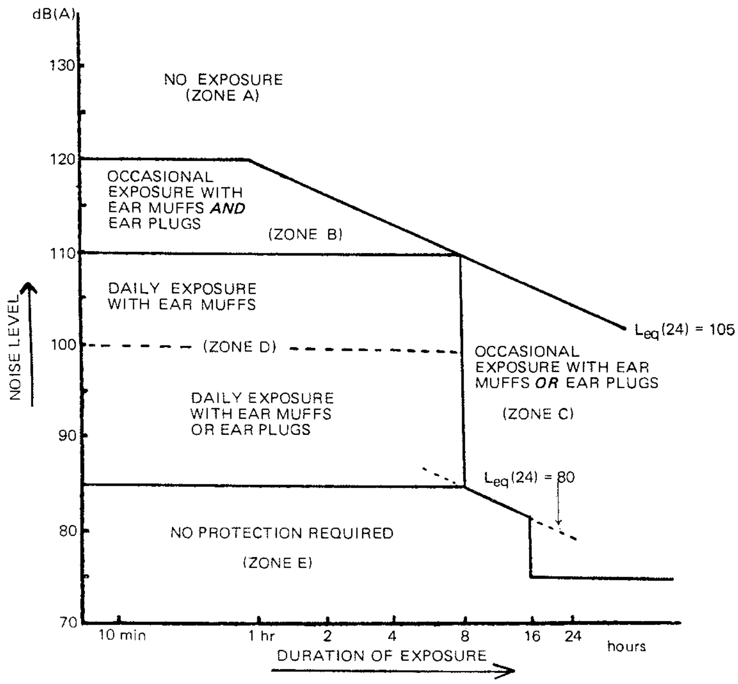

Fig. 5.1 Allowable daily and occasional noise exposure zones

5.4 24 hour equivalent continuous sound level limit

As an alternative to compliance with the provisions of 5.3 (fig. 5.1), no unprotected seafarer should be exposed to a 24 hour equivalent continuous sound level greater than 80 dB(A). Each individual's daily exposure duration in spaces requiring the use of ear protectors should not exceed 4 hours continuously or 8 hours in total. In those cases, where the Administration determines that exposures are intermittent, no unprotected seafarer should be exposed to an equivalent effective sound level which in the case of a 5 dB exchange rate would be $L_{ef(5)}(24)$ equal to 77 dB(A).

5.5 Hearing conservation programme

5.5.1 A hearing conservation programme may be provided for seafarers exposed to the noise levels referred to in 5.3.3 in order to train them in the hazards of noise and use of ear protection, and to monitor hearing acuity. Some elements of a hearing conservation programme are as follows:

- **.1** Initial and periodic audiometric tests administered by a trained and appropriately qualified person, to the satisfaction of the Administration.
- **.2** Instruction of exposed persons on the hazards of high and long duration noise exposures and on the proper use of ear protectors (see Appendix 2).
- **.3** Maintenance of audiometric test records.
- **.4** Periodic analysis of records and hearing acuity of individuals with high hearing loss.

An optional element of a hearing conservation programme is to control the 24 hour equivalent continuous or effective sound level to which individuals working in high noise level spaces are exposed. Such control requires calculation of the 24 hour equivalent continuous or effective sound level based upon the measurement of exposure durations for steady noise levels in accordance with 2.6.5 or the equivalent continuous sound level measurement for fluctuating noise in accordance with 2.6.4. If this 24 hour level does not meet the limits, the duration of exposure should be controlled or ear protectors used at appropriate times to bring the individual's exposure within the limit.

CHAPTER 6 - ACOUSTIC INSULATION BETWEEN ACCOMMODATION SPACES

6.1 General

Consideration should be given to the acoustic insulation between accommodation spaces in order to make rest and recreation possible even if activities are going on in adjacent spaces, e.g. music, talking, cargo-handling, etc.

6.2 Sound insulation index

6.2.1 The airborne sound insulation properties for bulkheads and decks within the accommodation should comply at least with the following airborne sound insulation index (l_a) according to ISO Standard R717[9]:

Cabin to cabin	l_a = 30
Messrooms, recreation rooms to cabins and hospitals	l_a = 45

6.2.2 The airborne sound insulation properties should be determined by laboratory tests in accordance with ISO Standard R140 Pt III[10], to the satisfaction of the Administration.

6.3 Erection of materials

Care should be taken in the erection of materials and in the construction of accommodation spaces to ensure to the greatest practicable extent that the attenuation values specified in 6.2 are not significantly impaired.

CHAPTER 7 - EAR PROTECTION AND WARNING INFORMATION

7.1 General

When the application of means for controlling sound at source does not reduce the noise level in any space to that specified in 4.1.3, seafarers who are required to enter such spaces should be supplied with effective ear protection on an individual basis. The provision of ear protectors should not be considered to be a substitute for effective noise control. Appendix 3 summarizes current noise abatement methods which may be applied on new ships.

7.2 Recommendation for ear protectors

7.2.1 Ear protectors should provide at least the attenuation listed in table 7.1. The attenuation to be compared with that in the table should be the result of the average value of the ear protector attenuation minus the standard deviation measured in accordance with ISO Standard (DIS 4869) or similar standard acceptable to the Administration.

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9 ISO Standard R717 - Rating of Sound Insulation for Dwellings.
10 ISO Standard R 140 Pt 111 - Laboratory Measurements of Airborne Sound Insulation and of Building Elements.

7.2.2 For the purpose of developing the criteria specified in Chapter 4 and section 5.3, ear protectors have been assumed to provide approximately the following insertion loss:

.1 ear plugs - 20 dB(A)
.2 ear muffs - 30 dB(A)
.3 ear plugs and ear muffs - 35 dB(A)

Therefore, care should be exercised when using ear plugs in very high noise areas (i.e. over 100 dB(A) unless the attenuation of the plug used sufficiently exceeds the values of table 7.1 or appropriate attenuations at individual frequencies are known.

TABLE 7.1 - REAL EAR ATTENUATION OF EAR PROTECTORS - dB

Type of ear protector	Octave band centre frequency – Hz							
	125	250	500	1000	2000	3150	4000	6300
Ear plugs	0	5	10	15	22	22	22	22
Ear muffs	5	12	20	30	30	30	30	30

7.3 Selection and use of ear protectors

Seafarers should be instructed in the proper use of ear protectors in accordance with Appendix 2.

7.4 Warning notices

Where the noise level in machinery spaces (or other spaces) is greater than 85 dB(A), entrances to such spaces should carry a warning notice comprising symbol and supplementary sign as prescribed by the Administration. If only a minor portion of the space has such noise levels the particular location(s) or equipment should be identified at eye level, visible from each direction of access.

7.5 Miscellaneous equipment

Where hand tools, galley and other portable equipment produce noise levels above 85 dB(A) in normal working conditions warning information should be provided.

APPENDIX 1

FORMAT FOR NOISE SURVEY REPORT

1 Ship particulars

.1 Name of ship
.2 Port of registry
.3 Name and address of shipowner, managing owner or agent

.4 Name and address of shipbuilder
.5 Place of build
.6 Builder's number
.7 Gross tonnage
.8 Type of ship
.9 Ship's dimensions – length
breadth
depth
maximum draught (summer load line)
.10 Displacement at maximum draught
.11 Date of keel laying
.12 Date of delivery

2 Machinery particulars

.1 Propulsion machinery
Manufacturer: Type: Number of units:
Maximum cont. rating – power kW
Normal designed service shaft speed: r.p.m.
Normal service rating - power: kW
.2 Auxiliary diesel engines
Manufacturer: Type:
Output: kW Number of units:
.3 Main reduction gear:
.4 Type of propeller (fixed propeller, controllable pitch propeller, Voith-Schneider propeller)
Number of propellers: Number of blades:
Designed propeller shaft speed: r.p.m.

3 Measuring instrumentation

.1 Instrumentation	**Make**	**Type**	**Serial No.**
Sound level meter			
Microphone			
Filter			
Windscreen			
Calibrator			
Other equipment			

.2 **C**alibration of sound level meter - at survey by competent authority	**Date**	**Calibration**	**Start**	**Finish**

4 Conditions during measurement

.1 Date of measurement Starting time: Completion time:
.2 Vessel's position during measurement

Note: Those spaces and areas where noise rating numbers are calculated are indicated by * and the data will be found in the Attachment.

.3 Type of voyage
.4 Conditions during measurement
- Draught forward
- Draught aft
- Depth of water under keel

.5 Weather conditions
- Wind force
- Sea state

.6 Ship speed
.7 Actual propeller shaft speed r.p.m.
.8 Propeller pitch:
.9 Propulsion machinery speed: r.p.m.
.10 Propulsion machinery power: kW
.11 Number of propulsion machinery units operating:
.12 Number of diesel auxiliary engines operating:
.13 Number of turbogenerators operating:
.14 Other auxiliary equipment operating:

5 Measuring data

	Noise limits dB(A)	Measured sound pressure levels dB(A)
Machinery spaces:		
Control rooms		
Workshops		
Propulsion machinery		
Turbocharger		
Top propulsion machinery		
Auxiliary diesel engines/ Turbogenerators		
Reduction gear		
Non-specified workspaces		
Accommodation and other spaces		
Messes		
Recreation rooms		
Offices		
Galleys		
Serveries and pantries		
Cabins		

	Noise limits dB(A)	Measured sound pressure levels dB(A)
Navigation spaces		
Bridge		

Note: Those spaces and areas where noise rating numbers are calculated are indicated by * and the data will be found in the Attachment.

Chart room
Radar room
Radio room
Navigating bridge wings

Open recreation area

6 Main noise abatement measures (list measures taken)

7 Remarks (list any exceptions to the Code)

............……………………… ……………………………
Name

………………..................
Address

……………........... …………… …………................
Place Date Signature

ATTACHMENT

PAGES OF FREQUENCY ANALYSIS

APPENDIX 2

INSTRUCTIONS TO SEAFARERS AND RESPONSIBILITY

1 Instruction to seafarers

1.1 Seafarers should be instructed in the hazards of high and long duration noise exposures and the risk of noise induced hearing loss. Instruction should be given to all seafarers on initial employment and periodically thereafter to those regularly working in spaces with noise levels in excess of 85 dB(A). Instruction in the provisions of the Code should include:

- **.1** noise exposure limits of Chapter 5 and the use of warning notices in complying with the criteria;
- **.2** the types of ear protectors provided, their approximate attenuation and their proper use, fitting, and risk effects experienced when first wearing such protection;
- **.3** any hearing conservation programme which may be available if working in spaces covered by warning notices;
- **.4** some of the possible signs of hearing loss such as ringing in the ear, dead ear, or fullness in the oar.

Note: Those spaces and areas where noise rating numbers are calculated are indicated by * and the data will be found in the Attachment.

1.2 Appropriate seafarers should receive such instruction as is necessary in the correct use and maintenance of machinery and silencers or attenuators in order to avoid the production of unnecessary noise.

2 Responsibility of shipowners

2.1 The shipowner should be responsible for ensuring that means for noise reduction and control are applied and maintained such that the requirements of the Code are met.

2.2 Where noise levels in any space exceed the limit of 85 dB(A), shipowners should ensure that:

.1 the space is identified and the warning notice described in 7.4 of the Code is displayed;

.2 the master and senior officers of the ship are notified as to the importance of controlling entry into the space and the importance of the use of suitable ear protectors;

.3 suitable ear protectors are provided in sufficient numbers for distribution on an individual basis;

.4 an instruction is issued to the master, senior officers and any safety officer of the ship pointing out the desirability of providing the instruction outlined in 1.1 and 1.2 to seafarers.

3 Responsibility of seafarers

3.1 Seafarers should be responsible for ensuring that:

.1 measures adopted for noise control are used;

.2 defective noise control equipment is reported to a responsible person;

.3 suitable ear protectors are normally worn when entering areas in which their use is required by warning notices and that these protectors are not removed, even for short periods; and

.4 ear protectors provided for use are not damaged or misused and are maintained in a clean condition.

APPENDIX 3

SUGGESTED METHODS OF CONTROLLING NOISE EXPOSURE

1 General

1.1 In order to obtain a noise reduction on board ships to comply with the recommended limits given in Chapters 4 and 5 of the Code careful consideration should be given to means of such reduction. This Appendix is intended to provide guidance for the design of a ship in this respect.

1.2 Design and construction of noise control measures should be supervised by persons skilled in noise control techniques.

1.3 Some of the measures which can be taken to control the noise level or reduce the exposure of seafarers to potentially harmful noise are indicated in sections 2 to 10 of this Appendix. It is emphasized that it will not be necessary to implement all or any of the measures recommended in this Appendix on all ships. This Code does not provide detailed technical information needed for putting constructional noise control measures into effect, or for deciding which measures are appropriate in particular circumstances.

1.4 In applying noise control measures, care should be taken to ensure that rules and regulations concerning ship structure, accommodation and other safety matters are not infringed and the use of sound reduction materials should not introduce fire or health hazards.

1.5 The need for noise control should be taken into account at the design stage when deciding which of different designs of engines and machinery are to be installed, the method of installation and the siting of machinery in relation to other spaces, and the acoustic insulation and siting of the accommodation spaces.

1.6 Due to the normal method of ship construction it is most probable that noise originating from machinery and propellers reaching the accommodation and other spaces outside the machinery spaces will be of the structure-borne type.

1.7 When designing efficient and economic measures for noise control of machinery installations in existing ships, the measurement of sound produced in terms of A-weighted sound level may need to be supplemented by some form of frequency analysis.

2 Isolation of sources of noise

2.1 Where practicable any engines or machinery producing noise levels in excess of the limits set out in 4.2 of the Code should be installed in compartments which do not require continuous attendance (see also 6.1 of this Appendix).

2.2 Accommodation should be sited both horizontally and vertically as far away as is practicable from sources of noise such as propellers and propulsion machinery.

2.3 Machinery casings should, where practicable, be arranged outside superstructures and deckhouses containing accommodation spaces. Where this is not feasible, passageways should be arranged between the casings and accommodation spaces, if, practicable.

2.4 Consideration should be given, where practicable, to the placing of accommodation spaces in deck houses not in superstructures extending to the ship's side.

2.5 Consideration may also be given where applicable to the separation of accommodation spaces from machinery spaces by unoccupied spaces, sanitary and washing rooms.

2.6 Suitable partitions, bulkheads, decks, etc. may be needed to prevent the spread of sound. It is important that these be of the correct construction and location in relation to the source of sound and the frequency of the sound to be attenuated.

2.7 Where a space, such as a machinery space, is being divided into noisy (not continually manned) and less noisy (capable of being continually manned) spaces, it is preferable to have complete separation[11].

2.8 It may be advisable to provide sound absorbing material in certain spaces in order to prevent increase of noise level due to reflection from partitions, bulkheads, decks, etc.

3 Exhaust and intake silencing

3.1 Exhaust systems from internal combustion engines, air intake systems to machinery spaces, accommodation spaces and other spaces should be so arranged that the inflow or discharge orifices are remote from places frequented by seafarers.

3.2 Silencers or attenuators should be fitted when necessary.

3.3 To minimize accommodation noise levels it is normally necessary to isolate exhaust systems and certain pipework and ductwork from casings, bulkheads, etc.

4 Machinery enclosure

4.1 In continuously manned spaces or spaces where seafarers might reasonably be expected to spend lengthy periods of time on maintenance or overhaul work, and where separation as detailed in section 2 of this Appendix is not practicable, consideration may have to be given to the fitting of sound insulating enclosures or partial enclosures to engines or machinery producing sound pressure levels in excess of the limits set out in 4.2 of the Code.

4.2 Where the noise level produced by engines or machinery installed in spaces as in 4.1 above fails within the criteria of 5.3.1 of the Code and zone A of figure 5.1, it is essential that noise reduction measures are provided.

[11] In these cases it may be necessary to ensure the supervision of the plant by installing alarms in the less noisy compartments and to arrange means of escape so that seafarers may leave these Compartments without danger.

4.3 When sound insulating enclosures are fitted, it is important that they entirely enclose the noise source.

5 Reduction of noise in the aft body

To reduce the noise influence in the aft body of the ship, especially to the accommodation spaces, consideration may be given to noise emission problems during the design procedures relating to the aft body, propeller, etc.

6 Enclosure of the operator

6.1 1n most machinery spaces it would be desirable and advisable to protect operating or watchkeeping seafarers by providing a sound reducing control room or other similar space (see 2.1 of this Appendix).

6.2 In continuously manned machinery spaces of small ships and of existing ships where noise levels are in excess of 85 dB(A), it would be desirable to provide a noise refuge at the control station or manoeuvring platform where the watchkeeper might be expected to spend the major part of the time.

7 Controls in accommodation spaces

7.1 To reduce noise levels in accommodation spaces it may be necessary to consider the isolation of deckhouses containing such spaces from the remaining structure of the ship by resilient mountings.

7.2 Consideration may also be given to the provision of flexible connexions to bulkheads, linings and ceilings and the installation of floating floors within accommodation spaces.

7.3 The provision of curtains to sidescuttles and windows and the use of carpets within accommodation spaces assists in absorbing noise.

8 Selection of machinery

8.1 The sound produced by each item of machinery to be fitted should be taken into account at the design stage. It may be possible to control noise by using a machine producing less airborne, fluid-borne or structure-borne sound.

8.2 Manufacturers should be requested to supply information on the sound produced by their machinery and also to provide recommended methods of installation in order to keep noise levels to a minimum.

9 Inspection and maintenance

All items of machinery, equipment and associated working spaces should be regularly inspected with respect to noise by a competent person.

Should such inspection reveal defects in the means for noise control, or other defects causing excessive noise, these should be rectified as soon as practicable.

10 Vibration isolation

10.1 Where necessary, machines should be supported on correctly designed and fitted resilient mountings.

10.2 Where structure-borne sound from auxiliary machinery, compressors, hydraulic units, generating sets, vents, exhaust pipes and silencers produces unacceptable noise levels in accommodation spaces or on the navigating bridge, resilient mountings should be fitted.

10.3 When sound insulating enclosures are fitted it is desirable that the machine should be resiliently mounted and that all pipe, trunk and cable connexions to it be flexible.

RESOLUTION A.471(XII)

Adopted on 19 November 1981

RECOMMENDATION ON TEST METHOD FOR DETERMINING THE RESISTANCE TO FLAME OF VERTICALLY SUPPORTED TEXTILES AND FILMS

1 SCOPE

This Recommendation specifies a procedure for qualifying textiles and films used primarily as vertically hanging curtains and draperies, as meeting the requirements for the resistance to propagation of flame specified in Regulation 3(s)(iii)[12] of Chapter II-2 of the International Convention for the Safety of Life at Sea, 1974. Fabrics which are not inherently flame resistant should be exposed to cleaning or exposure procedures and tested both before and after such treatment.

2 DEFINITIONS

AFTERFLAME TIME. The time during which the material continues to flame after the ignition source has been removed or extinguished.

SUSTAINED IGNITION. Afterflame time of 5 seconds or more.

AFTERGLOW. Persistence of glowing of a material after cessation of flaming or after the ignition source has been removed.

SURFACE FLASH. The rapid flash of a flame across the surface of the fabric primarily involving the surface pile finish and often leaving the base fabric in an essentially undamaged condition.

3 PURPOSE

The test method provides information on the ability of a fabric to resist sustained ignition and flame propagation when exposed to a small igniting flame. The performance of a fabric in this test does not necessarily indicate its resistance to flame propagation when exposed to conditions substantially different from those used in the test.

4 HEALTH AND SAFETY OF TEST OPERATORS

Burning of textiles may produce smoke and toxic gases which can affect the health of operators. The testing area should be cleared of smoke and fumes by suitable means of forced ventilation after each test, then restored to the required testing conditions.

5 TEST APPARATUS

[12] Regulation II-2/3.23.6 of the 1981 amendments to the 1974 SOLAS Convention.

5.1 Detailed drawings of both the test apparatus and enclosure for this test are available from the IMCO Secretariat.

5.2 Gas burner

A gas burner should be provided as illustrated in figure l.[13] This should be so mounted that the axis of the burner barrel is capable of adjustment to each of three fixed positions, viz. vertically upwards, horizontal or at an angle of 60° to the horizontal. The positions assumed by the burner with respect to the fabric are illustrated in figure 2.

5.3 Gas

Commercial grade propane of at least 95 per cent purity should be used.

5.4 Test enclosure

A 0.5 mm - 1.0 mm thick sheet metal draught shielding enclosure should be provided, measuring roughly 700 mm ± 25 mm x 325 mm ± 25 mm x 750 mm ± 25 mm high. The roof should be provided with 32 circular holes, each 13 mm ± 1 mm in diameter, symmetrically drilled, and baffled vent openings should be provided at the base of each side giving at least 32 cm^2 of free vent area, symmetrically distributed. One 700 mm x 325 mm face should be constructed to accommodate a closure door mainly of glass, and one smaller side should also be constructed as a vision panel. A hole should also be provided for the gas feed tube and remotely controlled burner positioning rod. The floor of the enclosure should be covered with a non-combustible insulating material. The interior should be painted black.

5.5 Specimen holder

A rectangular test frame, 200 mm ± 1 mm long x 150 mm ± 1 mm wide should be provided, constructed of stainless steel, 10 mm wide by 2 mm thick. Mounting pins incorporating distance stubs constructed of stainless steel 2.00 mm ± 1.00 mm diameter, should be fixed at each corner of the test frame and at the centre of both long members.

5.6 Base support

The test frame should be supported over a rigid metal base by means of two vertical uprights to which the frame may be attached. The metal base also provides a support for pivoting the burner pedestal to move the burner flame into contact with or away from the specimen.

6 TEST SPECIMENS

13 Figure 1 illustrates the burner as described in Deutsche Industrie Normen DIN 50 051 type KBN.

6.1 Preparation

The specimens should be as representative as possible of the material provided and should exclude selvages. At least ten specimens should be cut, each measuring 220 mm x 170 mm, five in the direction of the warp, five in the direction of the weft. Where the fabric has differing surfaces on the two sides enough samples should be cut for both surfaces to be tested.

Using a template 220 mm x 170 mm, with holes approximately of 5 mm diameter located on the template at the position of the pins on the frame, each specimen should be laid flat on a bench and premarked/punctured, to ensure a repeatable and reproducible tension of the specimen, after mounting on the frame.

6.2 Conditioning and exposure procedures

The specimens should be conditioned at 20°C ± 5°C and 65 per cent ± 5 per cent relative humidity for not less than 24 hours before test. If the material is not inherently flameproof, one of the exposure procedures detailed in Appendix 2 may, at the discretion of the approving authority, be applied to at least ten further specimens.

6.3 Mounting

Each sample should be removed from the conditioning atmosphere and either tested within three minutes or placed in a sealed container until required. The fabric should be mounted on the pins of the test frame in the locations previously marked on each fabric (see 6.1). The location of the fabric on the pins should be such that it is roughly centred in the width direction and the lower edge of the fabric extends 5 mm ± 1 mm below the lower pin.

7 TEST PROCEDURE

7.1 Presetting of the igniting flame

The gas burner should be ignited and preheated for at least two minutes. The fuel supply should then be adjusted so that, when the burner is in the vertical position, the distance between the tip of the burner tube and the visible tip of the flame is 40 mm ± 2 mm. If desired a gas flow meter may be used as a means of achieving reproducibility in adjusting the burner flame length.

7.2 Determining the mode of flame application for a given fabric

The angle of the burner should be adjusted to the horizontal position and the height fixed so that the flame, when the burner is in position, will impinge on the fabric at a central point, 40 mm above the level of the first row of pins. The door to the enclosure should then be closed and the burner moved into a position such that the burner tip is 17 mm from the face of the specimen. The flame should be applied for five seconds and then removed. If no sustained ignition occurs a new specimen should be fixed to the holder and the flame applied as before but in this case for 15 seconds. Failure to achieve sustained ignition at the longer duration requires the position of the burner to be adjusted to a position such that the tip of the burner lies 20 mm below the bottom edge of the fabric, the flame impinging on it. The flame should be applied in this position to a new specimen for five seconds and if no sustained ignition occurs another specimen should be inserted and the time of flame application should be extended to 15 seconds. The ignition condition to be used for testing the specimens should be that at which sustained ignition is first achieved when the order of test listed above is followed. In the absence of sustained ignition the specimens should be tested under conditions showing the greatest char length. The method of flame application for warp and weft specimens should be determined using the ignition sequence given above.

7.3 Flame test

Using the burner position and flame application time found to be appropriate for the specimens under test, a further five samples cut in both warp and weft directions should be tested as described in 6.2 and the afterflame times noted. Any evidence of surface flash should be noted. If afterglow is observed to occur during a test the specimen should be allowed to remain in place until all glowing has ceased. The extent of char is also measured. Where doubt exists as to the precise limit of damaged fabric, the procedure detailed in Appendix 1 should be followed.

7.4 Flaming drops

To investigate if burning drops of thermoplastic materials are capable of igniting combustible materials on the base of the apparatus, cotton wool as specified in 3.5(2) of the Annex to resolution A.163(ES.IV) as amended by resolution A.215(VII)[14] of the IMCO Assembly should be laid to a depth of 10 mm over the base plate, immediately below the specimen holder. Note should be made of any ignition or glowing of the cotton wool.

8 TEST REPORT

The test report should include the following information:

.1 name of the testing authority;
.2 name of the manufacturer of the material;
.3 date of supply of the material and date of test;
.4 name or identification mark of material;
.5 description of material;
.6 weight per unit area of material;

[14] The cotton wool should consist of new, undyed and soft fibres without any admixtures or artificial fibres, and it should be free from thread, leaf and shell fibre dust. A suitable material for this purpose is packaged in the form of rolls for surgical use.

.7 conditioning of samples and exposure procedures used, if any;
.8 mode of flame application used;
.9 duration of flame application;
.10 afterflame, length of char and ignition of cotton waste from drops, as applicable;
.11 type of cleaning and weathering procedures used, if any.

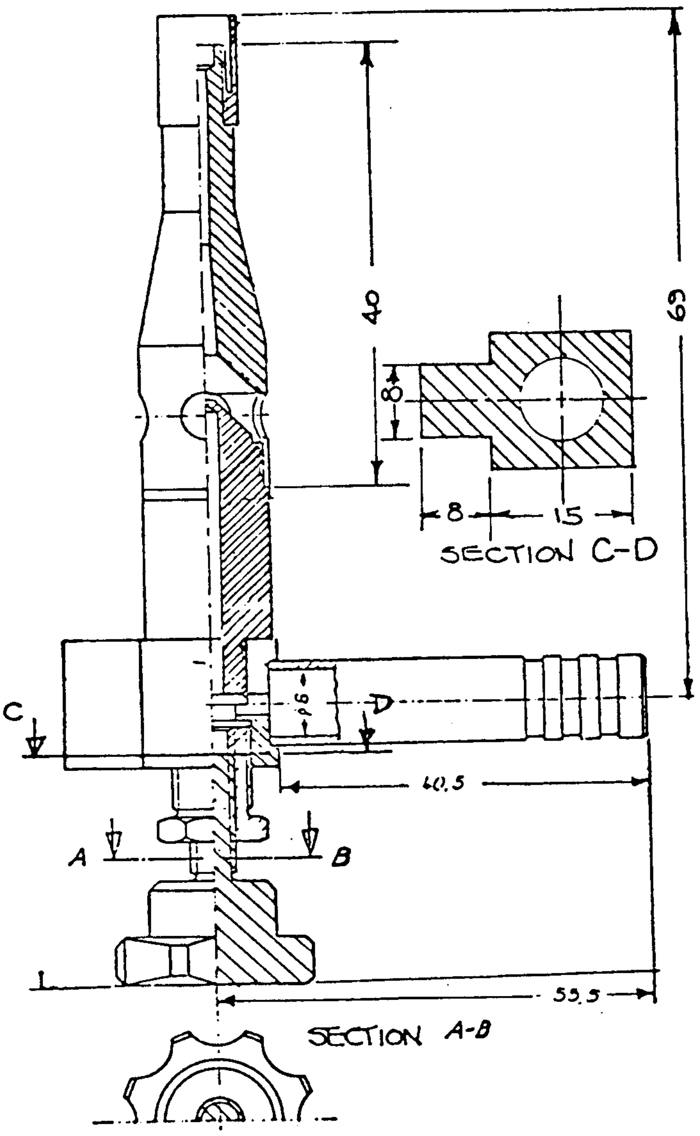
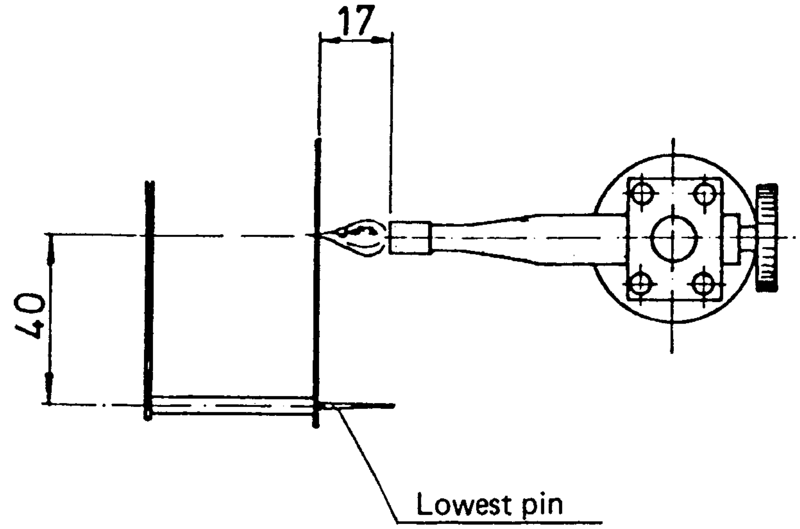


Figure 1 – Ignition burner*

* According to DIN 50 051 type KBN

SURFACE IGNITION



EDGE IGNITION

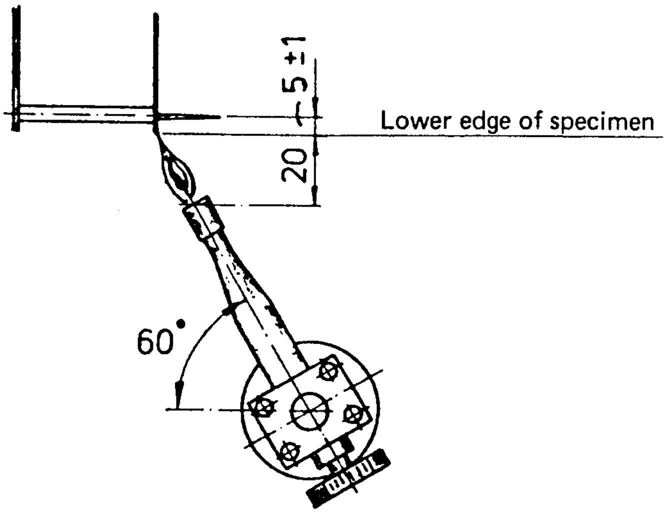


Figure 2 — Ignition burner — Fabric positions

2.2 Each fabric should be subjected to only those exposure procedures which are applicable to its intended use. It should meet the flame resistance requirements of section 5 after passing through the appropriate exposure cycles.

2.2.1 Accelerated exposure tests described in this Appendix should provide sufficient testing to permit a reasonable appraisal of the durability of the treatment (under the conditions for which it was designed) for the useful life of the fabric.

3 ACCELERATED DRY-CLEANING

3.1 The treated fabric should be dry-cleaned in a coin-operated dry-cleaning apparatus as part of a load made up with dummy pieces of dry-cleanable fabrics. The effective liquor ratio should be 1:10 or 10 kg of liquid per kilogram of fabric.

3.2 The coin-operated apparatus with perchloroethylene solvent (about 1 per cent charge system involving an emulsifying agent and water) should be run for the full cycle which includes tumble-drying. At the end of each dry-cleaning cycle, remove the load from the unit and separate the pieces.

3.3 The above dry-cleaning should be repeated until ten full cycles of cleaning and drying have been completed.

3.4 Test specimens should then be cut from the dry-cleaned fabric for testing.

4 ACCELERATED LAUNDERING

4.1 A sample of the treated fabric should be washed in an automatic commercial washing machine using a solution containing 0.5 per cent solution of IEC test detergent with perborate type 1[15]. The liquor ratio used should be 1:15.

4.2 The operating cycle outlined in table 1 should be followed.

TABLE 1

Operating cycle for accelerated laundering*

Operation	**Time, minutes**	**Temperature, °C**
1. Sudsing	6	55
2. Sudsing	6	70
3. Sudsing	6	70
4. Bleaching	8	70
5. Rinsing	2	70
6. Rinsing	2	70
7. Rinsing	2	70
8. Rinsing	2	55
9. Blueing	3	40
10. Hydroextraction	3	40

* This cycle is intended for white fabrics. For coloured fabrics, the bleaching and blueing operations are omitted and the temperature of the "sudsing" and "rinsing" operations is reduced by 17°C.

4.3 The sample should then be dried in a tumbler-drier at a temperature of 80°C.

4.4 The above procedure should be repeated until ten full cycles of washing and drying have been completed.

4.4.1 If the material is to be subjected to a special use, more laundering may be required.

15 The formulation of this detergent is defined in IEC Publication 456 as amended in 1980.

4.5 Where instructions for laundering a fabric are supplied by the manufacturer or finisher, those instructions should be followed in preference to the above procedure which simulates a typical commercial laundering practice.

5 ACCELERATED WATER LEACHING

5.1 A sample of the treated fabric should be totally submerged in a vessel containing tap water at room temperature for a period of 72 hours. The vessel should be capable of use with a liquor ratio of 1:20.

5.2 The water should be drained from the tank and replenished at 24-hour intervals during the immersion period.

5.3 At the conclusion of the immersion period, the sample should be removed from the test vessel and dried in a tumbler-drier or oven at a temperature of about 70°C.

6 ACCELERATED WEATHERING

6.1 Either a suitable accelerated weathering procedure using a xenon lamp or one of the following described procedures may be called for by the responsible Administration.

6.2 Alternative procedure No. 1.

6.2.1 Apparatus:
.1 the apparatus should consist of a vertical metal cylinder fitted with a vertical carbon arc at its centre and having a specimen holder mounted within;
.2 the diameter of the cylinder should be such that the distance to the face of the specimen holder from the centre of the carbon arc is 375 mm;
.3 the cylinder should be arranged to rotate about the arc at a rate of approximately one revolution per minute;
.4 a water spray should be provided within the cylinder and fitted with means to regulate the amount of water discharged;
.5 the vertical carbon arc should be either 13 mm diameter solid electrode type, if operating on direct current, or a single-cored electrode, if operating on alternating current. The electrodes should be of uniform composition;
.6 the arc should be surrounded by a clear globe of quartz glass, 1.6 mm thick, or other enclosure having equivalent absorbing and transmitting properties.

6.2.2 Operation of the test equipment:
.1 the specimens for test should be mounted on the inside of the cylinder facing the arc;
.2 the cylinder should rotate at approximately one revolution per minute for the duration of the test;

.3 the water spray should discharge about 0.0026 m^3/min on to the specimens for about 18 minutes during each 120-minute period;
.4 the arc should operate on 13A direct current or 17A, 60 Hz alternating current, with voltage at the arc of 140V;
.5 the electrodes should be renewed at intervals sufficiently frequent to ensure full operative conditions of the lamp;
.6 the globe should be cleaned when the electrodes are removed or at least once in each 36 hours of operation.

6.2.3 Test cycle:
.1 specimens should be subjected to this exposure for 360 hours;
.2 specimens should then be allowed to dry thoroughly at a temperature of between 20° and 40°C;
.3 after drying, the specimens should proceed through the flame test.

6.3 Alternative procedure No. 2

6.3.1 Apparatus:
.1 the apparatus should consist of a vertical carbon arc mounted at the centre of a vertical cylinder;
.2 a rotating rack should be mounted on the inside of the cylinder such that the distance from the face of the specimen to the centre of the arc is 475 mm;
.3 the arc should be designed to accommodate two pairs of carbon electrodes No. 22 upper electrodes and No. 13 lower electrodes. However, the arc should burn between only one pair of electrodes at a time;
.4 no filters or enclosures should be used between the arcs and the specimens;
.5 spray nozzles should be mounted in the cylinder so that the specimens should be exposed to wetting for about 18 minutes during each 120-minute period.

6.3.2 Operation of test equipment:
.1 the specimens for test should be mounted on the rotating rack, facing the arc;
.2 the rack should rotate about the arc at a uniform speed of about one revolution per minute;
.3 the arc should operate on 60A and 50V across the arc for alternating current or 50A and 60V across the arc for direct current.

6.3.3 Test cycle:
.1 specimens should be subjected to this exposure for 100 hours;
.2 they should then be allowed to dry thoroughly at a temperature of between 20° and 40°C;
.3 after drying, the specimens should proceed through the flame test.

PROPOSED CRITERIA FOR CURTAINS AND DRAPES

The following criteria for classification of materials are recommended as guidance. Where a different application of the test method is desired, other criteria may be applicable.

1 Following application of the flame test the experimental data from the ten or more specimens should be examined. Products which show any of the following characteristics should be considered unsuitable for use as curtains, draperies, or free-hanging fabric product for use in rooms containing furniture and furnishings of restricted fire risk as defined in Regulation 3(s)(iii)[16] of Chapter II-2 of the 1974 SOLAS Convention:

- **.1** An afterflame time greater than five seconds for any of the ten or more specimens tested with surface application of the pilot flame. But see 2 below.
- **.2** Burn through to any edge of any of the ten or more specimens tested with surface application of the pilot flame. But see 2 below.
- **.3** Ignition of cotton wool below the specimen in any of the ten or more specimens tested. But see 2 below.
- **.4** An average char length in excess of 150 mm observed in any of the batches of five specimens tested by either surface or edge ignition.
- **.5** The occurrence of a surface flash propagating more than 100 mm from the point of ignition with or without charring of the base fabric. But see 2 below.

2 If, following analysis of the experimental data from tests of a fabric, it is found that either or both of the batches of five specimens cut in both warp and weft directions fail to meet one or more of the first three criteria because of poor performance of only one of the five specimens tested, one complete retest of a similar batch is permitted. Failure of the second batch to meet any of the criteria should provide the basis for rejection of the fabric for use.

16 Regulation II-2/3.23.6 of the 1981 amendments to the 1974 SOLAS Convention.

RESOLUTION A.562(14)

Adopted on 20 November 1985

RECOMMENDATION ON A SEVERE WIND AND ROLLING CRITERION (WEATHER CRITERION) FOR THE INTACT STABILITY OF PASSENGER AND CARGO SHIPS OF 24 METRES IN LENGTH AND OVER

(recommended also for fishing vessels of 45 m in length and over in unrestricted service)

1 SCOPE

1.1 The criterion given hereunder is recommended for new decked seagoing passenger and cargo ships of 24 m in length and over and applies to all loading conditions.

1.2 This criterion supplements the stability criteria of the Recommendation on Intact Stability for Passenger and Cargo Ships under 100 m in Length in resolution A.167(ES.IV) as amended by resolution A.206(VII). The more stringent criteria of resolution A.167(ES.IV) and the weather criterion of the present Recommendation should govern the minimum requirements for passenger or cargo ships under 100 m in length.

1.3 The minimum stability of passenger and cargo ships of 100 m in length and over should comply with the weather criterion of the present Recommendation in addition to other appropriate stability criteria to the satisfaction of the Administration.

1.4 Administrations are invited to adopt, in conjunction with other appropriate criteria, the weather criterion of the present Recommendation unless satisfied that experience justifies departures therefrom.

2 RECOMMENDED CRITERION

2.1 The ability of a ship to withstand the combined effects of beam wind and rolling should be demonstrated for each standard condition of loading, with reference to the figure as follows:

.1 The ship is subjected to a steady wind pressure acting perpendicular to the ship's centreline which results in a steady wind heeling lever (lw1).

.2 From the resultant angle of equilibrium (θo), the ship is assumed to roll owing to wave action to an angle of roll (θ1) to windward. Attention should be paid to the effect of steady wind so that excessive resultant angles of heel are avoided.[17]

17 The angle of heel under action of steady wind (θo) should be limited to a certain angle to the satisfaction of the Administration. As a guide, 16° or 80 % of the angle of deck edge immersion, whichever is less, is suggested.

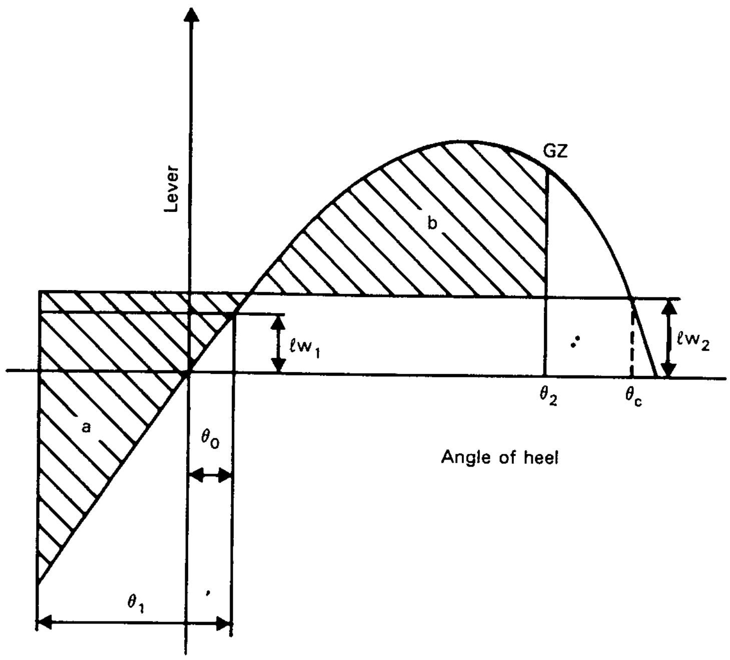


Figure – Severe wind and rolling

The angles in the above figure are defined as follows:

θ_0 = angle of heel under action of steady wind (see 2.1.2 and footnote)

θ_1 = angle of roll to windward due to wave action

θ_2 = angle of downflooding (θ_f) or 50° or θ_c whichever is less,

where:

θ_f = angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight immerse. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

θ_c = angle of second intercept between wind heeling lever lw2 and GZ curves.

2.2 The wind heeling levers lw1 and lw2 referred to in 2.1.1 and 2.1.3 are constant values at all angles of inclination and should be calculated as follows:

$$lw1 = \frac{P \cdot A \cdot Z}{\Delta} \text{ (m) ; ands}$$

$$lw2 = 1{,}5\ lw1 \text{ (m)}$$

where: P = 0.0514 (t/m^2)[18]

A = projected lateral area of the portion of the ship and deck cargo above the waterline (m^2)

Z = vertical distance from the centre of A to the centre of the underwater lateral area or approximately to a point at one half the draught (m)

Δ = displacement (t).

2.3 The angle of roll (θ1)[19] referred to in 2.1.2 should be calculated as follows:

$$\theta 1 = 109k \,.\, X1 \,.\, X2 \sqrt{r \cdot s} \text{ (degrees)}$$

where: X1 = factor as shown in table 1

X2 = factor as shown in table 2

k = factor as follows:

k = 1.0 for round-bilged ship having no bilge or bar keels;

k = 0.7 for a ship having sharp bilges;

k = as shown in table 3 for a ship having bilge keels, a bar keel or both

r = 0.73 ± 0.6 OG/d

with: OG = distance between the centre of gravity and the waterline (m) (+ if centre of gravity is above the waterline, - if it is below)

d = mean moulded draught of the ship (m)

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18 The value of P used for ships in restricted service may be reduced subject to the approval of the Administration.

19 The angle of roll for ships provided with antirolling devices should be determined without taking into account the operation of these devices.

s = factor as shown in table 4.

Table 1		Table 2		Table 3		Table 4	
Values of factor X1		Values of factor X2		Values of factor k		Values of factor s	
B/d	X1	CB	X2	$\frac{A_k \cdot 100}{L \cdot B}$	k	T	s
≤ 2.4	1.0	≤ 0.45	0.75	0	1.0	≤ 6	0.100
2.5	0.98	0.50	0.82	1.0	0.98	7	0.098
2.6	0.96	0.55	0.89	1.5	0.95	8	0.093
2.7	0.95	0.60	0.95	2.0	0.88	12	0.065
2.8	0.93	0.65	0.97	2.5	0.79	14	0.053
2.9	0.91	≥ 0.70	1.0	3.0	0.74	16	0.044
3.0	0.90			3.5	0.72	18	0.038
3.1	0.88			≥ 4.0	0.70	≥ 20	0.035
3.2	0.86						
3.3	0.84						
3.4	0.82						
≥ 3.5	0.80						

(Intermediate values in tables 1-4 should be obtained by linear interpolation)

Rolling period $T = 2\,C \cdot B/\sqrt{GM}$ (seconds)

where: $C = 0.373 + 0.023\,(B/d) - 0.043\,(L/100)$.

The symbols in the above tables and formula for the rolling period are defined as follows:

L = waterline length of the ship (m)

B = moulded breadth of the ship (m)

d = mean moulded draught of the ship (m)

CB = block coefficient

Ak = total overall area of bilge keels, or area of the lateral projection of the bar keel, or sum of these areas (m^2)

GM = metacentric height corrected for free surface effect (m).

RESOLUTION A.563(14)

Adopted on 20 November 1985

AMENDMENTS TO THE RECOMMENDATION ON TEST METHOD FOR DETERMINING THE RESISTANCE TO FLAME OF VERTICALLY SUPPORTED TEXTILES AND FILMS (RESOLUTION A.471(XII))

APPENDIX 2 - CLEANING AND WEATHERING PROCEDURES

Paragraph 3.2 Insert ”10- to 15-minute" between "full" and "cycle" in the first sentence.

Paragraph 6.3.2 Add a new subparagraph to read:

”.4 Water-spray nozzles should discharge about 0.0026 m^3/min on to the specimens for about 18 minutes during each 120-minute period."

APPENDIX 3 - PROPOSED CRITERIA FOR CURTAINS AND DRAPES

Paragraph 2 Delete "the first three criteria" in the first sentence and insert "the criteria specified in .1, .2, .3 and .5 above".

RESOLUTION A.624(15)

Adopted on 19 November 1987

GUIDELINES ON TRAINING FOR THE PURPOSE OF LAUNCHING LIFEBOATS AND RESCUE BOATS FROM SHIPS MAKING HEADWAY THROUGH THE WATER

1 Chapter III of the 1974 SOLAS Convention, as modified by the 1983 amendments, contains no mandatory training requirements for launching lifeboats and rescue boats from ships making headway through the water. However, if such training is undertaken, the Guidelines should be followed.

2 These Guidelines apply to the launching drills referred to in regulation III/18.3.9 of the 1983 SOLAS amendments, undertaken with lifeboats and rescue boats capable of being safely launched with the ship making headway at speeds of up to 5 knots in calm water, as prescribed in regulations III/16.3 and III/28.2, and therefore apply to new cargo ships of 20,000 tons gross tonnage and upwards, other new ships fitted with rescue boats, and any other ship fitted with lifeboats or rescue boats having on-load release gear adequately protected against accidental or premature use.

3 These Guidelines supplement the procedures to be followed for the particular equipment provided on board a ship as described in the instructions and information found in the ship's training manual required by regulation III/18.2. This will include instructions on launching and recovery, the use of the release gear, clearing the boat from the ship and, where applicable, the use of a painter. The boat's crew should be instructed in the procedures to be followed before the drill commences.

4 Drills should be carried out either on board a ship at anchor or alongside where there is a suitable relative movement between ship and water, or at a suitable shore establishment where similar conditions prevail. Alternatively, at the master's discretion, drills may be carried out on board a ship when making headway in sheltered waters. For safety purposes, it is not necessary when training to exercise at the maximum design 5 knot headway launching capability of the equipment. Drills should be carried out with a low relative water speed particularly where inexperienced personnel are involved. When planning the drill, consideration should be given to ensuring that, as far as practicable, the relative water speed will be at a minimum when recovering the boat.

5 None of the provisions in these Guidelines are intended to inhibit launching drills carried out on ships where such drills are carried out on a frequent and regular basis with fully trained and experienced boat crews.

6 When planning for and carrying out the launching drills referred to in regulation III/18.3.9, the following precautions should be taken:

.1 Drills should only be carried out under the supervision of an officer experienced in such drills and under calm and clear conditions.

.2 Provisions should be made for rendering assistance to the boat to be used in the drill in the event of unforeseen circumstances; for example, where practicable a second boat should be made ready for launching.

.3 When practicable, the drill should be carried out when the ship has minimal freeboard.

.4 Instructions as to procedures should be given to the boat's crew by the officer in charge before the drill commences.

.5 The number of crew members in the boat should be the minimum compatible with the training to be carried out.

.6 Lifejackets and, where appropriate, immersion suits should be worn.

.7 Except in the case of totally enclosed boats, head protection should be worn.

.8 For the purposes of the drill, skates, where fitted, should be removed unless they are designed to be retained under all launch conditions.

.9 In the case of totally enclosed boots, all openings should be closed except for the helmsman's hatch which may be open to provide a better view for launching.

.10 Two-way radiotelephone communications should be established between the officer in charge of lowering, the navigating bridge and the boat before lowering commences, and be maintained throughout the exercise.

.11 During lowering and recovery and while the boat is close to the ship, steps should be taken to ensure that the ship's propeller is not turning, if practicable.

.12 The boat's engine should be running before the boat enters the water.

.13 The launching and recovery should be followed by a de-briefing session to consolidate the lessons learned.

RESOLUTION A.652(16)

Adopted on 19 October 1989

RECOMMENDATION ON FIRE TEST PROCEDURES FOR UPHOLSTERED FURNITURE

(Methods of test for the ignitability by smokers' materials of upholstered composites for seating)

1 SCOPE

This test procedure prescribes methods for assessing the ignitability of material combinations, e.g. covers and filling used in upholstered seating when subjected to either a smouldering cigarette or a lighted match as might be applied accidentally in the use of upholstered seats. It does not cover ignition caused by deliberate acts of vandalism.

2 DEFINITION

For the purposes of this test procedure the following definition applies.

Progressive smouldering. An exothermic oxidation not accompanied by flaming which is self-propagating, i.e., independent of the ignition source. It may or may not be accompanied by incandescence.

Note: In practice it has been found that there is usually a clear distinction between materials which may char under the influence of the ignition source but which do not propagate further (non-progressive) and those where smouldering develops in extent and spreads (progressive).

3 PRINCIPLE

The principle is to subject an assembly of upholstery materials arranged to represent, in stylized form, the join between the seat and back (or seat and arm) surfaces of a chair to two sources of ignition, one being a smouldering cigarette, and the other a flaming source approximating to the calorific output of a burning match.

4 HEALTH AND SAFETY OPERATORS

4.1 General

There is a considerable risk with these tests and precautions have to be taken.

4.2 Enclosure

For safety, the tests should be conducted in a suitable fume cupboard. If such a cupboard is not available, an enclosure should be constructed so that the tester is not exposed to the fumes (see clause 8).

4.3 Extinguishers

Accessible means of extinguishing the samples should be provided, for example a bucket of water, a fire blanket, or fire extinguisher.

5 APPARATUS

5.1 Test rig

A suitable test rig is illustrated in figures 1 and 2. It shall consist of two rectangular frames hinged together and capable of being locked at right angles to each other.

The frames shall be made from nominal 25 mm x 3 mm steel flat bar and shall securely hold expanded steel platforms set 6 ± 1 mm below the top edge of the frames.

Note: The size of the mesh of the expanded steel is not critical, but a mesh size across the diagonals of approximately 28 mm x 6 mm has been found to be suitable.

The internal width and height of the back frame shall be 450 ± 2 mm x 300 ± 2 mm and the width and depth of the base frame 450 ± 2 mm x 150 ± 2 mm. A standard edging section may be used around the expanded steel to give protection and greater rigidity.

The sides of the frame shall extend beyond the back of each frame to provide for the hinge holes and to form the back legs. The hinge rod shall be of nominal 100 mm diameter steel, continuous across the back of the rig, and its axis 22.5 ± 0.5 mm beyond the back member of each frame.

The frames shall be lockable at right angles by a bolt or pin through each of the pairs of members forming the back legs. The front legs may be welded across the front corners of the base frame. The height of the legs shall be such as to leave a gap not less than 50 mm high between the base frame and the supporting surface.

For the tests, the rig shall be sited within the enclosure (see 4.2) and the testing shall be performed in a substantially draught-free environment permitting an adequate supply of air.

5.2 Smouldering cigarette source

An untipped cigarette, complying with the following requirements, is needed:

length 68 mm approximately;
diameter 8 mm approximately;
mass 1 g nominal;
smouldering rate 12.0 ± 1.5 min/50 mm.

The smouldering rate shall be verified, as follows, on one sample from each batch of 10 cigarettes used.

Mark the cigarette, conditioned as described in 6.1, at 5 mm and 55 mm from the end to be lit. Light it as described in 8.2.1 and impale it horizontally in draught-free air on a horizontal wire spike inserted not more than 13 mm into the unlit end. Record the time taken to smoulder from the 5 mm mark to the 55 mm mark.

5.3 Butane flame ignition source

Note: This source has been designed to give a calorific output approximating to that of a burning match.

A burner tube consisting of a length of stainless steel tube (8.0 ± 0.1 mm outside diameter, 6.5 ± 0.1 mm internal diameter and 200 ± 5 mm in length) is connected by flexible tubing to a cylinder containing butane via a flowmeter, fine control valve, on-off valve (optional) and cylinder regulator providing an outlet pressure of 27.5 mbar[20].

Note: Such steel tubing may be marketed as 5/16 in outside diameter, 0.028 in wall thickness. Where tubing of these dimensions is not readily available, stainless steel tubing of approximately similar dimensions may be used providing that the 50 mm length at the "flame" end of the tube is machined to the given sizes.

The flowmeter shall be precalibrated to supply a butane gas flow rate at 25°C of 45 ± 2 ml/min. The flexible tubing connecting the output of the flowmeter to the burner tube shall be 2.5 m to 3.0 m in length with an internal diameter of 7.0 ± 1.0 mm.

Notes:

1. Under these conditions, the flame height is approximately 35 mm. Any divergence from this height may be due to lack of equilibration of the butane gas with the environmental conditions specified for test. A sufficient length of tubing should be provided within the controlled environment (23 ± 7°C) to ensure that the butane achieves the required temperature before flow measurement.

2. Butane/propane mixture may be used as fuel for the flame ignition source provided that the same calorific output as that prescribed in the paragraph above is maintained.

[20] 1 mbar = 102 N/m^2 = 0.1 kPa.

6 ATMOSPHERE FOR CONDITIONING AND TESTING

6.1 Conditioning

The materials to be tested and the cigarettes shall be conditioned immediately before the test for 72 h in indoor ambient conditions and then for at least 16 h in an atmosphere having a temperature of 20 ± 5°C and a relative humidity of 50 ± 20%.

6.2 Testing

For testing, a substantially draught-free environment, having a temperature of 15°C to 30°C and a relative humidity of 20% to 70%, shall be used.

7 TEST PIECES

7.1 General

The test piece materials shall be representative of the cover, filling and any other components to be used in the final assembly.

7.2 Cover material and fabric interliner

The cover size needed for each test is 800 ± 10 mm x 650 ± 10 mm. The long dimension shall be cut parallel to the selvage. The cover may be constructed from smaller pieces of material provided that the resulting seams are not located within 100 mm of the area likely to be affected by the test.

The cover shall have triangular cut-outs 325 mm from one end on both sides. The cut-outs shall be so positioned that when assembled on the test rig the lie of any pile is down the back assembly and from the hinge to the front of the base frame. The size of these cut-outs shall be approximately 50 mm base and 110 mm high.

Where a fabric interliner is used, it shall be cut to the same dimensions and in the same orientation as the cover for fitting to the test rig under the cover.

7.3 Upholstery filling

Two pieces, one 450 ± 5 mm x 300 ± 5 mm x 75 ± 2 mm thick, and the other 450 ± 5 mm x 150 ± 5 mm x 75 ± 2 mm thick are required for each test.

Some cushioning assemblies may consist of several layers that may be typically felt, wadding or different foams. In these cases the test pieces shall reproduce the upper 75 mm of the cushioning assembly.

Where the filling is less than 75 mm thick, the test piece shall be built up to the required thickness by adding to the underside a further layer of the bottom material.

8 TEST PROCEDURE

Warning

For safety, all tests should be carried out in a suitably constructed fume enclosure (see 4.2).

8.1 Preparation

8.1.1 Ensure that the means of extinguishment are close at hand (see 4.3).

8.1.2 Open out the test rig and thread the covering fabric and, if any, the fabric interliner behind the hinge bar.

8.1.3 Place the filling pieces under the covering fabric and, if any, the fabric interliner locating the filling pieces in the frame recesses, and allowing approximately 20 mm of fabric to wrap round the inside of the frames.

8.1.4 Lock the frames at right angles using the bolts or pins ensuring that the filling components are not displaced.

8.1.5 Fasten the fabric over the top, bottom and sides of the frame using clips and ensure that the fabric or fabrics are secured and under even tension.

8.2 Smouldering cigarette test

8.2.1 Light a cigarette (see 5.2) and draw air through it until the tip glows brightly. Not more than 8 mm of the cigarette shall be consumed in this operation.

8.2.2 Place the smouldering cigarette in position along the junction between the vertical and horizontal test pieces, allowing at least 50 mm from the nearest side edge, or from any marks left by any previous test, to the cigarette and simultaneously start the clock.

8.2.3 Observe the progress of combustion, and record any evidence of progressive smouldering (see clause 2) or flaming in the interior and/or cover.

Note: The detection of smouldering may be difficult and is made easier if a watch is kept for smoke emerging at points at a distance from the cigarette. Smoke is most easily viewed by looking down a rising column by means of a mirror.

8.2.4 If progressive smouldering or flaming of the upholstery components is observed at any time within a period of one hour of the placement of the cigarette, extinguish the test piece and record a fail result for the smouldering cigarette test.

8.2.5 If progressive smouldering or flaming is not observed within the one hour period, or if the cigarette fails to smoulder its complete length, repeat the test with a new cigarette placed in a fresh position not less than 50 mm from any previous test damage. If progressive smouldering or flaming is not observed in this retest, or if the cigarette fails to smoulder its complete length, record a pass result for the smouldering cigarette test unless the test piece fails the final examination specified in 8.4. Otherwise, extinguish the test piece and record a fall result.

Note: This repeat test may be run concurrently with the first test.

8.3 Butane flame test

8.3.1 Light the butane emerging from the burner tube, adjust the gas flow to the appropriate rate (see 5.3) and allow the flame to stabilize for at least 2 min.

8.3.2 Position the burner tube axially along the junction between the seat and back so that the flame is not less than 50 mm from the nearest side edge, or from any marks left by any previous test, and simultaneously start the clock.

8.3.3 Allow the gas to burn for a period of 20 ± 1 s, then terminate by carefully removing the burner tube from the test pieces.

8.3.4 Observe for flaming or progressive smouldering (see clause 2) in the interior and/or cover. Disregard flames, afterglow, smoking or smouldering that cease within 120 s of the removal of the burner tube.

8.3.5 If flaming or progressive smouldering of the upholstery components is observed, extinguish the test piece. Record a fail result for the butane flame ignition source test.

8.3.6 If flaming or progressive smouldering is not observed, repeat the test at a fresh position, as described in 8.3.2. If flaming or progressive smouldering is not observed in this retest, record a pass result for the butane flame ignition source test unless the test piece fails the final examination specified in 8.4. Otherwise extinguish the test piece and record a fail result.

8.4 Final examination

Cases of progressive smouldering undetected from the outside have been reported. Immediately after completion of the test programme on the assembly, dismantle and examine it internally for progressive smouldering. If this is present, extinguish the test piece and record a fall result for the relevant test source. For safety reasons, ensure that all smouldering has ceased before the rig is left unattended.

APPENDIX A

Guidance notes

A.1 This test procedure prescribes methods for examining the ignitability, in defined circumstances, of an assembly of upholstery materials. These materials are combined together in a way intended to be generally representative of their end use in upholstered seating, and the ignition sources are a smouldering cigarette and a flame representing a burning match.

Thus, the potential ignitability of a particular cover, filling and interliner in combination can be assessed and this will allow the development of specifications concerned with ignition by smokers' materials. However, there are two important limitations, as follows:

(a) The tests are concerned only with ignitability, and any controls of fire hazard have to consider, in addition, other aspects of fire performance such as rate of fire development, heat output, rate and quantity of smoke production and toxic gas evolution. Ideally, any attempts to reduce ignitability ought not to affect these other properties adversely.

(b) The tests only measure the ignitability of a combination of materials used in upholstered seating and not of a particular finished item of furniture incorporating these materials. They give an indication of, but cannot guarantee, the ignition behaviour of the finished item of furniture. This limitation occurs because design features of the furniture can greatly affect its fire properties; any ignitability tests of a piece of furniture would therefore need to be carried out on the actual item and not on component materials or mock-ups. However, limited information on ignitability more specifically related to an intended design may be obtained, as indicated in A.2 and A.3.

A.2 This test procedure prescribes laboratory tests for an assembly of materials which will give general guidance on the ignitability of finished furniture, but where more specific information is required, or in critical areas of end use, the principles may be applied to complete items or components of furniture or to suitably modified test assemblies, some examples of which are given below. In such cases the sources of ignition described in 5.2 and 5.3 may be applied at positions which, as a general rule, correspond to those where the hazard of ignition occurs in use.

Example 1:

If a chair were to have a gap between the seat and back cushions, the placement of ignition sources in the angle of the test apparatus would be inappropriate. Instead, face ignition, where the sources are placed at the centre of the horizontal and vertical surfaces, would be more meaningful.

Example 2:

The test apparatus may be used to model the junction of any vertical and horizontal surfaces so that both arm and back constructions, if different, may be tested separately in conjunction with the seat.

Example 3:

The use of different materials in a back and seat of a chair may be reproduced in the test, two different cover fabrics being joined by sewing or staples behind the hinge bar.

Example 4:

If, in the final design, a loose cushion is to be placed on an upholstered seat platform, additional cigarette traps are produced between the loose cushion and the surrounding upholstery. This may be examined by constructing a loose cushion of the appropriate materials measuring 500 ± 5 mm x 75 ± 2 mm to be placed on top of the horizontal surface of the normally assembled test arrangement.

A.3 Another way in which this test principle might be used is to give information about individual materials to be used in a combination. For example, the ability of a cover material to provide protection against ignition can be indicated by testing it in combination with a substrate of known flammability; standard non-flame-retardant flexible polyether foam with a density of about 22 kg/m^3 has been found to be suitable. Such information about the individual materials does not eliminate the need to test the actual combination, but it can help in the short-listing of material combinations and so reduce the overall amount of testing required.

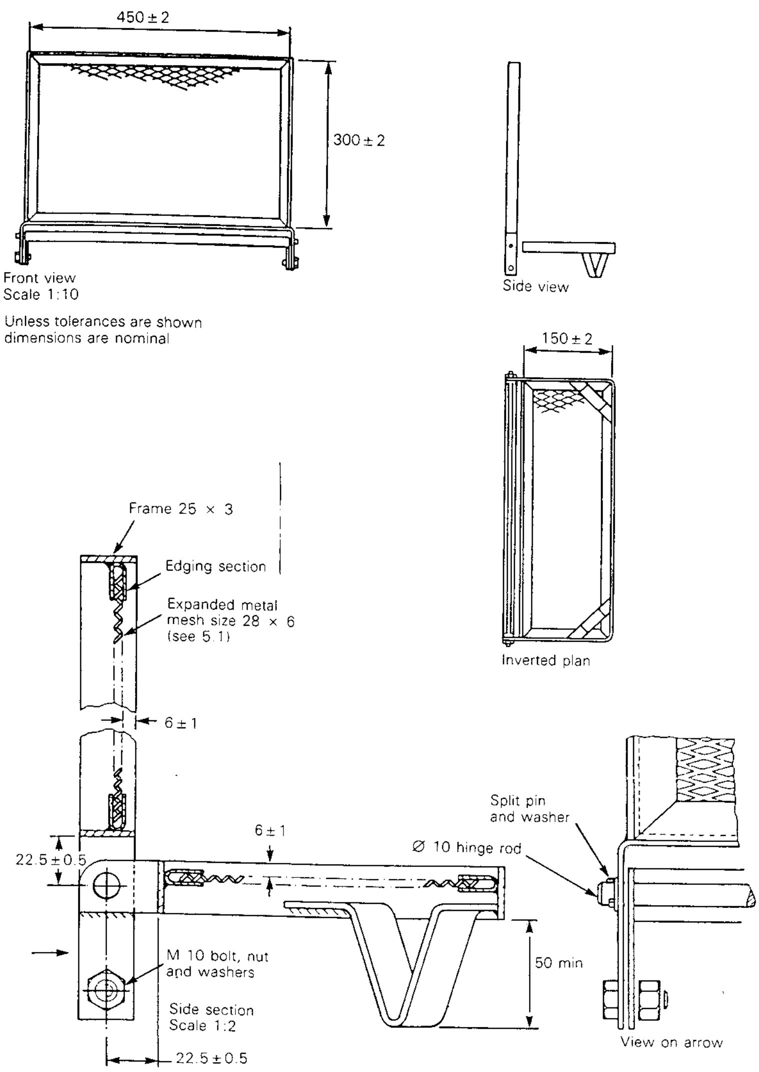

Figure 1 – *Test rig*

All dimensions are in millimetres. All parts are of steel.

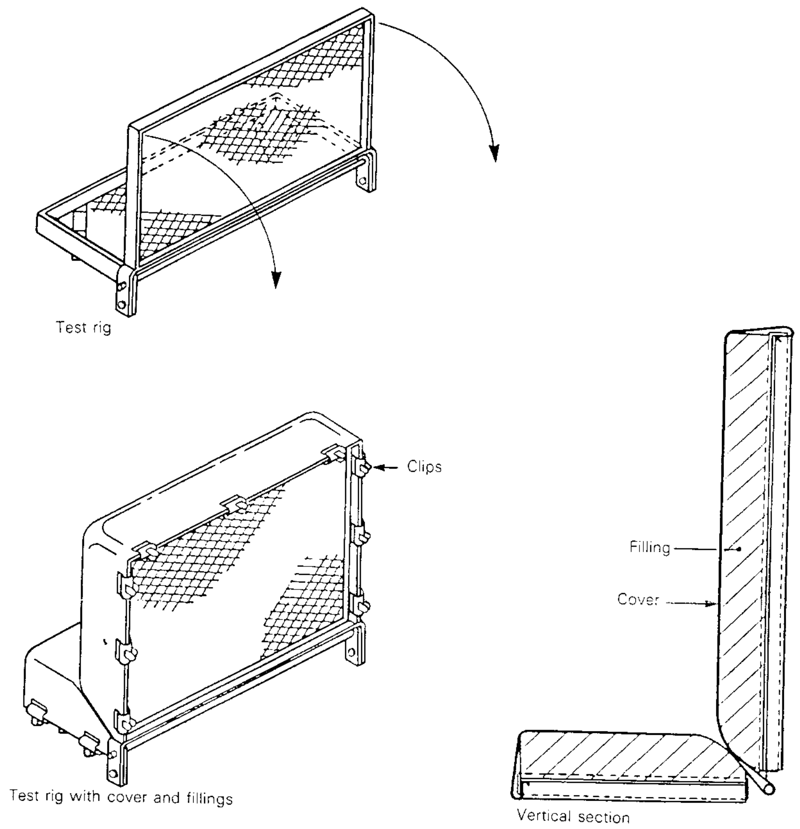

Figure 2 – *Test rig assembly*

RESOLUTION A.653(16)

Adopted on 19 October 1989

RECOMMENDATION ON IMPROVED FIRE TEST PROCEDURES FOR SURFACE FLAMMABILITY OF BULKHEAD, CEILING AND DECK FINISH MATERIALS

1 SCOPE

This Recommendation specifies a procedure for measuring fire characteristics of bulkhead, ceiling and deck finish materials as a basis for characterizing their flammability and thus their suitability for use in marine construction.

2 WARNING

2.1 Ignition hazards

The use of this test method involves the generation of very high heat flux levels which are capable of causing ignition of some materials such as clothing following even brief exposures. Precautions should be taken to avoid accidental ignitions of this type.

2.2 Toxic fume hazards

The attention of the user of this test is drawn to the fact that the fumes from burning materials often include carbon monoxide. Other more toxic products may in many instances be produced. Suitable precautions should be taken to avoid any extended exposure to these fumes.

3 DEFINITIONS

Certain terms used in this Recommendation require definition for clarity. Other fire characteristic terms are also used; these are defined hereunder but relate only to the results of measurements by this specific test method.

3.1 Compensating thermocouple

A thermocouple for the purpose of generating an electrical signal representing long-term changes in stack metal temperatures. A fraction of the signal generated is subtracted from the signal developed by the stack gas thermocouples.

3.2 Critical flux at extinguishment

A flux level at the specimen surface corresponding to the distance of farthest advance and subsequent self-extinguishment of the flame on the centreline of a burning specimen. The flux reported is based on calibration tests with a dummy specimen.

3.3 Dummy specimen

A specimen used for standardizing the operating condition of the equipment; it should be roughly 20 mm thickness, 800 ± 100 kg/m^3 density and should meet the requirements of resolution A.472(XII) as non-combustible.

3.4 Special calibration dummy specimen

A dummy specimen as defined by figure 14 intended only for use in calibration of heat flux gradient along with specimen.

3.5 Fume stack

A box-like duct with thermocouples and baffles through which flames and hot fumes from a burning specimen pass. Its purpose is to permit measurement of the heat release from the burning specimen.

3.6 Heat for ignition

The product of the time from initial specimen exposure until the flame front reaches the 150 mm position and the flux, level at this position; this latter obtained in prior calibration of the apparatus.

3.7 Heat release of specimen

The observed heat release under the variable flux field imposed on the specimen and measured as defined by the test method.

3.8 Heat for sustained burning

The product of time from initial specimen exposure until arrival of the flame front and the incident flux level at that same location as measured with a dummy specimen during calibration. The longest time used in this calculation should correspond to flame arrival at a station at least 30 mm prior to the position of furthest flame propagation on the centreline of the specimen.

3.9 Reverberatory wires

A wire mesh located in front of, but close to, the radiating surface of the panel heat source. This serves to enhance the combustion efficiency and increase the radiance of the panel.

3.10 Viewing rakes

A set of bars with wires spaced at 50 mm intervals for the purpose of increasing the precision of timing flame front progress along the specimen.

4 PRINCIPLE OF THE TEST

This test provides methods for evaluating flammability characteristics of 155 mm x 800 mm specimens in vertical orientation. The specimens are exposed to a graded radiant flux field supplied by a gas-fired radiant panel. Means are provided for observing the times to ignition, spread and extinguishment of flame along the length of the specimen as well as for measuring the compensated millivolt signal of the stack gas thermocouples as the burning progresses. Experimental results are reported in terms of: heat for ignition, heat for sustained burning, critical flux at extinguishment and heat release of specimen during burning.

5 FACILITY AND APPARATUS REQUIREMENTS

5.1 General

A detailed description of the facility and apparatus required for conduct of this test is included in the appendix. Compliance with the appendix forms an essential requirement of the test method. The equipment needed may be summarized as follows:

5.1.1 Special test room fitted with fume exhaust system as well as fresh air inlet.

5.1.2 Radiant panel frame fitted with blower or other source of combustion air, a methane[21] or natural gas supply system with suitable safety controls, and a radiant panel heat source, with reverberatory wires, arranged to radiate on a vertical specimen. Alternatively, an electrically heated radiant source of the same dimensions may be used provided it can expose the specimen to the heat flux distribution shown in table 1. The effective source temperature of any radiant panel is not greater than 1,000°C.

5.1.3 The specimen holder frame, three specimen holders, two parts of pilot burners, specimen holder guides, viewing rakes and a viewing mirror.

5.1.4 A specimen fume stack with both stack gas and stack temperature compensating thermocouples together with a means for adjusting the magnitude of the compensation signal.

5.1.5 Instrumentation comprising a chronograph, digital or sweep second electric clock, a digital millivoltmeter, a two-channel millivolt recorder, gas-flowmeter, heat-fluxmeters, a wide angle total radiation pyrometer and a stopwatch. Use of a data acquisition system to record both panel radiance and the heat release stack signal during test will facilitate data reduction.

6 CALIBRATION

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[21] The use of gases other than methane or natural gas is not recommended although with changes in panel-specimen spacing it has been reported possible to use the equipment with propane up to flux levels of 50 kW/m^2.

Mechanical, electrical and thermal calibrations should be performed as described in the appendix. These adjustments and calibrations should be performed following initial installation of the apparatus and at other times as the need arises.

6.1 Monthly verification

The calibration of the flux distribution on the specimen and the proper operation of the fume stack with its thermocouple system should be confirmed by monthly tests, or at more frequent intervals if this is found necessary (see 4.3.1 and 4.6 in the appendix).

6.2 Daily verification

As a means of assuring continued proper adjustment of the apparatus, the following tests should be performed on a daily basis, or more frequently if the nature of the specimens makes this necessary.

6.2.1 Adjustment of the pilot burner, the acetylene and air supply should be adjusted to provide a flame length of about 230 mm[22]. When this has been done, the flame length as viewed in a darkened laboratory will be seen to extend about 40 mm above the upper retaining flange of the specimen holder. The burner spacing from the specimen is adjusted while the radiant source is operating by the use of softwood splines of 3 mm thickness and of 10 mm and 12 mm width. When these splines are moved during a two second exposure along the flame length, between the pilot burner flame and a dummy specimen surface, the 10 mm spline should not be charred but the 12 mm spline should show char. With the specimen in the vertical position, the charring of the 12 mm spline should occur over a vertical distance of at least 40 mm from the upper exposed edge of the specimen (see figure 9 in the appendix).

6.2.2 The stack gas thermocouples should be cleaned by light brushing at least daily. This cleaning may be required even more frequently, in some instances before each test, when materials producing heavy soot clouds are tested. These thermocouples should also be individually checked for electrical continuity to ensure the existence of a useful thermojunction. Following daily cleaning of the parallel connected stack gas thermocouples, both they and the compensating junction should be checked to verify that the resistance between them and the stack is in excess of 10^6 ohms.

6.3 Continuous monitoring of operation

A dummy specimen should remain mounted in the position normally occupied by a specimen whenever the equipment is in stand-by operation. This is a necessary condition of the continuous monitoring procedure which is accomplished by measuring:

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[22] It is recommended that, to give increased precision, acetylene rather than other gases be used wherever possible.

.1 the millivolt signals from both the stack thermocouples and the total radiation pyrometer mounted securely on the specimen holder frame facing the surface of the radiant panel; or

.2 the millivolt signals from both the stack thermocouples and a heat-fluxmeter positioned at 350 mm from the exposed hot end of a marine board specimen of about 20 mm thickness (see appendix, paragraph 4.3.2).

Either of these measurement methods would be satisfactory for determining that an appropriate thermal operating level has been achieved. The use of the radiation pyrometer is preferable since it permits continuous monitoring of panel operating level even when tests are in progress. Both signals should remain essentially constant for three minutes prior to the test. The observed operating level of either the radiation pyrometer or the fluxmeter should correspond, within 2%, to the similar required level specified in table 1 and referred to in the calibration procedure mentioned in 6.1 above.

7 SPECIMENS

7.1 Number required

Three specimens should be tested for each different exposed surface of the product evaluated and applied.

7.2 Dimensions

The specimens should be $155\,^{+0}_{-5}$ mm wide by $800\,^{+0}_{-5}$ mm long, and should be representative of the product.

7.2.1 Specimen thickness: materials and composites of normal thickness 50 mm or less should be tested using their full thickness, attaching them, by means of an adhesive if appropriate, to the substrate to which they will be attached in practice. For materials and composites of normal thickness greater than 50 mm, the required specimens should be obtained by cutting away the unexposed face to reduce the thickness to $50\,^{+3}_{-0}$ mm.

7.3 Composites

Assembly should be as specified in 7.2. However, where thin materials or composites are used in the fabrication of an assembly, the presence of an air gap and/or the nature of any underlying construction may significantly affect the flammability characteristics of the exposed surface. The influence of the underlying layers should be recognized and care taken to ensure that the test result obtained on any assembly is relevant to its use in practice.

7.4 Metallic facings

If a bright metallic faced specimen is to be tested, it should be painted with a thin coat of flat black paint prior to conditioning for test.

7.5 Marking specimens

A line should be marked centrally down the length of the tested face of each specimen. Caution should be exercised to avoid the use of a line which would influence specimen performance.

7.6 Conditioning of specimens

Before test, the specimens should be conditioned to constant moisture content, at a temperature of 23 ± 2°C, and a relative humidity of 50 ± 10%. Constant moisture content is considered to be reached when, following two successive weighing operations, carried out at an interval of 24 hours, the measured masses do not differ by more than 0.1% of the mass of the specimen.

8 TEST PROCEDURE

8.1 General considerations

The test method involves mounting the conditioned specimen in a well-defined flux field and measuring the time of ignition, spread of flame, its final extinguishment together with a stack thermocouple signal as an indication of heat release by the specimen during burning.

8.1.1 Prepare a properly conditioned specimen for test in a cool holder away from the heat of the radiant panel. Prior to insertion in the specimen holder, the back and edges of the specimen should be wrapped in a single sheet of aluminium foil of 0.02 mm thickness and dimensions of (175 + a) mm x (820 + a) mm where "a" is twice the specimen thickness. When inserted in the specimen holder each specimen should be backed by a cool 10 ± 2 mm board of non-combustible refractory insulating material with the same lateral dimensions and density as the dummy specimen. When mounting non-rigid specimens in the holder, shims should be placed between specimen and holder flange to ensure that the exposed specimen face remains at the same distance from the pilot flame as a rigid specimen. For such materials, the shims may often only be required for a 100 mm length at the hot end of the specimen.

8.1.2 The dummy specimen in a specimen holder should be mounted in position facing the radiant panel. The equipment fume exhaust system should be started.

8.1.3 The radiant panel is operated to realize the test conditions as specified in 6.3. Start the millivolt recorder recording the output signal of the stack thermocouples, as well as signal from the total radiation pyrometer or heat-fluxmeter positioned, as described in 6.3.2.

8.1.4 When the radiant panel and stack signals have attained equilibrium, after the preheat period, light the pilot flame, adjust its fuel flow rate and observe both signals for at least three minutes and verify continued signal stability.

8.1.5 After both signals reach stable levels, remove the dummy specimen holder and insert the specimen in the lest position within 10 s. Immediately start both the clock and chronograph.

8.1.6 Operate the event marker of the chronograph to indicate the time of ignition and arrival of the flame front during the initial rapid involvement of the specimen. The arrival at a given position should be observed as the time at which the flame front at the longitudinal centreline of the specimen is observed to coincide with the position of two corresponding wires of the viewing rakes. These times are recorded manually both from measurement on the chronograph chart and from observations of the clock. As far as possible, the arrival of the flame front at each 50 mm position along the specimen should be recorded. Record both the time and the position on the specimen at which the progress of flaming combustion ceases. The panel operating level, as well as stack signals, should be recorded throughout the test and continued until test termination.

8.1.7 Throughout the conduct of the test, no change should be made in the fuel supply rate to the radiant panel to compensate for variations in its operating level.

8.2 Duration of test

The test should be terminated, the specimen removed, and the dummy specimen in its holder reinserted when any one of the following is applicable:

.1 the specimen fails to ignite after a 10 min exposure;
.2 3 min have passed since all flaming from the specimen ceased;
.3 flaming reaches the end of the specimen or self-extinguishes and thus ceases progress along the specimen. This criterion should only be used when heat release measurements are not being made.

8.2.1 Operations 8.1.1 to 8.1.7 should be repeated for two additional specimens (see 8.3).

8.3 Conditions of retest

In the event of failure, during test of one or more specimens, to secure complete flame spread times or a reasonable heat release curve, the data secured should be rejected and a new test or tests performed. Such failures might involve, but not be limited to, incomplete observational data or malfunction of data logging equipment. Excessive stack signal baseline drift should also require further equipment stabilization and retest.

8.3.1 In the event that the first two or three specimens do not ignite following exposure for 10 min, at least one specimen should be tested with the pilot flame angled to impinge on the upper half of the specimen. If this specimen ignites, two additional tests should be run under the same conditions.

8.3.2 If a specimen shows extensive loss of incompletely burned material during test, at least one additional specimen, restrained in the testing frame by poultry netting, should be tested and the data secured reported separately.

8.4 Observations

In addition to the recording of the experimental data, observations should be made and recorded on general behaviour of the specimen including: glowing, charring, melting, flaming drips, disintegration of the specimen, etc.

9 DERIVED FIRE CHARACTERISTICS

Experimental results should be reported in terms of the thermal measurements of incident flux measured with a dummy specimen in place.

The results should not be adjusted to compensate for changes in the thermal output of the radiant panel during the conduct of the test. The following data should be derived from the test results.

9.1 Heat for ignition

As defined in 3.6.

9.2 Heat for sustained burning

A list of the values of this characteristic as defined in paragraph 3.8.

9.3 Average heat for sustained burning

An average of the values for the characteristic defined in 3.8 measured at different stations, the first at 150 mm and then at subsequent stations at 50 mm intervals through the final station or the 400 mm station, whichever value is the lower.

9.4 Critical flux at extinguishment

A list of the values of this characteristic for the specimens tested and the average of these values.

9.5 Heat release of the specimen

Both a heat release time curve and a listing of the peak and total integrated heat release should be secured from the experimental data. They should be corrected for the non-linearity of the heat release calibration curve.

The curve of the millivolt signal from the stack thermocouples should include at least 30 s of the initial 3 min steady state verification period as well as the starting transient just prior to and following specimen insertion. In converting millivolt signals to heat release rate, the zero release level of the calibration curve should be set at the level of the initial steady state just prior to test of the specimen involved. (See figure 13.)

9.5.1 Total heat release

The total heat release is given by integration of the positive part of the heat release rate during the test period (see figure 13).

9.5.2 Peak heat release rate

The peak heat release rate is the maximum of the heat release rate during the test period (see figure 13).

10 CLASSIFICATION

Materials giving average values for all of the surface flammability criteria not exceeding those listed in the following table, are considered to meet the requirement for low flame spread in compliance with regulations II-2/3.8, II-2/34 and II-2/49 of the International Convention for the Safety of Life at Sea, 1974, as amended.

SURFACE FLAMMABILITY CRITERIA

Bulkhead, wall and ceiling linings				**Floor coverings**			
CFE	Q_{sb}	Q_t	Q_p	CFE	Q_{sb}	Q_t	Q_p

kW/m^2	MJ/m^2	MJ	kW	kW/m^2	MJ/m^2	MJ	kW
≥20.0	≥1.5	≤0.7	≤4.0	≥7.0	≥0.25	≤1.5	≤10.0

Where CFE = Critical flux at extinguishment
Q_{sb} = Heat for sustained burning
Q_t = Total heat release
Q_p = Peak heat release rate

11 TEST REPORT

The test report should include both the original data, observations made on each specimen tested and the derived fire characteristics. The following information should be supplied:

.1 Name and address of testing laboratory.
.2 Name and address of sponsor.
.3 Name and address of manufacturer/supplier.
.4 Full description of the product tested including trade name, together with its construction, orientation, thickness, density and, where appropriate, the face subjected to test. In the case of specimens which have been painted or varnished, the information recorded should include the quantity and number of coats applied, as well as the nature of the supporting materials.

.5 Data from the test including:
.5.1 number of specimens tested;
.5.2 type of pilot flame used;
.5.3 duration of each test;
.5.4 observations recorded in accordance with 8 above;
. .5.5 other relevant observations from the test, such as flashing, unstable flame front, whether or not pieces of burning. materials fall off, separations, fissures, sparks, fusion, changes in form;
.5.6 derived fire characteristics as described in 9 above;
.5.7 classification of the material.
.6 A limiting use statement.

Note: The test results relate only to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

APPENDIX

This appendix provides technical information intended to permit construction, erection, alignment and calibration of the physical equipment required for the conduct of tests by this procedure.

1 TEST EQUIPMENT FABRICATION

Figures 1 to 5 show photographs of the equipment as assembled ready for test. Detailed drawings and a parts list are available from the IMO Secretariat. These provide engineering information necessary for the fabrication of the main frame, specimen holders, stack and other necessary parts of the equipment.

1.1 Brief parts list for the test equipment assembly includes:

.1 The main frame (figure 1) which comprises two separate sections, the burner frame and the specimen support frame. These two units are bolted together with threaded rods permitting flexibility in mechanical alignment.

.2 Specimen holders which provide for support of the specimens during test. At least two of these are required. Three prevent delays resulting from required cooling of holders prior to mounting specimens.

.3 A specimen fume stack fabricated of stainless steel sheet of 0.5 ± 0.05 mm thickness complete with gas and stack metal compensating thermocouples.

.4 The radiant panel which has radiating surface dimensions of 280 mm x 483 mm. It has been specially fabricated for use with this equipment through use of commercially available porous refractory tiles.

.5 The blower for combustion air supply, radiant panel, air flow metering device, gas control valves, pressure reducer and safety controls which are all mounted on the burner frame (figure 3). Requirements are summarized below**:**

.5.1 Air supply of about 30 m^3/h at a pressure sufficient to overcome the friction losses through the line, metering device and radiant panel. The radiant panel drop amounts to only a few millimetres of water.

.5.2 The gas used may be either natural gas or methane. The use of gas other than methane or natural gas is not recommended[23], although with changes in panelspecimen spacing, it is possible to use the equipment with propane at flux levels of 50 kW/m^2. A pressure regulator should be provided to maintain a constant supply pressure. Gas is controlled by a manually adjusted needle valve. No venturi mixer is necessary. Safety devices include an electrically operated shutoff valve to prevent gas flow in the event of electric power failure, air pressure failure and loss of heat at the burner surface. The gas flow requirements are roughly 1.0 m^3/h to 3.7 m^3/h for natural gas or methane at a pressure to overcome line pressure losses.

.6 The specimen holder, pilot flame holder, fume stack, flame front viewing rakes, radiation pyrometer and mirror are all

[23] Flashback limits the maximum operating level with propane.

assembled on the specimen support frame. The arrangement of parts on this frame is shown in figures 1 and 2.

.7 A dummy specimen approximately 20 mm thick, made of non-combustible refractory board of 800 ± 100 kg/m^3 density should be continuously mounted on the apparatus in the position of the specimen during operation of the equipment. This dummy specimen should only be removed when a test specimen is to be inserted.

2 INSTRUMENTATION

2.1 Total radiation pyrometer

This should have a sensitivity substantially constant between the thermal wave lengths of 1 µm and 9 µm and should view a centrally-located area on the panel of about 150 mm x 300 mm. The instrument should be mounted on the specimen support frame in such a manner that it can view the panel surface.

2.2 Heat fluxmeters

It is desirable to have at least two fluxmeters for this test method. They should be of the thermopile type with a nominal range of 0 kW/m^2 to 50 kW/m^2 and capable of safe operation at three times this rating. One of these should be retained as a laboratory reference standard. They should have been calibrated to an accuracy of within ±5%. The target sensing the applied flux should occupy an area not more than 80 mm^2 and be located flush with and at the centre of the water-cooled 25 mm circular exposed metallic end of the fluxmeter. If fluxmeters of smaller diameter are to be used, these should be inserted into a copper sleeve of 25 mm outside diameter in such a way that good thermal contact is maintained between the sleeve and water-cooled fluxmeter body. The end of the sleeve and the exposed surface of the fluxmeter should lie in the same plane. Radiation should not pass through any window before reaching the target.

2.3 Timing devices

Both a chronograph and either an electric clock with a sweep second hand or a digital clock should be provided to measure time of ignition and flame advance. The chronograph for timing ignition and initial flame advance may comprise a strip chart recorder with paper speed of at least 5 mm/s and an event marker pen. Both the chronograph paper drive and the electric clock should be operated through a common switch to initiate simultaneous operation when the specimen is exposed. This may be either hand operated or actuated automatically as a result of complete specimen insertion.

2.4 Recording millivoltmeter

A two-channel strip chart recording millivoltmeter having at least one megohm input resistance should be used to record signals from the fume stack thermocouples and the output from the radiation pyrometer. The signal from the fume stack will in most instances be less than 15 mV but in some cases this may be exceeded by a small amount. The sensitivity of the other channel should be selected to require less than full scale deflection with the total radiation pyrometer of fluxmeter chosen. The effective operating temperature of the radiant panel should not normally exceed 935°C.

2.5 Digital voltmeter

A small digital millivoltmeter will be found convenient for monitoring changes in operating conditions of the radiant panel. It should be capable of indicating signal changes of 10 µV or less.

3 SPACE FOR CONDUCTING TESTS

3.1 Special room

A special room should be provided for performance of this test. The dimensions of it are not critical but it may be roughly 45 m^3 volume with a ceiling height of not less than 2.5 m.

3.2 Fume exhaust system

An exhaust system should be installed above the ceiling with a capacity for moving air and combustion products at a rate of 30 m^3/min. The ceiling grill opening to this exhaust system should be surrounded by a 1.3 m x 1.3 m refractory fibre fabric skirt hanging from the ceiling down to 1.7 ± 0.1 m from the floor of the room. The specimen support frame and radiant panel should be located beneath this hood in such a way that all combustion fumes are withdrawn from the room.

3.3 The apparatus

This should be located with a clearance of at least one metre separation between it and the walls of the test room. No combustible finish material of ceiling, floor or walls should be located within 2 m of the radiant heat source.

3.4 Air supply

Access to an exterior supply of air, to replace that removed by the exhaust system, is required. This should be arranged in such a way that the ambient temperature remains reasonably stable (for example: the air might be taken from an adjoining heated building).

3.5 Room draughts

Measurements should be made of air speeds near a dummy specimen while the fume exhaust system is operating but the radiant panel and its air supply are turned off. At a distance of 100 mm the airflow perpendicular to the lower edge at midlength of the specimen should not exceed 0.2 m/s in any direction.

4 ASSEMBLY AND ADJUSTMENT

4.1 General

The test conditions are essentially defined in terms of the measured heat flux incident on a dummy specimen during calibration. Radiation transfer will predominate, but convection transfer will also play a part. The flux level incident at the specimen surface is a result of the geometrical configuration between the radiant panel and the specimen, as well as the thermal output from the radiant panel.

4.1.1 Both in original adjustment of test operating conditions and periodic verification of this adjustment, the measured heat flux at the surface of the specimen is the controlling criterion. This heat flux is measured by a fluxmeter (see 2.2) mounted in a special dummy specimen (figure 14).

4.1.2 Between consecutive tests, the operating level should be monitored either by use of a fluxmeter mounted in a dummy specimen as defined in paragraph 3.3 of the Recommendation under "Definitions" or preferably by use of a radiation pyrometer which has been previously periodically calibrated on the basis of the readings of such a fluxmeter. This radiation pyrometer should be rigidly fixed to the specimen-holder frame in such a manner that it continuously views the radiating panel surface (see 2.1).

4.2 Mechanical alignment

Most of the adjustments of the components of the test apparatus may be conducted in the cold condition. The position of the refractory surface of the radiant panel with respect to the specimen must correspond with the dimensions shown in figure 6. These relationships can be achieved by appropriate use of shims between the panel and its mounting bracket, adjustment or separation between the two main frames, and adjustment of the position of the specimen holder guides. Detailed procedures for making these adjustments are suggested in paragraph 5.

4.2.1 The fume stack for heat release measurements should be mechanically mounted on the specimen support frame in the position shown in figure 7. The method of mounting should ensure the relative positions shown but should allow easy stack removal for cleaning and/or repair. The compensating thermocouple should be mounted in such a manner that good thermal contact is achieved while ensuring greater than one megohm electrical resistance from the stack metal wall.

4.3 Thermal adjustment of panel operating level

Thermal adjustment of the panel operating level is achieved by first setting an air flow of about 30 m^3/h through the panel. Gas is then supplied and the panel ignited and allowed to come to thermal equilibrium with a dummy specimen mounted before it. At proper operating condition, there should be no visible flaming from the panel surface except when viewed from one side parallel to the surface plane. From this direction, a thin blue flame very close to the panel surface will be observed. An oblique view of the panel after a 15 min warm-up period should show a bright orange radiating surface.

4.3.1 With a water-cooled[24] fluxmeter mounted in a special dummy specimen, the flux incident on the specimen should correspond to the values shown in table 1. Compliance with this requirement is achieved by adjustment of the gas flow. If necessary, small changes in air flow can be made to achieve the condition of no significant flaming from the panel surface. Precise duplication of the flux measurements specified in table 1 for the 50 mm and 350 mm positions on the basis of the fluxmeter calibration used will fix the flux at the other stations well within the limits called for. This does not mean that all other flux levels are correct, but it does ensure that a fixed configuration or view geometry between the panel and specimen has been achieved. To meet these requirements, it may be necessary to make small changes in the specimen longitudinal position shown in figure 6. A plot and smooth curve should be developed on the basis of the eight flux measurements required. The shape of the curve should be similar to that defined by the typical data shown in table 1. These measurements are important, since the experimental results are reported on the basis of these flux measurements. If a total radiation pyrometer is to be used to monitor panel operation, records of its signal should be kept following successful completion of this calibration procedure. If a change in panel-specimen axial position is necessary to meet the requirements for flux at the 50 mm and 350 mm positions, this should be accomplished by adjusting the screws connecting the two frames. In this way, the pilot position with respect to the specimen will remain unchanged. The specimen stop screw adjustment may be changed to meet the flux requirements in the standard and then the position of the pilot burner mount may require adjustment to maintain the 10 ± 2 mm pilot spacing.

4.3.2 Once these operating conditions have been achieved, all future panel operation should take place with the established air flow with gas supply as the variable to achieve the specimen flux level as calibrated. This level should be monitored with use of either a radiation pyrometer fixed to

[24] Water cooling of the fluxmeter is required to avoid erroneous signals at low flux levels. The temperature of the cooling water should be controlled in such a manner that the fluxmeter body temperature remains within a few degrees of room temperature. If this is not done, correction of the flux measurement should be made for temperature difference between the fluxmeter body and room temperature. Failure to supply water cooling may result in thermal damage to the thermal sensing surface and loss of calibration of the fluxmeter. In some cases repairs and recalibration are possible.

view an area of the source surface or a fluxmeter mounted in a dummy specimen, as defined in paragraph 3.3 under "Definitions", at the 350 mm position. If the latter method is used, the assembly of dummy specimen and fluxmeter should remain in place between tests.

4.4 Adjustments and calibrations - general

The following adjustments and calibrations are to be achieved by burning methane gas from the line heat source located parallel to, and in the same plane as, the centreline of a dummy specimen located in position and without fluxmeters. This line burner comprises a 2 m length of pipe of 9.1 mm internal diameter. One end is closed off with a cap and a line of 15 holes of 3 mm diameter are drilled at 16 mm spacing through the pipe wall. The gas burned as it flows through this line of vertically positioned holes flames up through the stack. The measured flow rate and the net or lower heat of combustion of the gas serve to produce a known heat release rate which can be observed as a compensated stack millivolt signal change. Prior to performing calibration tests, measurements must be conducted to verify that the stack thermocouple compensation has been properly adjusted.

4.5 Compensation adjustment

The fraction of the signal from the compensator thermocouple which is subtracted from the stack thermocouple output should be adjusted by means of the resistance of one leg of the potential divider shown in figure 10. The purpose of this adjustment is, as far as practical, to eliminate from the stack signal the long-term signal changes resulting from the relatively slow stack metal temperature variations. Figure 11 shows the curves resulting from under-compensation, correct compensation, and over-compensation. These curves were obtained by abruptly placing the lighted gas calibration burner adjacent to the hot end of a dummy specimen and then extinguishing it. For this adjustment, the calibration gas feed rate should be set to correspond to a heat rate of one kW. The compensator potential divider should be adjusted to yield curves that show a rapid rise to a steady state signal which is essentially constant over a 5 min period following the first minute of transient signal rise. When the calibration burner is shut off, the signal should rapidly decrease and reach a steady state value within two minutes. Following this, there should be no longterm rise or fall of the signal. Experience has shown that between 40% and 50% of the compensation thermocouple signal should be included in the output signal to achieve this condition. When properly adjusted, a square thermal pulse of 7 kW should show not more than approximately 7% overshoot shortly after application of the calibration flame (see figure 11).

4.6 Fume stack calibration

With the adjustment described in 4.5 completed and a steady state base signal having been achieved, stack calibration should be carried out with the radiant panel operating at 50.5 kW/m^2 and the pilot burner not lit. The calibration of the stack millivolt signal rise should be made by introducing and removing the line burner, as described in 4.4. The flow rate of methane gas of at least 95% purity should be varied over the range of about 0.004 m^3/min to 0.02 m^3/min in sufficient increments to permit plotting the data in a well defined curve of stack compensated millivolt signal rise against the net or lower heat input rate. A similar calibration should be performed with the calibration burner located at the cool end of the specimen. The two curves should show agreement in indicated heat release rate within about 15%. A typical curve is shown in figure 12. The curve for the calibration burner at the hot end of the specimen should be the one used for reporting all heat release measurements. This completes the calibration and the test equipment is ready for use.

5 ASSEMBLY AND MECHANICAL ADJUSTMENT OF THE FLAMMABILITY TEST APPARATUS

The following instructions assume that parts of the flammability test apparatus have been made according to the drawings. The radiant panel subassembly has been completed with the exception of the support brackets and reverberatory screen. The equipment can be assembled to permit test of specimens of thickness up to 50 mm or 75 mm. Unless there is a real need for test of thicker specimens, assembly for 50 mm specimens is preferable.

5.1 The panel frame should be placed upright on a level floor, preferably in the location in which the equipment will be used.

5.2 The rotating ring should be mounted on its three guide bearings.

5.3 The panel mount frame should be bolted together, and to the ring, by four bolts.

5.4 A check should be made that the ring lies in a vertical plane. If the error is large, an adjustment of the upper ring support-bearing location may be necessary. Prior to making such an adjustment, it should be determined whether the error is due to excessive clearance between the ring and bearing rollers. If this is the case, rollers of larger diameter may correct the problem.

5.5 The four panel support brackets should be fastened to the radiant panel at four corners. Do not use too much force in bolting these brackets in place. Prior to mounting these brackets, one 35 mm M9 cap screw is placed in the hold that will be farthest from the panel end. These screws provide a means for mounting the panel.

5.6 Four washers should be placed on each of the panel mounting screws and the panel assembled on the mount bracket.

5.7 The angularity of the radiant panel surface with the plane of the mounting ring should be checked. This can be accomplished by means of a carpenter's square and measurements to the refractory tile surface at both ends of the panel. Any deviation from the required 15° angle may be adjusted by increasing or reducing the number of washers on the mounting screws.

5.8 The radiant panel should be rotated to face a specimen mounted in a vertical plane.
5.9 The panel surface should be checked with a level to ensure that it also lies in a vertical plane.

5.10 The specimen frame with specimen support rails on side and bottom positions and pilot burner holders assembled in approximate positions should be brought up to the burner frame and the two frames fastened together with two bolts and six nuts or two threaded rods and eight nuts. The spacing between the frames is roughly 100 mm.

5.11 The spacing of the two sides of the frames is adjusted to ensure that the specimen support frame longitudinal members are at a 15° angle to the radiant panel surface.

5.12 The single specimen holder side guide rail for vertical specimen orientation should be adjusted so that it is at the required 15° angle to the radiant panel surface.

5.13 An empty specimen holder should be slid into position on the rail and the position of the upper guide fork adjusted to ensure that when a specimen is inserted in the holder its surface will lie in a vertical plane.

The stop screw determining the axial position of the specimen holder should be adjusted to ensure that the axis of the pilot burner is 10 ± 2 mm from the closest exposed edge of the specimen. This adjustment should again be made by use of an empty specimen holder and substitution of a 6 mm steel rod of 250 mm length for the pilot burner ceramic tube. When viewed from the back of the specimen holder, the spacing between rod axis and the edge of the specimen retaining flange of the holder should be 10 ± 2 mm.

5.15 With the specimen holder still in place against the top screw, the spacing between the panel and specimen support frames should be adjusted to make dimension B, figure 6, equal to about 125 mm. This adjustment is made by means of the two screws, fastening the frames together. In making this adjustments, it is important to make equal adjustments on each side to maintain the angular relationship called for in adjustments 5.11 and 5.12.

5.16 The nuts supporting the specimen holder side guide rail should be adjusted to ensure that dimension A, figure 6, is 125 ± 2 mm. Again, equal adjustments to the two mounting points are required. When doing this, a check should be made to ensure that the guide rail and edge of the specimen holder are in a horizontal plane. In making this adjustment, it is important to ensure that the 45 mm stack position dimension shown in figure 7 is maintained. Another way of adjustment to dimension A is through changes in the number of washers mentioned in 5.6.

If necessary, procedure 5.13 should be repeated.

5.18 The reverberatory screen should be mounted on the radiant panel. This must be done in such a manner that it is free to expand as it heats up during operation.

5.19 The viewing rake with 50 mm pins is mounted on an angle fastened to the specimen holder guide rail. Its position is adjusted so that pins are located at multiples of 50 mm distance from the closest end of the specimen exposed to the panel. It should be clamped in the position.

TABLE 1
CALIBRATION OF FLUX TO THE SPECIMEN

Typical flux incident on the specimen and specimen positions at which the calibration measurements are to be made. The flux at the 50 mm and 350 mm positions should be matched. Calibration data at other positions should agree with typical values within 10%.

Distance from exposed end of the specimen	**Typical flux levels at the specimen**	**Calibration position to be used**
0	49.5 kW/m^2	
50	50.5	50.5 kW/m^2
100	49.5	
150	47.1	X
200	43.1	
250	37.8	X
300	30.9	
350	23.9	23.9
400	18.2	
450	13.2	X
500	9.2	
550	6.2	X
600	4.3	
650	3.1	X
700	2.2	
750	1.5	X

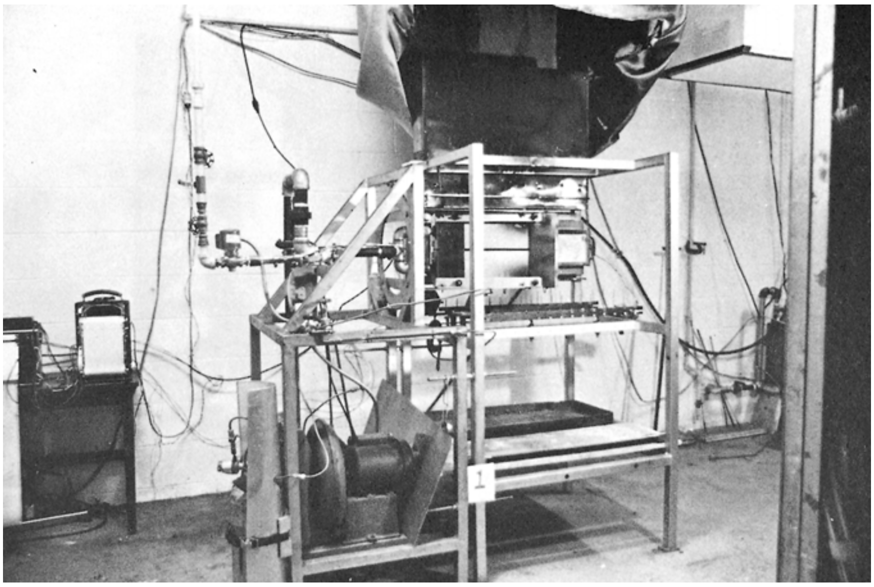


Figure 1 – *General view of the apparatus*

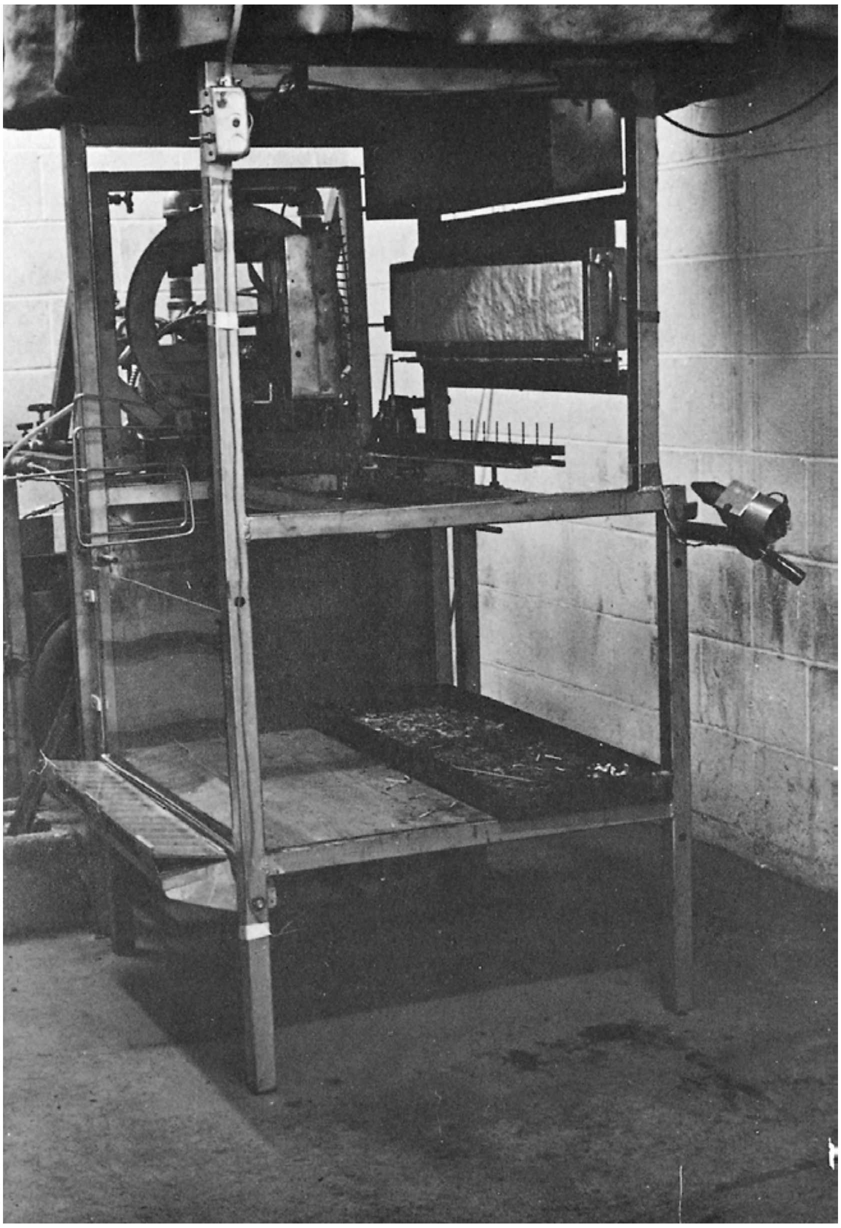


Figure 2 – *View from specimen end*

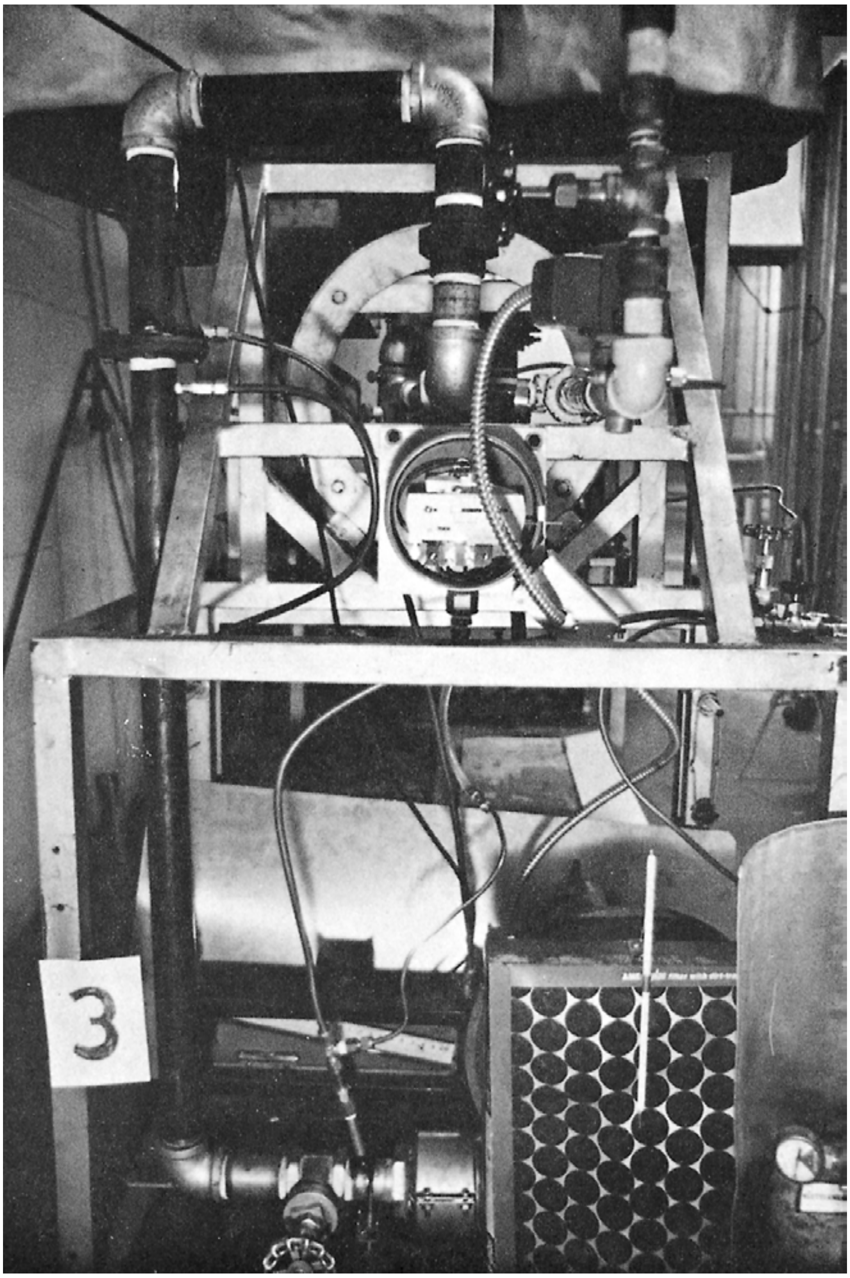


Figure 3 – *View from radiant panel end*

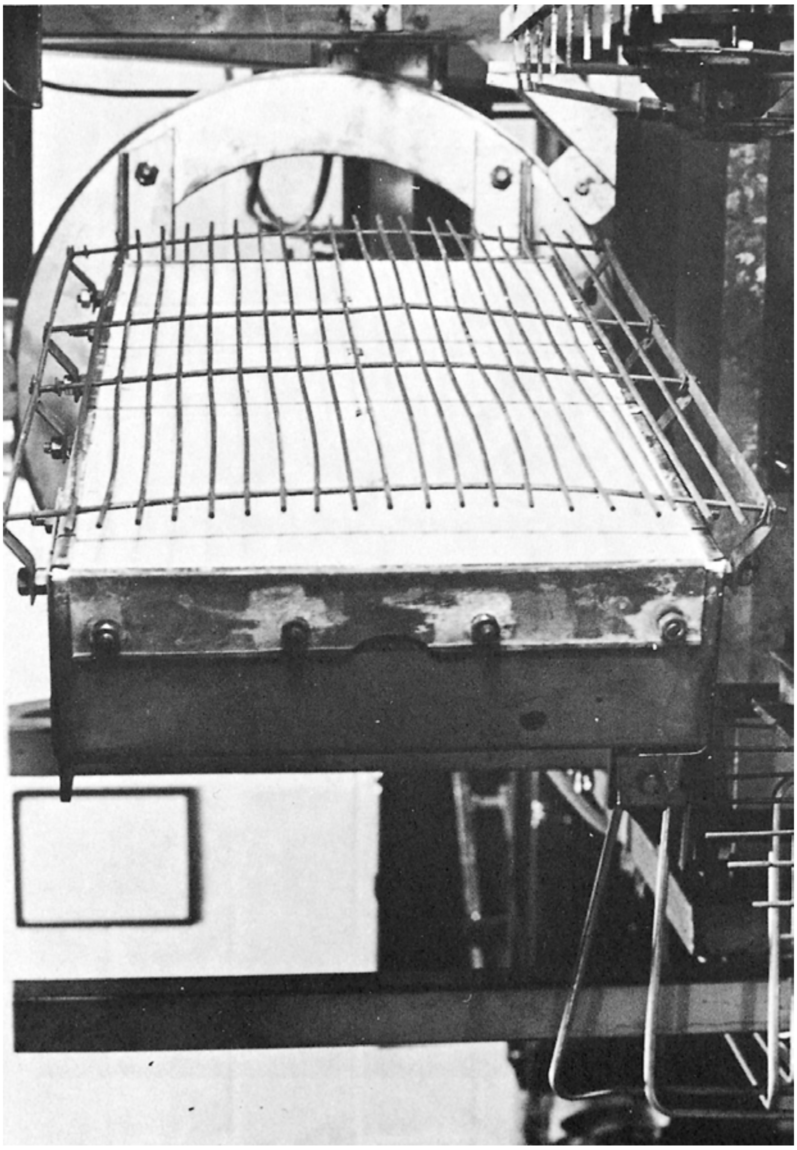


Figure 4 – *Radiant panel with reverberatory wires viewed through specimen mount frame*

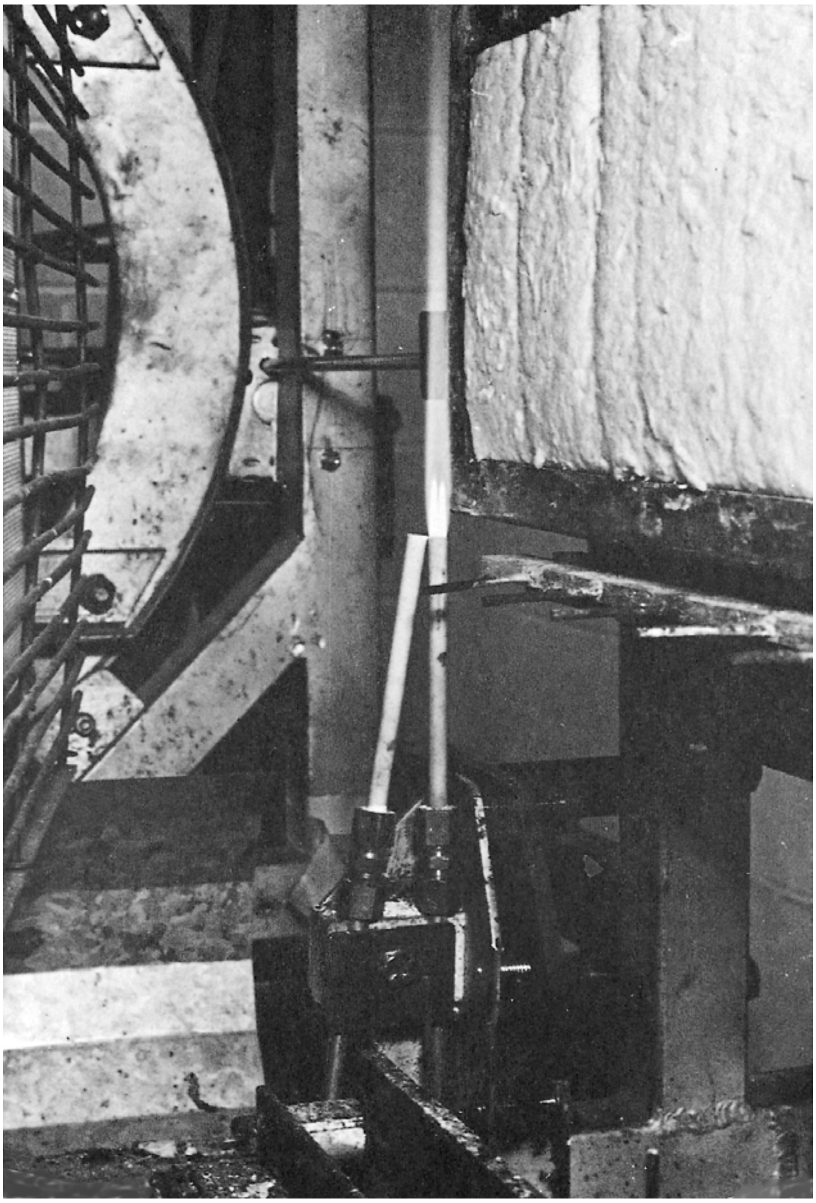


Figure 5 – *Pilot burner and mount*

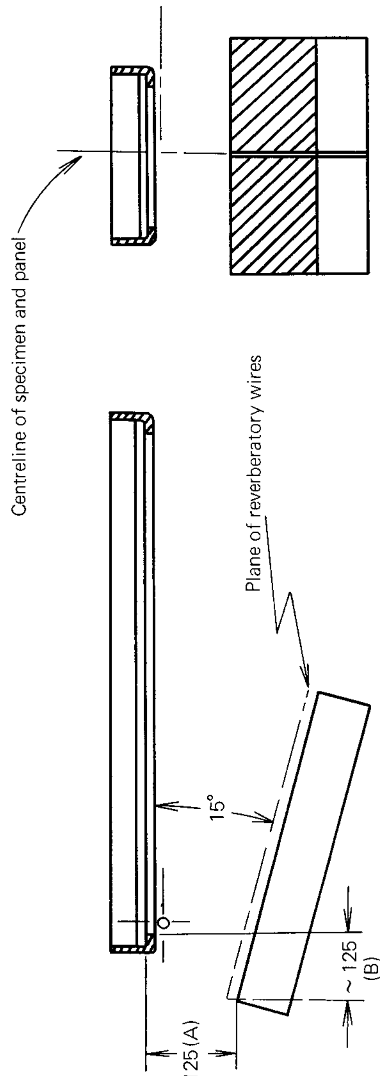


Figure 6 — *Specimen – panel arrangement*

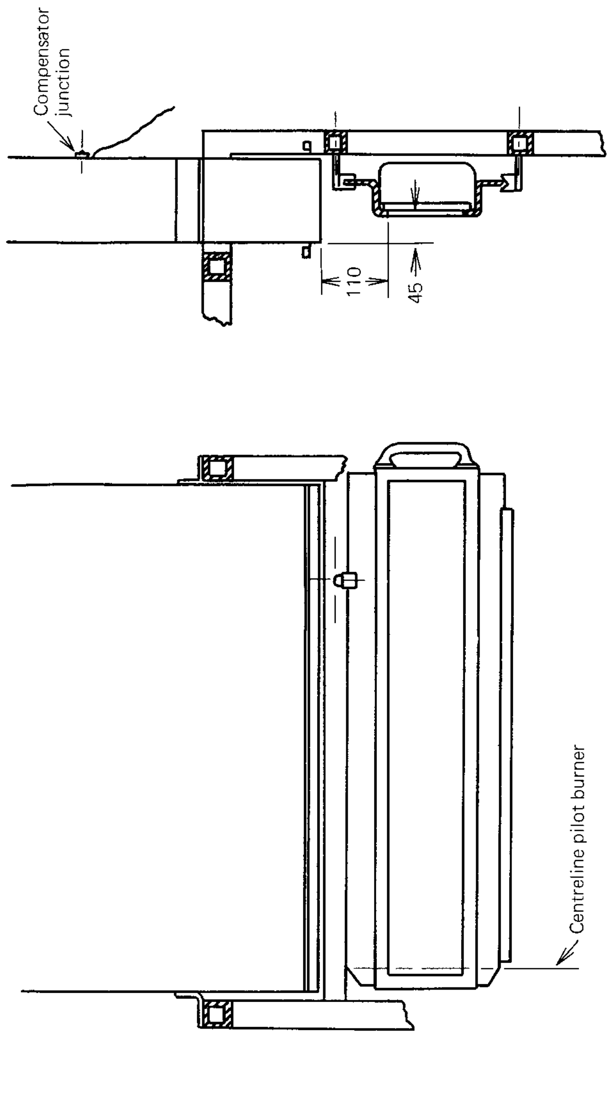


Figure 7 – *Stack – specimen position dimensions*

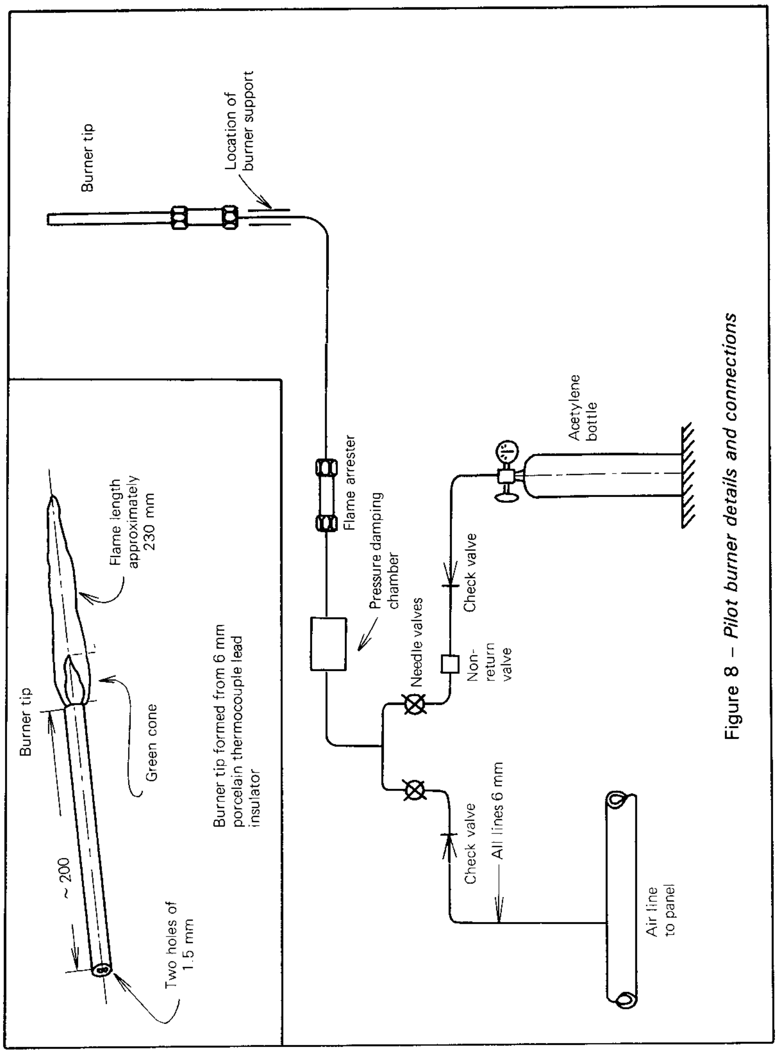


Figure 8 – Pilot burner details and connections

Figure 9 – *Position of pilot flame*

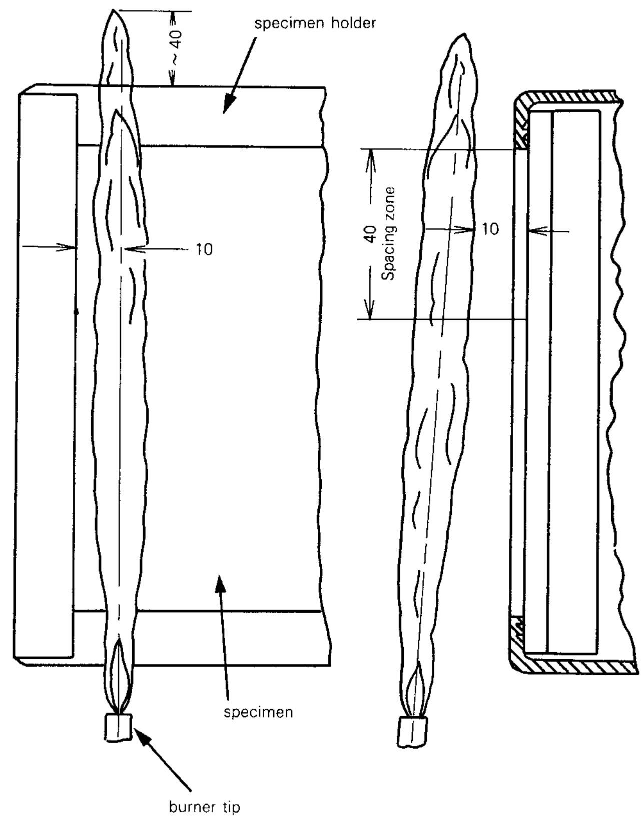
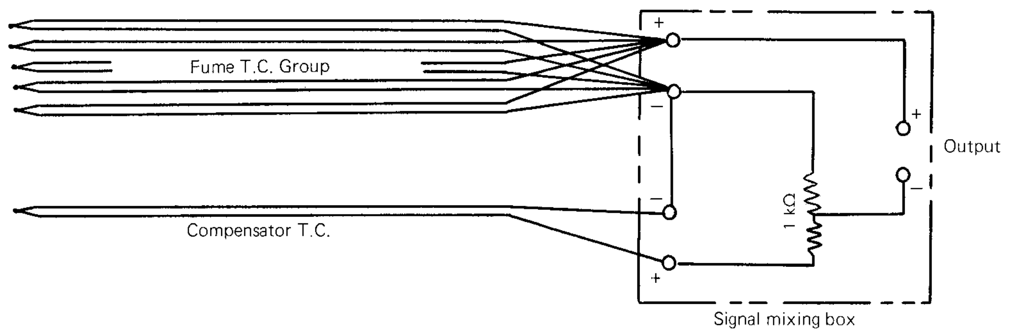


Figure 10 – *Diagrammatic sketch of thermocouple circuit*

Two sets of thermocouples and lead wires are required. The wire size and lengths within the fume T.C. group must be the same to ensure proper signal averaging. The parallel connection of the couples may be achieved at the mixing box by plug connection of the leads. This allows quick removal and checks for continuity and grounding problems with minimum delay. No cold junction should be used but the signal mixing box shall be shielded from panel radiation.



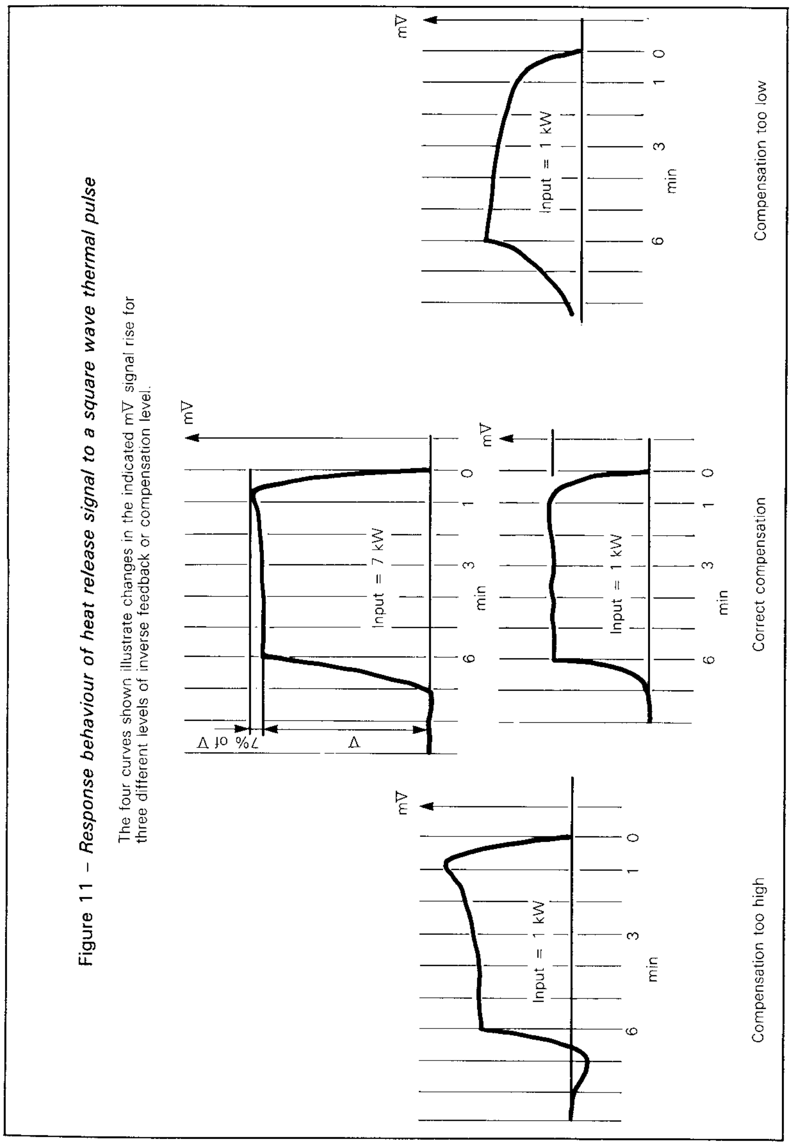


Figure 11 – Response behaviour of heat release signal to a square wave thermal pulse

The four curves shown illustrate changes in the indicated mV signal rise for three different levels of inverse feedback or compensation level.

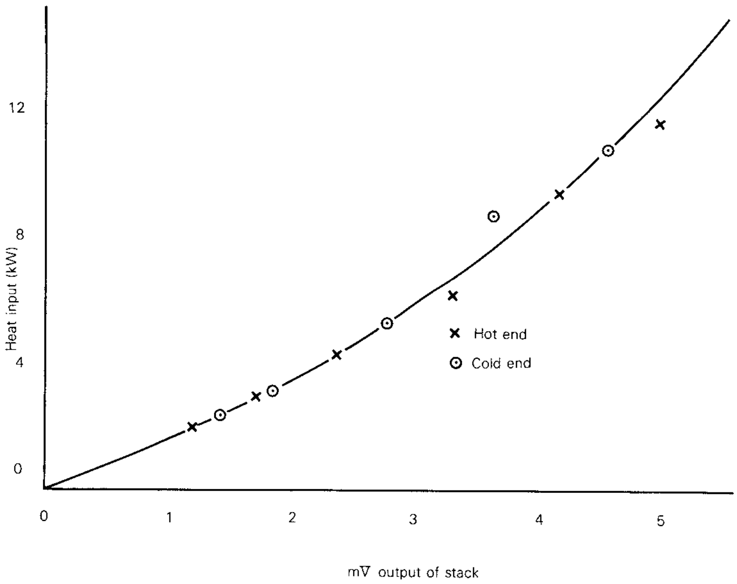


Figure 12 – *Typical stack calibration*

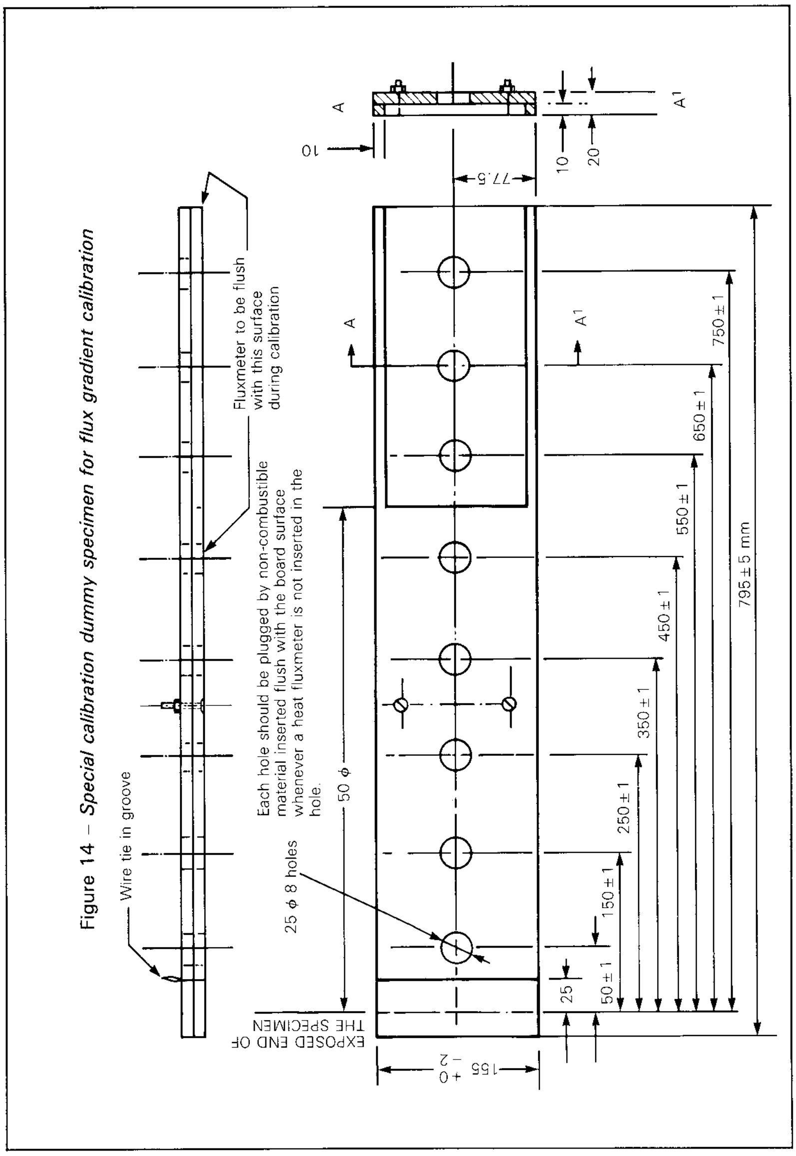


Figure 14 – *Special calibration dummy specimen for flux gradient calibration*

200

RESOLUTION A.654(16)

Adopted on 19 October 1989

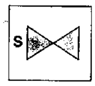
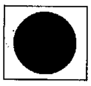
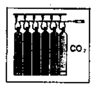
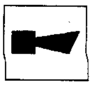
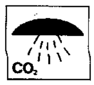
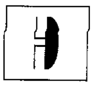
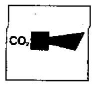
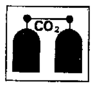
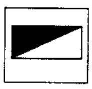
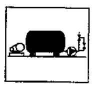
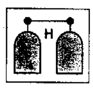
ANNEX

GRAPHICAL SYMBOLS FOR FIRE CONTROL PLANS

SYMBOLS FOR USE IN ACCORDANCE WITH REGULATION II-2/20 OF THE 1974 SOLAS CONVENTION AS AMENDED

ANNEX

SYMBOLS* FOR USE IN ACCORDANCE WITH REGULATION II-2/20 OF THE 1974 SOLAS CONVENTION, AS AMENDED

fire control plan		sprinkler section valve	
push-button/switch for fire alarm		CO_2 battery	
horn fire alarm		space protected by CO_2	
bell fire alarm		CO_2 horn	
manually operated call point		CO_2 release station	
space protected by automatic fire alarm		halon 1301 battery	
fire alarm panel		space protected by halon 1301	
sprinkler installation		halon horn	
space protected by sprinkler		halon release station	

* Available in colour in poster form (Sales No. 847 90.06.E) from: Publications Section, IMO, 4, Albert Embankment, London SE1 7SR.

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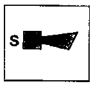
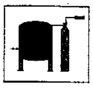
sprinkler horn

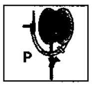


powder installation

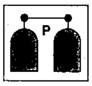


powder monitor (gun)

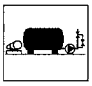
powder hose and handgun



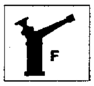
powder release station



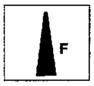
foam installation



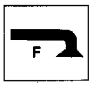
foam monitor (gun)



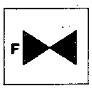
foam nozzle



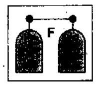
space protected by foam



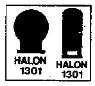
foam valve



foam release station

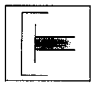


halon 1301 bottles placed in protected area

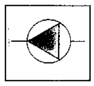


hose box with spray/jet fire nozzle

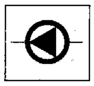
international shore connection



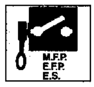
fire pump



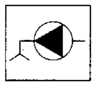
emergency fire pump



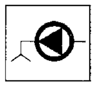
remote controlled fire pumps or emergency switches



bilge pump

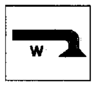


emergency bilge pump

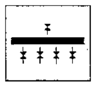


water monitor (gun)

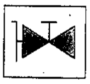
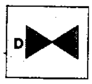
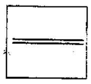
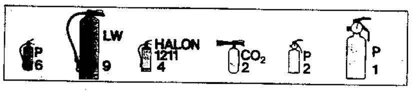
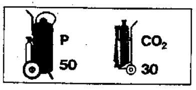
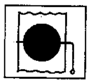
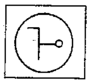
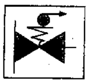
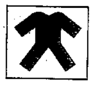
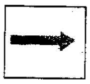
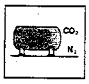
water fog applicator



drenching installation

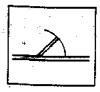


Res. A.654(16)

fire main with fire valves		space protected by drenching system	
section valves drenching system		A class division	
portable fire extinguishers			
wheeled fire extinguishers		B class division	
fire damper in vent duct		remote controlled skylights	
fire station		remote controlled fuel/ lubricating oil valves	
locker with fireman's outfit		control station	
locker with additional breathing apparatus		portable foam applicator	
locker with additional protective clothing		inert gas installation	
primary means of escape		high expansion foam supply trunk	
secondary means of escape		CO_2/nitrogen bulk installation	

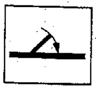
emergency generator

A class fire door



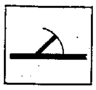
A class fire door

A class fire door
self-closing



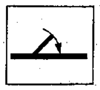
A class fire door
self-closing

B class fire door



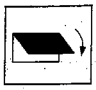
B class fire door

B class fire door
self-closing

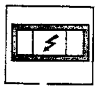


B class fire door
self-closing

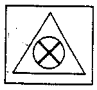
closing appliance for
exterior ventilation
inlet or outlet



emergency switchboard



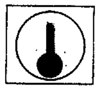
remote ventilation
shut off



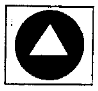
main vertical zone

smoke detector

heat detector



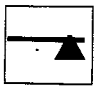
gas detector



flame detector

emergency telephone
station

fire axe



RESOLUTION A.657(16)

Adopted on 19 October 1989

ANNEX 1

LIFERAFT SURVIVAL INSTRUCTIONS

Part A

INSTRUCTIONS FOR IMMEDIATE ACTION IN A LIFERAFT

The instructions concerning immediate action upon entering the liferaft should be written in easily legible type on waterproof material, and displayed so as to be easily seen by a person entering the liferaft. The instructions should be written in one of the official languages of the Organization in addition to the official language of the country.

1 Cut painter and get clear of ship.
2 Look for and pick up other survivors.
3 Ensure sea-anchor streamed when clear of ship.
4 Close up entrances.
5 Read survival Instructions.

Part B

INSTRUCTIONS ON HOW TO SURVIVE IN A LIFERAFT

1 Identify person in charge of liferaft.
2 Post a look-out.
3 Open equipment pack.
4 Issue anti-seasickness medicine and seasickness bags.
5 Dry liferaft floor and inflate, if appropriate.
6 Administer first aid, if appropriate.
7 Manoeuvre towards other liferafts, secure liferafts together and distribute survivors and equipment between survival craft.
8 Arrange watches and duties.
9 Check liferaft for correct operation and any damage and repair as appropriate (ventilate if CO_2 leaking into liferaft).
10 Check functioning of canopy light and if possible conserve power during daylight.
11 Adjust canopy openings to give protection from weather or to ventilate the liferaft as appropriate.
12 Prepare and use detection equipment including radio equipment.
13 Gather up any useful floating objects.
14 Protect against heat, cold and wet conditions.
15 Decide on food and water rations.
16 Take measures to maintain morale.
17 Make sanitary arrangements to keep liferaft habitable.
18 Maintain liferaft including topping up of buoyancy tubes and canopy supports.
19 Make proper use of available survival equipment.

20 Prepare action for:
- **.1** arrival of rescue units;
- **.2** being taken in tow;
- **.3** rescue by helicopter,- and
- **.4** landing and beaching.

Notes: 1 The order in which the above instructions are followed will depend on the particular circumstances.

2 The above instructions can stand alone or can be amplified as appropriate to the satisfaction of the Administration.

ANNEX 2

LIST OF CONTENTS FOR THE LIFEBOAT SURVIVAL INSTRUCTIONS OR MANUAL

Contents

1 The person in charge of the lifeboat shall immediately, after clearing the ship, organize the following:
- **.1** look for and pick up other survivors from the water;
- **.2** marshal liferafts;
- **.3** secure survival craft together, distribute survivors and equipment between survival craft;
- **.4** stream sea-anchor; and
- **.5** if appropriate, rig exposure cover or foldable canopy.

2 Post a look-out.
3 Issue anti-seasickness medicine and seasickness bags.
4 Administer first aid, if appropriate.
5 Arrange watches and duties.
6 Prepare and use detection equipment including radio equipment.
7 Gather up any useful floating objects.
8 Protect against heat, cold and wet conditions.
9 Decide on food and water rations.
10 Take measures to maintain morale.
11 Make sanitary arrangements to keep lifeboat habitable.
12 Prepare for onset of adverse weather.
13 Make proper use of survival equipment.
14 Prepare action for:
- **.1** arrival of rescue units;
- **.2** being taken in tow;
- **.3** rescue by helicopter; and
- **.4** landing and beaching.

Note: The above list of contents should be used to compile a lifeboat survival manual to the satisfaction of the Administration.

RESOLUTION A.686(17)

Adopted on 6 November 1991

CODE ON ALARMS AND INDICATORS

PREAMBLE

This Code has been developed on the basis of the following principles:

1 The Code is a recommendatory document primarily directed to ships covered by the International Convention for the Safety of Life at Sea, 1974 (1974 SOLAS Convention), as amended, and associated Codes (IBC, BCH, IGC and Gas Carrier Codes). Although alarms and indicators required by the Codes on mobile offshore drilling units, nuclear merchant ships, dynamically supported craft and similar specialized vessels and also by MARPOL 73/78 are not specifically included, the Code can be used for guidance where appropriate, and in the future it could be extended to include these instruments. The Code can also be used for guidance for alarms and indicators fitted in excess of or in addition to those required by IMO instruments. It permits present practices in use in world fleets and provides flexibility for alternative methods. It is, however, intended to promote uniformity of the system between ships which will improve crew safety and training.

2 The Code will benefit designers and operators by consolidating in one document the references to priorities, grouping, locations and types, including colours, symbols, etc., of shipboard alarms and indicators. Where the applicable IMO instruments do not specify the type and location of particular alarms, this information, as far as practicable, is presented in this Code to promote uniform application.

3 Although preference was given to promoting consistency of terminology with IMO instruments, harmonization with the contents of IEC publication 92-203:985 *Electrical Installations in Ships. System Design - Acoustic and Optical Signals* was achieved as far as practicable.

4 It is recognized that changing technology and future amendments to the IMO instruments referred to in the Code will necessitate changes to the Code itself. Accordingly, the Organization will review the Code as necessary taking into account both amendments to IMO instruments and future development.

5 Administrations are encouraged to give wide dissemination of this Code to shipowners, operators, designers and other interested bodies.

1 PURPOSE AND APPLICATION

1.1 This Code is a recommendatory document for alarms and indicators. It is intended to provide general design guidance and to promote uniformity of type, location and priority for those alarms and indicators which are required by the 1974 SOLAS Convention, as amended, and associated Codes (IBC, BCH, IGC and Gas Carrier Codes).

1.2 In order to achieve similar uniformity, the Code also serves as guidance for alarms and indicators included in IMO instruments, other than those referred to in 1.1.

1.3 The Code applies to shipboard alarms and indicators on ships constructed on or after 1 July 1992. The Code also applies to major modifications to, or new installations of, alarms and indicators carried out on or after 1 July 1992.

2 DEFINITIONS

2.1 *Alarm*. An alarm or alarm system which announces by audible means, or audible and visual means, a condition requiring attention.

2.2 *Emergency alarms*. Alarms which indicate that immediate danger to human life or to the ship and its machinery exists and that immediate action must be taken. The following are classified as emergency alarms:

- **.1** *General emergency alarm*. An alarm given in the case of an emergency to all persons on board summoning passengers and crew to muster stations.
- **.2** *Fire alarm*. An alarm to summon the crew in the case of fire.
- **.3** Those alarms giving warning of immediate personnel hazard, including:
- **.3.1** *Fire-extinguishing medium alarm*. An alarm warning of the imminent release of fire-extinguishing medium into a space.
- **.3.2** *Power-operated sliding watertight door closing alarm*. An alarm required by SOLAS regulation II-1/15.9.1, or SOLAS regulation II-1/15.7.1.6 for ships constructed on or after 1 February 1992, warning of the closing of a power-operated sliding watertight door.

2.3 Primary alarms. Alarms which indicate a condition that requires prompt attention to prevent an emergency condition. The following are classified as primary alarms:

- **.1** *Machinery alarm*. An alarm which indicates a malfunction or other abnormal condition of the machinery and electrical installation.
- **.2** *Steering gear alarm*. An alarm which indicates a malfunction or other abnormal condition of the steering gear system, i.e. overload alarm, phase failure alarm, no-voltage alarm, and hydraulic oil tank low-level alarm.
- **.3** *Control system fault alarm*. An alarm which indicates a failure of an automatic or remote control system, e.g., the navigating bridge propulsion control failure alarm.

.4 *Bilge alarm*. An alarm which indicates an abnormally high level of bilge water.

.5 *Engineers' alarm*. An alarm to be operated from the engine control room or at the manoeuvring platform, as appropriate, to alert personnel in the engineers' accommodation that assistance is needed in the engine-room.

.6 *Personnel alarm*. An alarm to confirm the safety of the engineer on duty when alone in the machinery spaces.

.7 *Fire detection alarm*. An alarm to alert the crew on the navigating bridge, at the fire control station or elsewhere that a fire has been detected.

.8 *Alarms indicating faults* in emergency or primary alarm or detection systems or failure of their power supplies.

.9 *Cargo alarm*. An alarm which indicates abnormal conditions originating in cargo, or in systems for the preservation or safety of cargo.

.10 *Gas detection alarm*. An alarm which indicates that gas has been detected.

.11 *Power-operated watertight door fault alarms*. Alarms which indicate low level in hydraulic fluid reservoir, low gas pressure or loss of stored energy in hydraulic accumulators, and loss of electrical power supply for power-operated sliding watertight doors.

2.4 *Secondary alarms*. Alarms which are not included in 2.2 and 2.3.

2.5 *Indicator*. Visual indication giving information about the condition of a system or equipment.

2.6 *Required alarm or indicator*. An alarm or indicator required by IMO instruments referred to in 1.1 and 1.2. Any other alarms and indicators are referred to in this Code as non-required alarms or indicators.

2.7 *Call*. The request for contact, assistance and/or action from an individual to another person or group of persons, i.e. the complete procedure of signalling and indicating this request.

2.8 *Accept*. Manually acknowledge receipt of an alarm or call.

2.9 *Cancel.* Manual stopping of an alarm or call after the cause has been eliminated.

2.10 *Grouping*. Grouping is a generic term meaning:

.1 the arrangement of individual alarms on alarm panels or individual indicators on indicating panels, e.g., steering gear alarms at the navigating bridge steering position, or door indicators on a watertight door position indicating panel;

.2 the combining of individual alarms to provide one alarm at a remote position, e.g., the machinery alarm at the engineers' accommodation or at the navigating bridge; and

.3 the arrangement of alarms in terms of their priority, e.g., emergency alarms, primary alarms, secondary alarms.

2.11 *IBC Code*. The International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (resolution MSC.4(48), as amended).

2.12 *BCH Code*. The Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (resolution MSC.9(53), as amended).

2.13 *IGC Code*. The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (resolution MSC.5(48), as amended).

2.14 *GC Code*. The Code for the Construction and Equipment of Ships Carrying liquefied Gases in Bulk (resolution A.328(IX), as amended).

3 GENERAL

3.1 The presentation of alarms and indicators should be clear, unambiguous, and consistent.

3.2 All required alarms should be indicated by both audible and visual means, except the emergency alarms of 2.2 which should be indicated primarily by audible alarms. In machinery spaces with high ambient noise level, audible alarms should be supplemented by visual alarms in accordance with 5.1. Audible alarms may also be supplemented by visual alarms in accommodation spaces.

3.3 A new alarm condition should be clearly distinguishable from those existing and accepted, e.g., existing and accepted alarms are indicated by a constant light and new alarms are indicated by a flashing light. At control positions or other suitable positions as required, alarm systems should clearly distinguish between normal, alarm, and accepted alarm conditions.

3.4 Alarms should be maintained until they are accepted and the visual indications of individual alarms should remain until the fault has been corrected, when the alarm system should automatically reset to the normal operating condition. If an alarm has been accepted and a second fault occurs before the first is rectified, the audible and visual alarms are to operate again.

3.5 Alarms should only be capable of being cancelled if the condition causing them has been dealt with successfully.

3.6 Required alarm systems should be continuously powered and should have an automatic change-over to a stand-by power supply in case of loss of normal power supply. Emergency alarms and primary alarms should be powered from the main source of electrical power and from emergency source of electrical power defined by SOLAS regulations II-1/42 or II-1/43 unless other arrangements are permitted by those regulations, as applicable, except that:

.1 the power-operated sliding watertight door closure alarm power sources may be those used to close the doors;

.2 the fire-extinguishing medium alarm power source may be the medium itself; and

.3 continuously charged, dedicated accumulator batteries of an arrangement, location, and endurance equivalent to that of the emergency source of electrical power may be used instead of the emergency source.

3.7 Required rudder angle indicators and power-operated sliding watertight door position indicators should be powered from the main source of electrical power and should have an automatic change-over to the emergency source of electrical power in case of loss of normal power supply.

3.8 Failure of the normal power supply of required alarm systems should be indicated by an audible and visual alarm.

3.9 Required alarm systems should, as far as is practicable, be designed on the fail-to-safety principle, e.g., an open detection circuit should cause an audible and visual alarm; see also SOLAS regulations II-2/13.1.2 and II-1/51.1.4.

3.10 Provision should be made for functionally testing required alarms and indicators. The Administration should ensure, e.g., by training and drills, that the crew is familiar with all emergency and primary alarms.

3.11 Required alarms and indicator systems should be functionally independent of control systems and equipment, or should achieve equivalent redundancy. Any additional requirements for particular alarms in the IMO instruments applicable to the ship should be complied with.

3.12 Computer programs for computerized alarm and indicator systems should not be permanently lost or altered as a result of power supply loss or fluctuation. Provision should be made to prevent unintentional or unauthorized alteration of computer programs.

3.13 Cables for emergency alarms and their power sources should be of a fire-resistant type and be run as directly as is considered practicable by the Administration. Equipment and cables for emergency alarms should be arranged to minimize risk of total loss of service due to localized fire, collision, flooding or similar damage.

3.14 To the extent considered practicable by the Administration, emergency alarms should be arranged so that the audible alarm signal can be heard regardless of failure of any one circuit or component.

3.15 Means should be provided to prevent normal operating conditions from causing false alarms, e.g., provision of time delays because of normal transients.

3.16 Alarms and indicators on the navigating bridge are to be minimized. Alarms and indicators which are not required alarms and indicators for the navigating bridge should not be placed on the navigating bridge, unless permitted by the Administration.

3.17 The system should be arranged so that all alarm signals can be accepted or cancelled at the appropriate control position only.

3.18 In order to facilitate maintenance and reduce risk of fire or harm to personnel, consideration should be given to providing means of isolation of sensors fitted to tanks and piping systems for flammable fluids or fluids at high temperature or pressure (e.g. valves, cocks, pockets for temperature sensors).

4 AUDIBLE ALARMS AND CALLS

4.1 Required alarms should be clearly audible and distinguishable in all parts of the spaces where they are called for. Where a distinct difference between the various audible alarms and calls cannot be determined satisfactorily, as in machinery spaces with high ambient noise levels, it is permitted, with the exception of the fire-extinguishing medium alarm, to install common audible alarm and call devices supplemented by visual alarms and indicators identifying the meaning of the audible alarm or call.

4.2 The fire-extinguishing medium alarm should have a characteristic which can be easily distinguished from any other audible alarm or call installed in the space(s) concerned, and should not be combined with any other audible alarm or call.

4.3 Audible alarms and calls should have characteristics in accordance with section 6.

4.4 In large spaces, more than one audible alarm or call device should be installed, in order to avoid shock to persons close to the source of sound and to ensure a uniform sound level over all the space as far as practicable.

4.5 Facilities for adjusting the frequency of audible alarms within the prescribed limits may be provided to optimize their performance in the ambient conditions. The adjustment devices should be sealed, to the satisfaction of the Administration, after setting has been completed.

4.6 Arrangements should not be provided to adjust the sound pressure level of required audible alarms.

4.7 Administrations may accept electronically generated sound signals provided all applicable requirements herein are complied with.

4.8 Administrations may accept the use of a public address system for the general emergency alarm and the fire alarm provided that:

.1 all requirements for those alarms in chapters II and III of the 1974 SOLAS Convention, as amended, are met;

.2 all the relevant requirements for required alarms in this Code are met;

.3 the system automatically overrides any other input system when an emergency alarm is required and the system automatically overrides any volume controls provided to give the required output for the emergency mode when an emergency alarm is required;

.4 the system is arranged to prevent feedback or other interference; and

.5 the system is arranged to minimize the effect of a single failure, e.g., by the use of multiple amplifiers with segregated cable routes to public rooms, alleyways, stairways and control stations; use of more than one device for generating electronic sound signals; and use of electrical protection for individual loudspeakers against short circuits.

4.9 The general emergency alarm, fire alarm (if not incorporated in the general emergency alarm system), fire-extinguishing medium alarm, and machinery alarm should be so arranged that the failure of the power supply or the signal generating and amplifying equipment (if any) to one will not affect the performance of the others.

4.10 The general emergency alarm should be audible in the spaces specified by SOLAS regulation III/50 with all doors and accesses closed.

4.11 In general, audible alarm sound pressure levels at the sleeping positions in the cabins and one metre from the source should be at least 75 dB(A) and at least 10 dB(A) above ambient noise levels existing during normal equipment operation with the ship under way in moderate weather. The sound pressure level should be in the 1/3-octave band about the fundamental frequency. In no case should audible alarm levels in a space exceed 120 dB(A).

4.12 With the exception of bells, audible alarms should have a signal frequency between 200 Hz and 2,500 Hz.

5 VISUAL ALARMS, CALLS AND INDICATORS

5.1 Supplemental visual alarms and calls provided in machinery spaces with high ambient noise levels and in accommodation spaces should:

.1 be clearly visible and distinguishable either directly or by reflection in all parts of the space in which they are required;

.2 be of a colour and symbol in accordance with tables 6.1.1-6.1.3;

.3 flash in accordance with 5.2;
.4 be of high luminous intensity, and
.5 be provided in multiple in large spaces.

5.2 Flashing alarms and calls should be illuminated for at least 50% of the cycle and have a pulse frequency in the range of 0.5 Hz to 1.5 Hz.

5.3 Visual alarms and indicators on the navigating bridge should not interfere with night vision.

5.4 Alarms and indicators should be clearly labelled unless standard visual indicator symbols, such as those in tables 6.1.1-6.1.3, are used. These standard visual indicator symbols should be arranged in columns for ready identification from all directions. This applies in particular to the emergency alarms in table 6.1.1. Standard visual indicator symbols may also be used on consoles, indicator panels, or as labels for indicator lights.

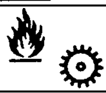
5.5 Alarm and indicator colours should be in accordance with ISO Standard 2412 as deemed appropriate by the Administration.

6 CHARACTERISTICS

6.1 The emergency and primary alarms and call signals listed should have the audible and visual characteristics shown in the tables of this section. All other alarms, indicators and call signals should be clearly distinct from those listed in this section to the satisfaction of the Administration. These tables are not all-inclusive and other alarms may be added by the Administration in a manner consistent with this Code.

Table 6.1.1 - *Emergency alarms*

Note: see table 6.2 for audible codes.

ction		IMO Instrument	Audible Device	Code	Visual Colour	Visual Symbol*	Remarks
eral rgency n		SOLAS III/50, III/6.4	Whistle Siren Bell Klaxon Horn	1.a, 1.b	Green/ White	 passengers  crew	Muster stations for passengers. Boat stations for crew.
	Other than in machinery space	SOLAS II-2/40.4 II-2/13	Bell Klaxon Siren Horn	2, 1.b	Red		Fire stations for crew
rm	In machinery space	SOLAS II-2/11.8 II-2/14	Bell Buzzer Horn	2	Red		Horn/bell in machinery space, buzzer/bell elsewhere
-extinguishing dium release rm		SOLAS II-2/5.1.6	Siren Horn	2	Red	CO_2 HALON	Signal precedes release. Audible signal distinct from all others.
ver-operated ing watertight r closing alarm		SOLAS II-1/15.9.1; for ships constructed on or after 1 February 1992, II-1/15.7.1.6 and 15.8.2.	Horn Klaxon Bell	2	Red Green	No symbol allocated	Signal at door precedes and continues during door closing. At remote position: door open red indicator, door closed – green indicator. On ships constructed on or after 1 February 1992, red indicator on navigating flashes while door closes.

* For use with alarm indicator columns.

Table 6.1.2 - *Primary alarms*

Note: see table 6.2 for audible codes.

Function	IMO Instrument	Audible Device	Audible Code	Visual Colour	Visual Symbol*	Remarks
Machinery alarm	SOLAS II-1/51.1	Horn Buzzer	3	Amber		Horn in machinery space, buzzer elsewhere
Steering gear alarm	SOLAS II-1/29.5.2 29.8.4 29.12.2 30.3	Horn Buzzer	3	Amber		Horn in machinery space, buzzer elsewhere
Control system Fault alarm	SOLAS II-1/29.8.4 II-1/49.5	Horn Buzzer	3	Amber	No symbol allocated	Horn in machinery space, buzzer elsewhere
Bilge alarm	SOLAS II-1/48	Horn Buzzer	3	Amber		Horn in machinery space, buzzer elsewhere
Engineers' alarm	SOLAS II-1/38	Horn Buzzer	3	Amber		Horn/buzzer in engineers' corridors, buzzer in engineers' cabins
Personnel alarm	Resolution A.481(XII), paragraph 7.3	Horn Buzzer	3	Amber		Horn in machinery space, buzzer elsewhere
Fire detection alarm	SOLAS II-2/12	Bell Buzzer Horn	2	Red		
	SOLAS II-2/13	Ditto	2	Red		Should automatically actuate fire alarm if not accepted in 2 min or less. Horn/bell in machinery space, buzzer/bell elsewhere.
	SOLAS II-2/13.1 for ships constructed on or after 1 February 1992	Ditto	2	Red		
Alarm system fault Alarm	II-1/51.2.2	Horn Buzzer	3	Amber	No symbol allocated	Horn in machinery space, buzzer elsewhere
Cargo alarm	IBC, BCH, IGC, GC	Horn Buzzer	3	Amber	No symbol allocated	See tables 9.1.1-9.1.8 for IMO instrument references. Horn in machinery space, buzzer in engine control room, cargo control station

				and navigating bride.

* For use with alarm indicator columns.

Table 6.1.2 - *Primary alarms* (cont.)

Note: see table 6.2 for audible codes.

Function		IMO Instrument	Audible Device	Code	Visual Colour	Symbol*	Remarks
Gas Detection Alarm	For chlorine gas	IGC 17.14.4.3 17.14.1.4 GC 17.12.5(d)(iii) 17.12.5(a)(iv)	Siren Horn Bell	2	Red	GAS Cl	
	Except for chlorine gas	IGC 13.6.17.9 16.2.1.2, 16.2.9 GC 13.6, 17.11, 16.2(b), 16.10	Buzzer Horn	3	Amber	GAS XXX	xxx Gas abbreviation may be indicated
Power-operated sliding watertight door fault alarm		SOLAS II-1/15.7.3, 15.7.8 for ships constructed on or after 1 February 1992	Horn Buzzer	3	Amber	No symbol allocated	Horn in machinery spaces, buzzer elsewhere

* For use with alarm indicator columns.

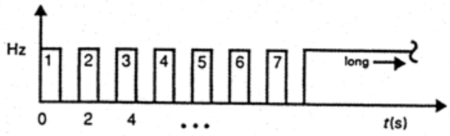
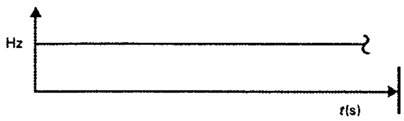
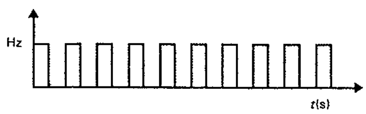
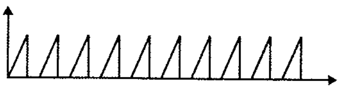
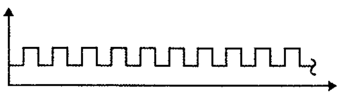
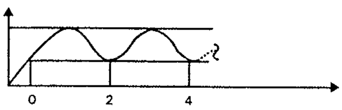
Table 6.1.3 - *Call signals*

Note: see table 6.2 for audible codes.

Function	IMO Instrument	Audible Device	Code	Visual Colour	Symbol*	Remarks
Telephone	SOLAS II-1/50	Horn Buzzer Bell	3.a	White		Horn/bell in machinery spaces and engineers' accommodation corridors; buzzer/bell in engine control room, on navigating bridge and in engineers' cabins
Engine-room telegraph	SOLAS II-1/37	Horn Bell Buzzer	2, 3.a	White		Horn/bell in machinery space, buzzer/bell in engine control room and on navigating bridge

* For use with alarm indicator columns.

Table 6.2 - *Audible alarm and call waveforms*

Audible code	Waveform	Remarks
1.a 1.b	 Specific codes per muster list	General emergency alarm
2		Continuous until cancelled or accepted
3.a 3.b 3.c 3.d	   	Optional waveforms to provide distinction between alarms. To be used consistently for primary and secondary alarms. Pulse frequency between 0.5 Hz and 2.0 Hz.

7 REQUIREMENTS FOR PARTICULAR ALARMS

7.1 Personnel alarm

7.1.1 The personnel alarm should automatically give an alarm on the navigating bridge or in the officers' quarters as appropriate, if it is not reset from the machinery spaces in a period satisfactory to the Administration, but not exceeding 30 min.

7.1.2 A pre-warning signal should be provided in the machinery spaces which operates 3 min before the alarm required by 7.1.1 is given.

7.1.3 The alarm system is to be put into operation.

.1 automatically when the engineer on duty has to attend machinery spaces in case of a machinery alarm; or

.2 manually by the engineer on duty when attending machinery spaces on routine checks.

7.1.4 The alarm system is to be disconnected by the engineer on duty after leaving the machinery spaces. When the system is brought into operation in accordance with 7.1.3.1, disconnection should not be possible before the engineer has accepted the alarm in the machinery spaces.

7.1.5 The personnel alarm may also operate the engineers' alarm.

7.2 Engineers' alarm

In addition to manual operation from the machinery space, the engineers' alarm on vessels with periodically unattended machinery spaces should operate when the machinery alarm is not accepted in the machinery spaces or control room in a specified period of time, e.g. 2 min.

8 GROUPING OF ALARMS AND INDICATORS

8.1 Where audible and visual alarms and indicators are required at central positions, e.g. on the navigating bridge, in the machinery space, or engine control room, the alarms and indicators should be arranged in groups, as far as practicable, except emergency alarms.

8.2 The scope of alarms and indicators will vary with the type of ship and machinery. The basic recommendations given in tables 8.1 through 8.3 should be adhered to.

8.3 When visual alarms are grouped in accordance with 2.10.2, individual alarms should be provided at the appropriate position to identify the specific alarm condition.

8.4 The purpose of grouping is to achieve the following:

.1 In general: to reduce the variety in type and number of audible and visual alarms and indicators so as to provide quick and unambiguous information to the personnel responsible for the safe operation of the ship.

.2 On the navigating bridge:

.2.1 to enable the officer on watch to devote full attention to the safe navigation of the ship;

.2.2 to readily identify any abnormal situation requiring action to maintain the safe navigation of the ship; and

.2.3 to avoid distraction by alarms which require attention but have no direct influence on the safe navigation of the ship and which do not require immediate action to restore or maintain the safe navigation of the ship.

.3 In the machinery space/engine control room, to readily identify and locate any area of abnormal conditions (e.g. main propulsion machinery, steering gear, bilge level) and to enable the degree of urgency for remedial action to be assessed.

.4 In the engineers' public rooms and to each of the engineers' cabins on ships where the machinery space/engine control room is periodically unattended, to inform the engineer officer on watch of any alarm situation which requires immediate presence in the machinery space/engine control room.

Table 8.1 - *Grouping of alarms and indicators: machinery space attended, remote control of the main propulsion machinery from the navigating bridge not provided*

Navigating bridge		**Machinery space**
One common audible alarm device, except emergency alarms (e.g. buzzer, continuous)		**Audible alarm devices, in accordance with sections 4, 6 and 8**
1	**2**	**3**
Main steering position	**Other locations on navigating bridge**	**Machinery space or control room**
Individual visual alarms and indicators for: Each required steering gear: - Power unit power failure - Control system power failure - Hydraulic fluid level alarm - Running indication - Alarm system failure alarm Engine-room telegraph Rudder angle indicator Propeller speed/direction/pitch Telephone call	Visual alarms and indicators at any position on the navigating bridge other than the main steering position for: Required alarms and indicators, as indicated under "Notes" in table 9.1.1 Any non-required alarm or indicator which the Administration considers necessary for the officer on watch Fire detection alarm	Visual alarms and indicators grouped at a position in the machinery space or, in the case of ships provided with a control room, in that control room. In complex machinery alarmarrangements, due account should be taken of 8.4.3. Alarms and indicators as indicated under "Notes" in table 9.1.2 Engine-room telegraph

Table 8.2 - *Grouping of alarms and indicators: machinery space attended, remote control of the main propulsion machinery from the navigating bridge provided*

Navigating bridge		**Machinery space**
One common audible alarm device, except emergency alarms (e.g. buzzer, continuous)		**Audible alarm devices, in accordance with sections 4, 6 and 8**
1	**2**	**3**
Main steering position	**Other locations on navigating bridge**	**Machinery space or control room**
Individual visual alarms and indicators as in column 1, table 8.1, plus: Failure of remote control for main propulsion machinery Starting air low pressure, when the engine can be started from the navigating bridge Propulsion station in control	Visual alarms and indicators at any position on the navigating bridge other than the main steering position as in column 2 of table 8.1, plus: Machinery alarm, if provided	Alarms and indicators as in column 3 of table 8.1, plus: Failure of remote control for main propulsion machinery s Sarting air low pressure Propulsion station in control Indication of propulsion machinery orders from navigating bridge Alarms and indicators as indicated under "Notes" in table 9.1.2

Table 8.3 - *Grouping of alarms and indicators: machinery space unattended, remote control of the main propulsion machinery from the navigating bridge provided*

Navigating bridge		**Machinery space**	
One common audible alarm device, except emergency alarms (e.g. buzzer, continuous)		**Audible alarm devices, in accordance with sections 4, 6 and 8**	
1	**2**	**3**	**4**
Main steering position	**Other locations on navigating bridge**	**Machinery space or control room**	**Engineers' public spaces and accommodations**
Individual visual alarms and indicators as in column 1 of table 8.1 and 8.2, plus: Override of automatic Propulsion shutdown, if provided	Visual alarms and indicators at any position on the navigating bridge other than the main steering position as in column 2 of tables 8.1 and 8.2, plus: Machinery space fire detection alarm Alarm conditions requiring action by or the attention of the officer on watch on the navigating bridge Alarms and indicators as indicated under ”Notes” in table 9.1.1	As in column 3, tables 8.1 and 8.2, plus: Alarms as indicated under ”Notes” in table 9.1.2 Alarm system power failure alarm	Engineers' alarm Machinery space fire detection alarm Machinery alarm* Steering gear alarm (common)* Machinery space bilge alarm* Alarm system power failure alarm Alarms and indicators under ”Notes” in table 9.1.5

* Alarm may be common.

9 ALARM AND INDICATOR LOCATIONS

9.1 Required alarms and indicator type and location should be in accordance with tables 9.1.1-9.1.8.

9.2 Applicable regulations in the IMO instruments referred to should be consulted for additional requirements.

Notes to be applied to tables 9.1.1-9.1.8:

(1) A - audible alarm (visual may be necessary in high noise areas)
V - visual alarm
I - visual indicator
A,V - both audible and visual alarms should be provided
MI - measuring indicator
EM - emergency alarm
P - primary alarms and additional indicators
S - secondary alarms and additional indicators

(2) *Cargo control station* means a position from which the cargo pumps and valves can be controlled. If a central cargo control station is not provided, then the alarm or indicator should be located in a suitable position for the operator (such as at the equipment monitored).

(3) If a cargo control station is not provided, the alarm or indication should be given at the gas detector device readout location.

(4) Where the types of alarms are not specifically identified in the IMO instruments referred to, the recommendations of the IMO Sub-Committee on Bulk Chemicals are enclosed in parentheses, e.g. (A,V).

Table 9.1.1 - *Location: navigating bridge*

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-1			
P	29.11	Rudder angle indicator	MI	Column 1, table 8.1
P	29.5.2, 30.3	Steering gear power unit power failure	A,V	Ditto
P	29.8.4	Steering control system power failure	A,V	Ditto
P	29.12.2	Low steering gear hydraulic fluid level	A,V	Ditto
P	30.1	Steering gear running	I	Column 1, table 8.1
P	51	Steering gear overload alarm	A,V	Column 1, table 8.3
P	31.2.7, 49.5	Propulsion machinery remote control failure	A,V	Column 1, table 8.2
P	31.2.9, 49.7	Low propulsion starting air pressure	A,V	Ditto
P	52	Automatic propulsion shutdown override	I	Column 1, table 8.3
P	52	Automatic shutdown of propulsion machinery	A,V	Ditto
P	51.1.3	Fault requiring action by or attention of the officer on watch	A,V	Column 1, table 8.3 (machinery alarm including 53.4.2 and 53.4.3)
P	31.2.8	Propeller speed/direction/pitch	MI	Column 1, table 8.2
P	49.6	Propeller speed/direction/pitch	MI	Column 1, table 8.3
P	37	Engine-room telegraph	I	Ditto
P	15.9.2	Power available for watertight doors	I	Column 2, table 8.1
P	16.2, 15.6.5 15.11.1.1	Watertight door position	I	Ditto; if central operating station is on navigating bridge.
P	**15.6.4, **15.8.2, 16.2	Watertight door position	I	Column 2, table 8.1
P	**15.7.3.1	Watertight door low hydraulic fluid level	A,V	Ditto
P	**15.7.3.1 **15.7.3.2	Watertight door low gas pressure, loss of stored energy	A,V	Ditto
P	**15.7.8	Watertight door electrical power loss	A,V	Ditto
P	**21.1.6.2	High water level alarm	A	I, where required.
P	**23-1.2	Watertight door position	I	Column 2, table 8.1 Recommended colours: red - door is not fully closed or not secured, green - door fully closed and secured.
P	**23-2.1	Shell door position indicator	I	Column 2, table 8.1, passenger ships with ro-ro cargo spaces or special category spaces. Recommended colours: red - door is not fully closed or not secured, green - door fully closed and secured.

Table 9.1.1 - *Location: navigating bridge* (cont.)

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-1			
P	**23-2.2	Water leakage detection indicator	I	Column 2, table 8.1, with ro-ro cargo spaces or special category spaces. For details see regulation 23-2.2.
S	31.2.5, 49.3	Propulsion control station in control	I	Column 1, table 8.2
P	51.2.2	Alarm system normal power supply failure	A,V	Column 2, table 8.3
	SOLAS II-2			
EM	+5.3.4.3	Local auto halon release	A,V	Column 2, table 8.1
P	11.8, 14.2	Fire detection in automated or remotely controlled machinery space	A,V	Column 2, table 8.2
P	12.1.2, + 12.1.2.1 12.1.2.2, + 13.1.5 13.1.6	Fire detection or auto sprinkler operation	A,V	Column 2, table 8.1
P	12.1.2, + 12.1.2.1 12.1.2.2, 13.1.2 + 13.1.5	Fire detection system fault	A,V	Column 2, table 8.1
P	**13-1.1.3	Smoke detection system power loss	A,V	Ditto
P	+, **13-1.1.6 +, **13-1.3.4	Smoke detection	A,V,I	Ditto
P	+ 5.3.3.8	Loss of halon container pressure	A,V	Ditto
P	+ 5.3.3.2	Halon system electric circuit fault or power loss	A,V	Ditto
P	+ 5.3.3.3	Halon system hydraulic or pneumatic pressure loss	A,V	Ditto
S	37.1.6.3, 38.3.3 53.2.3.3	Loss or reduction of required ventilation	I	Ditto
S	37.1.2.2	Fire door position	I	Ditto
S	62.16.3.1	Inert gas supply main pressure	MI	Ditto; forward of non-return devices.
S	62.16.3.1	Inert gas pressure	MI	Column 2, table 8.1 In slop tanks of combination carriers.
	Resolution A.481(XII)			
P	Paragraph 7.3	Personnel alarm	A,V	Column 2, table 8.1
	SOLAS III			
S	15.9	Position of stabilizer wings	I	Ditto
	SOLAS IV			
P	11(a)(vi) 18(a)	Radiotelegraph/radiotelephone alarm and failure of apparatus	A	Ditto
	SOLAS V			
S	12(m)	Pitch of lateral thrust propeller	MI	Column 1, table 8.1

Table 9.1.1 - *Location: navigating bridge* (cont.)

Priority	IMO Instrument	Function	Type	Notes
	Gas or chemical codes			Column 2, table 8.1 for the following:
P	IBC 15.2.4 BCH 4.19.4	High and low temperature of cargo and high temperature of heat exchanging medium	A,V	Ammonium nitrate solution
P	IBC 15.5.6 BCH 4.20.6	High temperature in tanks	A,V MI	Hydrogen peroxide solution over 60% but not over 70%
P	IBC 15.5.7 BCH 4.20.7	Oxygen concentration in void spaces	A,V MI	Hydrogen peroxide solution over 60% but not over 70%
P	IBC 15.8.23.1 BCH 4.7.15(a)	Malfunctioning of temperature controls of cooling systems	(A,V)	!, propylene oxide
P	IGC 13.4.1 GC 13.4.1	High and low pressure in cargo tank	A,V	High and low pressure alarms
P	IGC 13.6.4, 17.9 GC 13.6.4, 17.11	Gas detection equipment	A,V	
P	IGC 13.5.2 GC 13.5.2	Hull or insulation temperature	A, (V,) MI	!
P	IGC 17.18.4.4 GC 17.12.2(d)(iv)	Cargo high pressure, or high temperature at discharge of compressors	A,V	Methyl acetylene-propadiene mixtures
P	IGC 17.14.4.3 GC 17.12.5(d)(iii)	Gas detecting system monitoring chlorine concentration	A,V	!
P	IGC 17.14.4.4 GC 17.12.5(d)(iv)	High pressure in chlorine cargo tank	A, (V)	!
P	IBC 15.5.18 BCH 4.20.19	High temperature in tanks	A,V, MI	
P	IBC 15.5.19 BCH 4.20.20	Oxygen concentration in void spaces	A,V, MI	
P	IBC 15.10.2 BCH 4.3.1(b)	Failure of mechanical ventilation of cargo tanks	(A,V) (A,V)	! !
P	IBC 19.8.4	Low pressure in inerted cargo tanks	A,V	!
P	IGC 5.2.1.7 GC 5.2.5(b)	Liquid cargo in the ventilation system	(A,V)	
P	IGC 8.4.2.1 GC 8.4.2(a)	Vacuum protection of cargo tanks	(A,V)	!
P	IGC 9.5.2 GC 9.5.2	Inert gas pressure monitoring	(A,V)	!
P	IGC 13.6.11 GC 13.6.11	Gas detection equipment	A,V	!
P	IGC 17.14.1.4 GC 17.12.5(a)(iv)	Gas detection after bursting disk for chlorine	(A,V)	!

+ These alarms may by omitted if they are provided at the central fire control station.

** Applicable to ships constructed on or after 1 February 1992.

! No location specified in other IMO instruments. Location is recommended.

Table 9.1.2 - *Location: machinery space/machinery control room*

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-1			
P	29.12.2	Low steering gear fluid level	A,V	Column 3, table 8.1
P	30.1	Steering gear running	I	Ditto
P	30.3	Steering system electric phase failure or overload	A,V	Ditto
P	31.2.7, 49.5	Propulsion machinery remote control failure	A,V	Column 3, table 8.2
P	31.2.9, 49.7	Low propulsion starting air pressure	A,V	Ditto
P	32.2	Oil fire boiler low water level, air supply failure, or flame failure	A,V	Column 3, table 8.1
P	32.3	Propulsion boiler high water level	A,V	Ditto
S	31.2.5, 49.3	Propulsion control station in control	I	Column 3, table 8.2
P	37	Engine-room telegraph	I	Column 3, table 8.1
S	31.2.4, 49.2	Propulsion machinery orders from bridge	I	Column 3, table 8.2
P	47.1.1, 47.1.2	Boiler and propulsion machinery internal fire	A,V	Column 3, table 8.3
P	47.2	Internal combustion engine monitors	MI	Ditto
P	48.1, 48.2	Bilge monitors	A,V	Ditto
P	51.2.2	Alarm system normal power supply failure	A,V	Ditto
P	53.4.3, 51.1.1	Essential and important machinery parameters	A,V	Column 3, table 8.3 (machinery alarm)
S	42.5.3, 43.5.3	Emergency battery discharge	I	Column 3, table 8.1
P	52	Automatic shutdown of propulsion machinery	A,V	Column 3, table 8.3
P	52	Automatic propulsion shutdown override	I	Ditto
P	53.4.2	Automatic change-over of propulsion auxiliaries	A,V	Ditto
S	45.4.2	Electrical distribution system low insulation level	A or I	!, column 3, table 8.1
	SOLAS II-2			
P	5.3.3.2	Halon system electric circuit fault or power loss	A,V	Column 3, table 8.1
P	5.3.3.3	Halon system hydraulic or pneumatic pressure loss	A,V	Column 3, table 8.1
P	11.8, 14.2	Fire detection in automated or remotely controlled machinery space	A,V	Column 3, table 8.2
P	15.5.1	High-pressure fuel oil leakage	A,V	Column 3, table 8.3
P	15.5.3	Service fuel oil tank high temperature	A,V	Ditto
P	62.19.6	Inert gas system:	A,V	Column 3, table 8.1
	62.19.1.1	- low water pressure/flow		
	62.19.1.2	- high water level		
	62.19.1.3	- high gas temperature		
	62.19.1.4	- blower failure		
	62.19.1.5	- oxygen content		
	62.19.1.6	- power supply failure		
	62.19.1.7, 62.19.7	- water seal low level		
	62.19.1.8, 62.19.8	- low gas pressure		
	62.19.1.9	- high gas pressure		
	62.19.2	gas generator failure:		
	62.19.2.1	- low fuel supply		
	62.19.2.2	- power supply failure		
	62.19.2.3	- control power failure		
S	62.16.3.2	Inert gas O_2 content	MI	Ditto

Table 9.1.2 - *Location: machinery space/machinery control room* (cont.)

Priority	IMO Instrument	Function	Type	Notes
	Gas or chemical codes			
P	IGC 16.2.1.1 GC 16.2(a)	Loss of inert gas pressure between pipes	A,V	!, column 3, table 8.1
P	IGC 16.2.9 GC 16.10	Cargo gas/fuel system gas detection	A,V	!, Ditto
P	IGC 16.2.1.2 GC 16.2(b)	Flammable gas in ventilation duct	(A,V)	!, Ditto
P	IGC 16.2.4 GC 16.5	Flammable gas in ventilation casing	(A,V)	!, Ditto
	Resolution A.481(XII)			
P	Paragraph 7.3	Personnel alarm	A,V	Column 3, table 8.1

! No location specified in other IMO instruments. Location is recommended.

Table 9.1.3 - *Location: central fire control station where provided*

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-2			
EM	+ 5.3.4.3	Local automatic halon operation	A,V	
P	+ 5.3.3.8	Loss of halon container pressure	A,V	
P	+ 11.8, 14.2	Fire detection in automatic or unattended machinery space	A,V	
S	12.2.3	Automatic sprinkler system pressure	MI	
P	12.1.2, + 12.1.2.1 + 13.1.5, 13.1.6	Fire detection or automatic sprinkler operation	A,V	
P	12.1.2, + 12.1.2.1 13.1.2, + 13.1.5	Fire detection system fault	A,V	
P	+,**13-1.1.3	Smoke detection system power loss	A,V	
P	+,**13-1.1.6 +,**13-1.3.4	Smoke detection	A,V, I	

\+ May be omitted if provided on the navigating bridge.
** Applicable to ships constructed on or after 1 February 1992.

Table 9.1.4 - *Location: at the equipment or at the location being monitored*

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-1			
P	29.11	Rudder angle indicator	MI	
S	17.9.2.1, 17.9.3	Shell valve closure	I	
S	32.6	Water level of essential boiler	MI	
EM	15.9.1, **15.7.1.6	Watertight door closing	A	**Distinct from other alarms in area; in passen-ger areas and high noise areas, add intermittent visual alarm
P	**15.7.3.2	Watertight door loss of stored energy	A,V	At each local operating position
S	33.3	Steam pressure	MI	
	SOLAS II-2			
EM	5.3.4.3	Local automatic halon release	A,V	Outside each access to the protected space
EM	5.1.6, 63.1.1.1 IBC 11.2.1.2 BCH 3.13.3(b)	Release of fire-extinguishing medium	A	
P	5.3.3.8	Loss of halon container pressure	A,V	
S	12.2.3	Automatic sprinkler system pressure	MI	At each section stop valve
S	12.4.1	Automatic sprinkler system tank level	MI	
S	15.2.6	Fuel oil tank level	MI	If provided
S	**15.2.6.1.1	Oil tank level	MI	
S	**15.2.6.2			
S	62.5	Flue gas isolating valve open/closed	I	
S	62.15	Inert gas discharge temperature/pressure	MI	Measured at discharge of gas blower
	SOLAS IV			
S	15(e)	Condition of batteries	I	At radiotelephone station
	Gas or chemical codes			
P	IBC 19.4.5	High temperature on outside furnace surfaces of incinerator	(A,V) MI	!
P	IGC 9.5.1, GC 9.5.1	Content of oxygen in inert gas/trace of oxygen in nitrogen	(A,V) MI	!
S	IGC 3.6.3, GC 3.6.3	Warning on both sides of the airlock	A,V	
S	IGC 8.2.8.2 GC 8.2.8(b)	Indicates which one of the pressure relief valves is out of service	I	
EM	IGC 11.5.2 GC 11.5.2	Inerting/extinguishing medium release	A	Gas-dangerous enclosed spaces
S	IGC 13.4	Cargo pressure	MI	Local gauges required by 13.4.1, 13.4.2, 13.4.3 and 13.4.4
P	IGC 13.6, 17.9 GC 13.6, 17.11	Gas detection equipment	A,V	

** Applicable to ships constructed on or after 1 February 1992.
! No location specified in other IMO instruments. Location is recommended.

Table 9.1.5 - *Location: engineers' accommodation*

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-1			
P	38	Engineers' alarm	A	Column 4, table 8.3
P	51.1.2, 51.1.5	Fault requiring attention of the engineer on duty	A,V	Ditto (machinery alarm)
	SOLAS II-2			
P	11.8, 14.2	Fire detection in automated or remotely controlled machinery space	A,V	Ditto
	Resolution A.481(XII)			
P	Paragraph 7.3	Personnel alarm	A,V	Column 4, table 8.3 (when the navigating bridge is unmanned)

Table 9.1.6 - *Location: miscellaneous*

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-1			
P	15.6.5, **15.6.4	Watertight door position	I	At operating stations from which the door is not visible ** At all remote operating positions
S	21.2.12	Bilge cocks and valves position	I	At their place of operation
	SOLAS II-2			
P	12.1.2.2	Fire detection or automatic sprinkler operation	A,V	On cargo ships, alarm at attended location other than navigating bridge
P	11.8, 14.2	Fire detection in automated or unattended machinery space	A,V	Alarm at attended location when navigating bridge is unmanned
P	40.3, 13.1.6	Fire detection alarm	A,V	Alarm at location easily accessible to crew at all times
EM	40.4	Fire (special alarm to summon crew)	A	May be part of general emergency alarm
EM	13.1.4	Fire detection alarm not receiving attention	A	Alarmed to crew; may be part of general emergency alarm
P	59.3.3	Flammable vapour monitoring	MI	
	SOLAS III			
EM	6.4.2, 50	General emergency alarm	A	Throughout all the accommodation and normal crew working spaces
	SOLAS IV			
P	11(a)(vi), 18(a)	Radiotelegraph/radiotelephone alarm and failure of apparatus	A	In the radio room and radio officer cabin

**Applicable to ships constructed on or after 1 February 1992.

Table 9.1.7 - *Location: cargo control station*

Priority	IMO Instrument	Function	Type	Notes
	SOLAS II-2			
P	+ 59.1.6	Cargo tank high level alarm and gauging	A,I	!, if required
S	62.16.1.1, 62.16.2	Inner gas pressure	MI	
S	62.16.1.2, 62.16.2	Inert gas O_2 content	MI	
P	62.19.6	Inert gas system:	A,V	
	62.19.1.1	- low water pressure/flow		
	62.19.1.2	- high water level		
	62.19.1.3	- high gas temperature		
	62.19.1.4	- blower failure		
	62.19.1.5	- oxygen content		
	62.19.1.6	- power supply failure		
	62.19.1.7, 62.19.7	- water seal low level		
	62.19.1.8, 62.19.8	- low gas pressure		
	62.19.1.9	- high gas pressure		
	62.19.2	Gas generator failure:		
	62.19.2.1	- low fuel supply		
	62.19.2.2	- power supply failure		
	62.19.2.3	- control power failure		
	Gas or chemical codes			
P	IBC 8.1.2 BCH 2.13.1	High level of the liquid in any tank	A,V	!, (2)
S	IBC 15.10.2 BCH 4.3.1(b)	Failure of mechanical ventilation system for maintaining low gas concentration in cargo tanks	A,V	!, sulphur liquid
P	IBC 15.19.2 BCH 4.14.3	Power failure on any system essential for safe loading	A,V	!, (2)
P	IBC 15.19.6 BCH 4.14.1	High level alarm, cargo tank	A,V	!, (2)
S	IGC 13.2.1 GC 13.2.1	Cargo level	MI	(2)
P	IGC 13.4.1 GC 13.4.1	High and low pressure in cargo tank	(A,V), MI	(2)
P	IGC 13.6.4, 17.9 GC 13.6.4, 17.11	Gas detection equipment	A,V	(3)
P	IGC 17.18.4.4 GC 17.12.2(d)(iv)	Cargo high pressure, or high temperature at discharge of compressors	A,V	(2), methyl acetylene propadiene mixtures
S	IGC 10.2.2 GC 10.2.2	Shutdown of submerged cargo pumps	(A,V)	
P	IGC 17.14.4.3 GC 17.12.5(d)(iii)	Gas detecting system monitoring chlorine concentration	A,V	!, (3)
P	IGC 17.14.4.4 GC 17.12.5(d)(iv)	High pressure in cargo tanks (chlorine)	A, (V)	!, (2)
P	IGC 13.3.1 GC 13.3.1	High liquid level in cargo tank	A,V	!, (2)
S	IGC 13.5.1 GC 13.5.1	Cargo temperature	MI	!, (2)
P	IGC 13.5.2 GC 13.5.2	Hull or insulation temperature	MI, A, (V)	!
	Gas or chemical codes			
P	IGC 13.5.3 GC 13.5.3	Cargo tank temperature	MI	!, (2)
P	IGC 13.6.11 GC 13.6.11	Gas detection equipment	A,V, MI	!, (3)
P	IGC 17.14.1.4 GC 17.12.5(a)(iv)	Gas detection after bursting disk for chlorine	(A,V) MI	!, (2)
P	IBC 10.2.2.1	Shutdown of submerged cargo pumps	(A,V)	
P	IBC 15.7.10 BCH 4.5.10	High level of phosphorus	(A,V)	!, (2)
P	IBC 15.19.7.2 BCH 4.14.2(b)	Overflow alarm	A,V	!
P	IGC 5.2.1.7 GC 5.2.5(b)	Liquid cargo in the vent system	(A,V)	!, (2)
P	IGC 8.4.2.1 GC 8.4.2(a)	Vacuum protection of cargo tanks	(A,V)	!, (2)
P	IGC 9.5.2 GC 9.5.2	Inert gas pressure monitoring	(A,V)	!

! No location specified in other IMO instruments. Location is recommended.

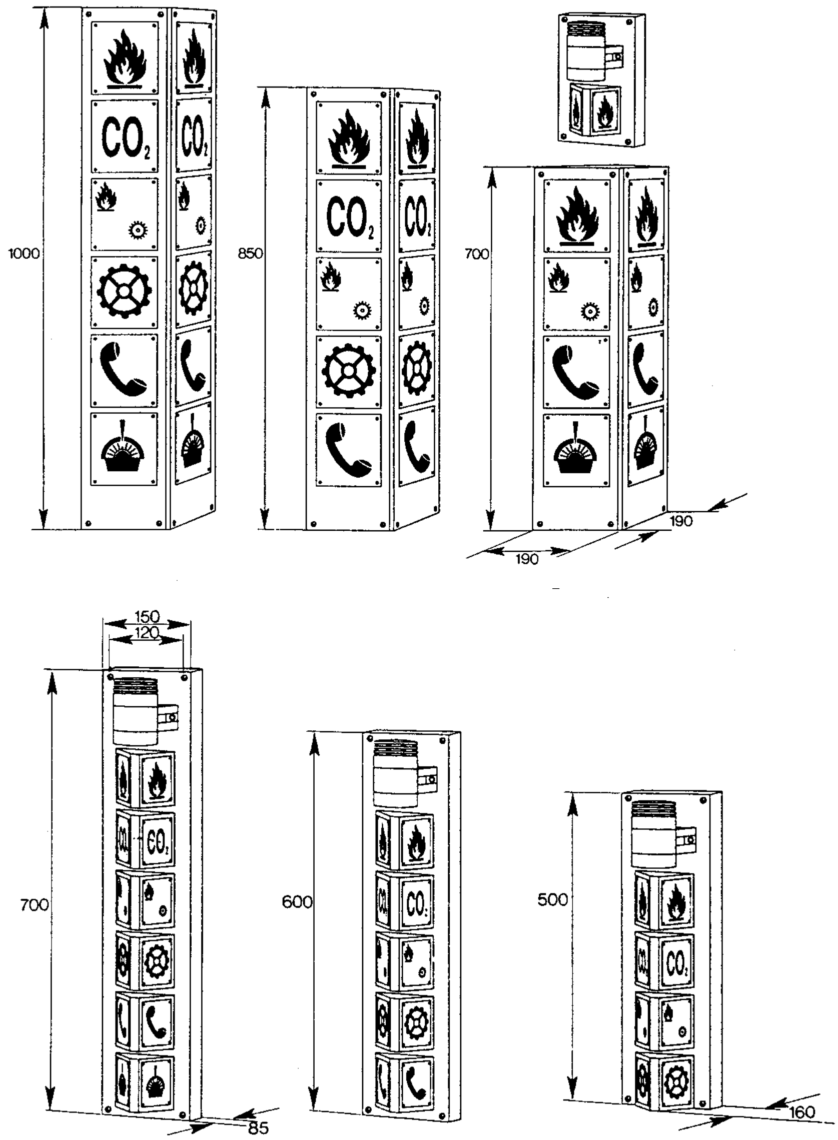
(2) and (3) See notes following paragraph 9.2.

Table 9.1.8 - *Location: not indicated by IMO instruments*

Priority	IMO Instrument	Function	Type	Notes
S	SOLAS II-1 8.7.3	Draught indicator	MI	Passenger ships only (if required). For details see regulation 8.7.3
P	Gas or chemical codes IBC 7.1.5 BCH 2.15.5(a)	Monitoring of cargo temperature	A,V MI	Alarm system only required if overheatingor overcooling could result in a dangerous condition
P	IBC 13.1.1 BCH 3.9	Cargo tank levels	MI	
P	IBC 15.7.7 BCH 4.5.7	High temperature of phosphorus	A,V	

Appendix

Samples of indicator columns with dimensions (mm)



Note: Diagrams above are representative only. Symbols should be as in tables 6.1.1-6.1.3.

RESOLUTION A.687(17)

Adopted on 6 November 1991

RECOMMENDATION ON FIRE TEST PROCEDURES FOR IGNITABILITY OF PRIMARY DECK COVERINGS

1 SCOPE

In accordance with the provisions of the International Convention for the Safety of Life at Sea, 1974, and subsequent amendments thereto, primary deck coverings, if applied within accommodation and service spaces and control stations, should be of approved materials which will not readily ignite, or give rise to toxic or explosive hazards at elevated temperatures. This Recommendation specifies a procedure for evaluating the ignitability of the primary deck coverings. Toxic and explosive hazards of the primary deck coverings should be verified to the satisfaction of the Administration.

2 FIELD OF APPLICATION

2.1 Taking into account the wide range of materials used as coverings and their application, this Recommendation should be applied to those deck coverings which are laid upon a steel deck plate and beneath a surface material, if applied, of the floor. However, thin films such as paints may be exempted from consideration.

2.2 If a deck covering applied on a steel deck plate is exposed and no other floor covering is provided, the deck coverings in areas where low flame spread materials are required should meet the requirement of floor coverings specified in the Recommendation on improved fire test procedures for surface flammability of bulkhead, ceiling and deck finish materials, adopted by the Organization by resolution A.653(16).

2.3 If the deck covering has a multilayer construction, the Administration may require the tests to be conducted for each layer or for combinations of some layers of the deck covering.

3 TEST PROCEDURE

The deck covering should be tested in accordance with the Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling and Deck Finish Materials, adopted by the Organization by resolution A.653(16), and additional provisions given below.

3.1 Specimen

The deck covering should be applied to a steel plate having the thickness of 3 ± 0.3 mm. The specimens should have a nominal thickness and the components and construction of the deck covering should be the same as those used in practice.

3.2 Classification

The deck covering is classified as not readily ignitable if it fulfils the requirements of floor coverings specified in paragraph 10 of the annex to Assembly resolution A.653(16) and does not produce burning droplets.

RESOLUTION A.691(17)

Adopted on 6 November 1991

SAFETY INSTRUCTIONS TO PASSENGERS

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 requirements of regulations III/18.3.2 and III/18.3.3 of the International Convention for the Safety of Life at Sea, 1974, as amended in 1983 (SOLAS), to draw the attention of passengers to the emergency instructions required by regulations III/8.2 and III/8.4 thereof, if a muster is not held,

CONSIDERING the need to provide emergency instructions to passengers so that they are aware of the essential actions that they should take in an emergency,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its fifty-ninth session,

1. *RECOMMENDS* that, if a muster is not held on departure of a passenger ship at the commencement of the voyage immediately after sailing, the attention of passengers be drawn to the emergency instructions required by SOLAS regulations III/8.2 and III/8.4 by means of an announcement, in appropriate languages, on the ship's public address system or by other suitable means;

2. *INVITES* the Maritime Safety Committee to prepare and adopt guidelines on the method of briefing and content of the safety instructions passengers should be given with regard to the essential actions they should take in any emergency and to circulate them to Governments;

3. *INVITES* Governments, in implementing this resolution, to take account of the recommendations to be made by the Maritime Safety Committee in the guidelines referred to in paragraph 2 above.

RESOLUTION A.749(18)

Adopted on 4 November 1993

CODE ON INTACT STABILITY FOR All TYPES OF SHIPS COVERED BY IMO INSTRUMENTS

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Code on intact stability for all types of ships covered by IMO instruments

PREAMBLE

1 This Code has been assembled to provide, in a single document, recommended provisions relating to intact stability, based primarily on existing IMO instruments. Where recommendations in this Code appear to differ from other IMO Codes, such as the MODU Code or DSC Code, the other Codes should be taken as the prevailing instrument. For the sake of completeness and for the convenience of the user, this Code also contains relevant provisions from mandatory IMO instruments. Such requirements have been identified with an asterisk. However, in all cases, the authoritative text for requirements in contained in the mandatory instruments.

2 Criteria included in the Code are based on the best "state of art" concepts taking into account sound design and engineering principles and experience gained from operating such ships. Furthermore, design technology for modern ships is rapidly evolving and the Code should not remain static but be re-evaluated and revised, as necessary. To this end, the Organization will periodically review the Code, taking into consideration both experience and further development.

3 Throughout the development of the Code it was recognized that, in view of a wide variety of types, sizes of ships and their operating and environmental conditions, problems of safety against accidents related to stability have generally not yet been solved. In particular, the safety of a ship in a seaway involves complex hydrodynamic phenomena which up to now have not been adequately investigated and understood. Ships in a seaway should be treated as a dynamical system and relationships between ship and environmental conditions like wave and wind excitations are recognized as extremely important elements. It is recognized that development of stability criteria, based on hydrodynamic aspects and stability analysis of a ship in a seaway, poses, at present, complex problems which require further research.

CHAPTER I - GENERAL

1.1 Purpose

The purpose of the Code on Intact Stability for All Types of Ships Covered by IMO Instruments, hereinafter referred to as the Code, is to recommend stability criteria and other measures for ensuring the safe operation of all ships to minimize the risk to such ships, to the personnel on board and to the environment.

1.2 Application

1.2.1 This Code contains intact stability criteria for the following types of ships and other marine vehicles of 24 m in length and above unless otherwise stated:

- cargo ships
- cargo ships carrying timber deck cargo
- cargo ships carrying grain in bulk
- passenger ships
- fishing vessels
- special purpose ships
- offshore supply vessels
- mobile offshore drilling units
- pontoons
- dynamically supported craft
- containerships

1.2.2 The coastal State may impose additional requirements regarding the design aspects of ships of novel design or ships not otherwise covered by the Code.

1.3 Definitions

For the purpose of this Code the definitions given hereunder apply. For terms used, but not defined in this Code, the definitions as given in the 1974 SOLAS Convention apply.

1.3.1 *Administration* means the Government of the State whose flag the ship is entitled to fly.

1.3.2 A *passenger ship* is a ship which carries more than twelve passengers as defined in regulation 1/2 of the 1974 SOLAS Convention, as amended.

1.3.3 A *cargo ship* is any ship which is not a passenger ship.

1.3.4 A *fishing vessel* is a vessel used for catching fish, whales, seals, walrus or other living resources of the sea.

1.3.5 A *special purpose ship* means a mechanically self-propelled ship which, by reason of its function, carries on board more than 12 special personnel as defined in paragraph 1.3.3 of the IMO Code of Safety for Special Purpose Ships (resolution A.534(13)) including passengers (ships engaged in research, expeditions and survey; ships for training of marine personnel; whale and fish factory ships not engaged in catching; ships processing other living resources of the sea, not engaged in catching or other ships with design features and modes of operation similar to ships mentioned above which, in the opinion of the Administration, may be referred to this group).

1.3.6 An *offshore supply vessel* means a vessel which is engaged primarily in the transport of stores, materials and equipment to offshore installations and designed with accommodation and bridge erections in the forward part of the vessel and an exposed cargo deck in the after part for the handling of cargo at sea.

1.3.7 A *mobile offshore drilling unit (MODU)* or *unit* is a ship capable of engaging in drilling operations for the exploration or exploitation of resources beneath the sea-bed such as liquid or gaseous hydrocarbons, sulphur or salt:

.1 a *column-stabilized* unit is a unit with the main deck connected to the underwater hull or footings by columns or caissons;

.2 a *surface unit* is a unit with a ship- or barge-type displacement hull of single or multiple hull construction intended for operation in the floating condition;

.3 a *self-elevating* unit is a unit with movable legs capable of raising its hull above the surface of the sea.

1.3.8 A *dynamically supported craft (DSC)* is a craft which is operable on or above water and which has characteristics so different from those of conventional displacement ships, to which the existing international conventions, particularly SOLAS and Load Line, apply, that alternative measures should be used in order to achieve an equivalent level of safety. Within the aforementioned generality, a craft which complies with either of the following characteristics would be considered a DSC:

.1 if the weight, or a significant part thereof, is balanced in one mode of operation by other than hydrostatic forces;

.2 if the craft is able to operate at speeds such that the Froude number is equal to or greater than 0,9.

1.3.9 An *air-cushion vehicle* is a craft such that the whole or a significant part of its weight can be supported, whether at rest or in motion, by a continuously generated cushion of air dependent for its effectiveness on the proximity of the surface over which the craft operates.

1.3.10 A *hydrofoil* boat is a craft which is supported above the water surface in normal operating conditions by hydrodynamic forces generated on foils.

1.3.11 A *side-wall craft* is an air-cushion vehicle whose walls extending along the sides are permanently immersed bard structures.

1.3.12 A *containership* means a ship which is used primarily for the transport of marine containers.

Note: When the revision of the Intact Stability Code is undertaken, the standards for dynamically supported craft will be replaced by the provisions of the High Speed Craft (HSC) Code currently under development.

1.3.13 *Freeboard* is the distance between the assigned load line and freeboard deck.[25]

CHAPTER 2 - GENERAL PROVISIONS AGAINST CAPSIZING AND INFORMATION FOR THE MASTER

2.1 Stability booklet

2.1.1 Stability data and associated plans should be drawn up in the official language or languages of the issuing country and the language of the master if the languages used are neither English nor French the text should include a translation into one of these languages.

2.1.2* Each ship should be provided with a stability booklet, approved by the Administration, which contains sufficient information to enable the master to operate the ship in compliance with the applicable requirements contained in the Code. On a mobile offshore drilling unit, the stability booklet is referred to as an operating manual.[26]

2.1.3 The format of the stability booklet, consideration should be given to including the following and operation. In developing the stability information:

- **.1** a general description of the ship;
- **.2** instructions on the use of the booklet;
- **.3** general arrangement plans showing watertight compartments, closures, vents, downflooding angles, permanent ballast, allowable deck loadings and freeboard diagrams;
- **.4** hydrostatic curves or tables and cross curves of stability calculated on a free-trimming basis, for the ranges of displacement and trim anticipated in normal operating conditions;
- **.5** capacity plan or tables showing capacities and centres of gravity for each cargo stowage space;
- **.6** tank sounding tables showing capacities, centres of gravity, and free surface data for each tank;
- **.7** information on loading restrictions, such as maximum KG or minimum GM curve or table that can be used to determine compliance with the applicable stability criteria;
- **.8** standard operating conditions and examples for developing other acceptable loading conditions using the information contained in the stability booklet;

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[25] For the purposes of application of chapters I and II of the 1966 LL Convention to open-top containerships, ”freeboard deck” is the freeboard deck according to the 1966 LL Convention as if hatch covers are fitted on top of the hatch cargo coamings.

[26] Refer to regulation II-1/22 of the 1974 SOLAS Convention, as amended, regulation 10 of the 1966 LL Convention and the 1988 LL Protocol and regulation III/10 of the 1993 Torremolinos Protocol.

.9 a brief description of the stability calculations done, including assumptions;

.10 general precautions for preventing unintentional flooding;

.11 information concerning the use of any special cross-flooding fittings with descriptions of damage conditions which may require cross-flooding;

.12 any other necessary guidance for the safe operation of the ship under normal and emergency conditions;

.13 a table of contents and index for each booklet;

.14 inclining test report for the ship, or:

.14.1 where the stability data are based on a sister ship, the inclining test report of that sister ship along with the light-ship measurement report for the ship in question; or

.14.2 where light-ship particulars are determined by other methods than from inclining of the ship or its sister, a summary of the method used to determine those particulars;

.15 recommendation for determination of ship's stability by means of an in-service inclining test.

2.1.4 As an alternative to the stability booklet mentioned in 2.1.2 a simplified booklet in an approved form containing sufficient information to enable the master to operate the ship in compliance with the applicable provisions of the Code may be provided at the discretion of the authority concerned

2.1.5 As a supplement to the approved stability booklet, a loading computer may be used to facilitate the stability calculations mentioned in paragraph 2.1.3.9.

2.1.6 It is desirable that the input/output form in the computer and screen presentation be similar to the one in the stability booklet so that the operators will easily gain familiarity with the use of the stability booklet.

2.1.7 A simple and straightforward instruction manual, written as per sound marine practice and in a language common to all officers, should be provided with the loading computer.

2.1.8 In order to validate the proper functioning of the computer program, four loading conditions taken from the stability booklet (final) should be run in the computer periodically and the print-outs should be maintained on board as check conditions for future reference.

2.2 Operating booklets for certain ships

Special purpose ships, dynamically supported craft and novel craft should be provided with additional information in the stability booklet such as design limitations, maximum speed, worst intended weather conditions or other information regarding the handling of the craft that the master needs to operate the ship safely.

2.3 General precautions against capsizing

2.3.1 Compliance with the stability criteria does not ensure immunity against capsizing, regardless of the circumstances, or absolve the master from his responsibilities. Masters should therefore exercise prudence and good seamanship, having regard to the season of the year, weather forecasts and the navigational zone, and should take the appropriate action as to speed and course warranted by the prevaiIing circumstances.

2.3.2 Care should be taken that the cargo allocated to the ship is capable of being stowed so that compliance with the criteria can be achieved. If necessary, the amount should be limited to the extent that ballast weight may be required.

2.3.3 Before a voyage commences, care should be taken to ensure that the cargo and sizeable pieces of equipment have been properly stowed or lashed so as to minimize the possibility of both longitudinal and lateral shifting, while at sea, under the effect of acceleration caused by rolling and pitching.

2.3.4 A ship, when engaged in towing operations, should not carry deck cargo, except that a limited amount, properly secured, which would neither endanger the safe working of the crew on deck nor impede the proper functioning of the towing equipment, may be accepted.

2.3.5 The number of partially filled or slack tanks should be kept to a minimum because of their adverse effect on stability.

2.3.6 The stability criteria contained in chapter 3 set minimum values, but no maximum values are recommended. It is advisable to avoid excessive values of metacentric height, since these might lead to acceleration forces which could be prejudicial to the ship, its complement, its equipment and to safe carriage of the cargo.

2.3.7 Regard should be paid to the possible adverse effects on stability where certain bulk cargoes are carried. In this connection, attention should be paid to the IMO Code of Safe Practice for Solid Bulk Cargoes.

2.4 Fixed ballast

If used, fixed ballast should be installed under the supervision of the Administration and in a manner that prevents shifting of position. Fixed ballast should not be removed from the ship or relocated within the ship without the approval of the Administration.

2.5 Operational procedures related to weather conditions

2.5.1 All doorways and other openings through which water can enter into the hull or deck-houses, forecastle, etc., should be suitably closed in adverse weather conditions and accordingly all appliances for this purpose should be maintained on board and in good condition.

2.5.2 Weathertight and watertight hatches, doors, etc., should be kept closed during navigation, except when necessarily opened for the working of the ship, and should always be ready for immediate closure and be clearly marked to indicate that these fittings are to be kept closed except for access. Hatch covers and flush deck scuttles in fishing vessels should be kept properly secured when not in use during fishing operations. All portable deadlights should be maintained in good condition and securely closed in bad weather.

2.5.3 Any closing devices provided for vent pipes to fuel tanks should be secured in bad weather.

2.5.4 Fish should never be carried in bulk without first being sure that the portable divisions in the holds are properly installed.

2.5.5 Reliance on automatic steering may be dangerous as this prevents ready changes to course which may be needed in bad weather.

2.5.6 In all conditions of loading, necessary care should be taken to maintain a seaworthy freeboard.

2.5.7 In severe weather, the speed of the ship should be reduced if excessive rolling, propeller emergence, shipping of water on deck or heavy slamming occurs. Six heavy slammings or 25 propeller emergences during 100 pitching motions should be considered dangerous.

2.5.8 Special attention should be paid when a ship is sailing in following or quartering seas because dangerous phenomena such as parametric resonance, broaching to, reduction of stability on the wave crest, and excessive rolling may occur singularly in sequence or simultaneously in a multiple combination, creating a threat of capsize. Particularly dangerous is the situation when the wave length is of the order of 1.0 to 1.5 ship's length. A ship's speed and, /or course should be altered appropriately to avoid the above-mentioned phenomena.

2.5.9 Water trapping in deck wells should be avoided. If freeing ports are not sufficient for the drainage of the well, the speed of the ship should be reduced or the course changed, or both. Freeing ports provided with closing appliances should always be capable of functioning and are not to be locked.

2.5.10 Masters should be aware that steep or breaking waves may occur in certain areas, or in certain wind and current combinations (river estuaries, shallow water areas, funnel-shaped bays, etc.). These waves are particularly dangerous, especially for small ships.

2.5.11 Use of operational guidelines for avoiding dangerous situations in severe weather conditions or an on-board computer-based system is recommended. The method should be simple to use.

2.5.12 Dynamically supported craft should not be intentionally operated outside the worst intended conditions and limitations specified in the Dynamically Supported Craft Permit to Operate, in the Dynamically Supported Craft Construction and Equipment Certificate, or in documents referred to therein.

CHAPTER 3 - DESIGN CRITERIA APPLICABLE TO All SHIPS

3.1 General intact stability criteria for all ships

3.1.1 *Scope*

The following criteria are recommended for passenger and cargo ships.

3.1.2 *Recommended general criteria*

3.1.2.1 The area under the righting lever curve (GZ curve) should not be less than 0.055 metre-radian up to $\theta = 30°$ angle of heel and not less than 0.09 metre-radian up to $\theta = 40°$ or the angle of flooding θ_f[27] if this angle is less than 40°. Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40° or between 30° and θ_f, if this angle is less than 40% should not be less than 0.03 metre-radian.

3.1.2.2 The righting lever GZ should be at least 0.20 m at an angle of heel equal to or greater than 30°.

3.1.2.3 The maximum righting arm should occur at an angle of heel preferably exceeding 30° but not less than 25°.

3.1.2.4 The initial metacentric height GM_o should not be less than 0.15 m

3.1.2.5 In addition, for passenger ships, the angle of heel on account of crowding of passengers to one side as defined in paragraphs 3.5.2.6 to 3.5.2.9 should not exceed 10°.

3.1.2.6 In addition, for passenger ships, the angle of heel on account of turning should not exceed 10° when calculated using the following formula:

$$M_R = 0.02 \frac{V_o{}^2}{L} (KG - \frac{d}{2})$$

M_R = heeling moment (m-t)
V_o = service speed (m/s)
L = length of ship at waterline (m)
Δ = desplacement (t)
d = mean draught (m)
KG = heigth of centre of gravity above keel (m)

3.1.2.7 Where anti-rolling devices are installed in a ship, the Administration should be satisfied that the above criteria can be maintained when the devices are in operation.

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[27] θ_f is an angle of heel at which openings in the hull, superstructures or deck-houses which cannot be closed weathertight immerse. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

3.1.2.8 A number of influences, such as beam wind on ships with large windage area, icing of topsides, water trapped on deck, rolling characteristics, following seas, etc., adversely affect stability and the Administration is advised to take these into account, so far as is deemed necessary.

3.1.2.9 Provisions should be made for a safe margin of stability at all stages of the voyage, regard being given to additions of weight, such as those due to absorption of water and icing (details regarding ice accretion are given in chapter 5), and to losses of weight, such as those due to consumption of fuel and stores.

3.1.2.10 For ships carrying oil-based pollutants in bulk, the Administration should be satisfied that the criteria given in 3.1.2 can be maintained during all loading and ballasting operations.

3.1.2.11 See also general recommendations of an operational nature given in section 2.5 above.

3.2 Severe wind and rolling criterion (weather criterion)

3.2.1 *Scope*

This criterion supplements the stability criteria given in section 3.1. The more stringent criteria of section 3.1 given above and the weather criterion should govern the minimum requirements for passenger or cargo ships of 24 m in length and over.

3.2.2 *Recommended weather criterion*

3.2.2.1 The ability of a ship to withstand the combined effects of beam wind and rolling should be demonstrated for each standard condition of loading, with reference to figure 3.2.2.1 as follows:

.1 the ship is subjected to a steady wind pressure acting perpendicular to the ship's centreline which results in a steady wind heeling lever (l_{W1}).

.2 from the resultant angle of equilibrium (θ_O), the ship is assumed to roll owing to wave action to an angle of roll (θ_1) to windward. Attention should be paid to the effect of steady wind so that excessive resultant angles of heel are avoided;[28]

.3 the ship is then subjected to a gust wind pressure which results in a gust wind heeling lever (l_{W2});

.4 under these circumstances, area *b* should be equal to or greater than area a;

[28] The angle of heel under action of steady wind (θ_o) should be limited to a certain angle to the satisfaction of the Administration. As a guide, 16° or 80 % of the angle of deck edge immersion, whichever is less, is suggested.

.5 free surface effects (section 3.3) should be accounted for in the standard conditions of loading as set out in section 3.5.

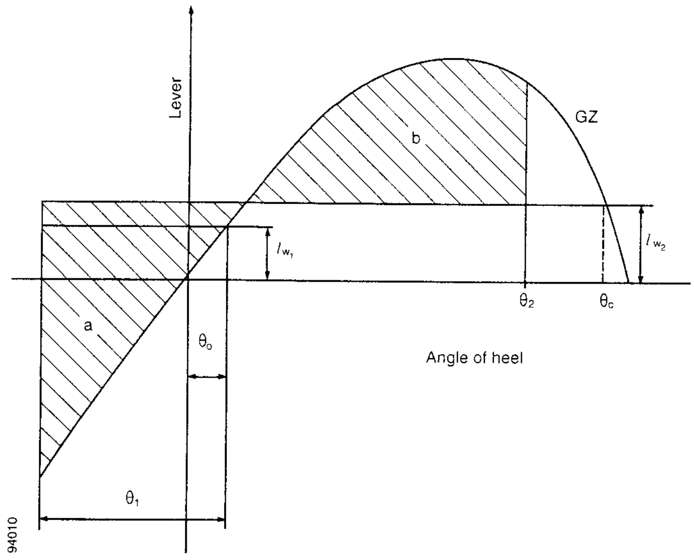

Figure 3.2.2.1 - *Severe wind and rolling*

The angles in figure 3.2.2.1 are defined as follows:

θ_o = angle of heel under action of steady wind (see 3.2.2.1.2 and footnote)

θ_1 = angle of roll to windward due to wave action

θ_2 = angle of downflooding (θ_f) or 50° or $\theta_{c,}$ whichever is less:

where:

θ_f = angle of heel at which openings in the hull, superstructures of deck-houses which cannot be closed weathertight immerse. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

θ_c = angle of second intercept between wind heeling lever (l_{w2}) and GZ curves.

3.2.2.2 The wind heeling levers (l_{w1}) and (l_{w2}) referred to in 3.2.2.1.1 and 3.2.2.1.3 are constant values at all angles of inclination and should be calculated as follows:

$$l_{W1} = \frac{PAZ}{1000 g\Delta} \text{ (m) and}$$

l_{w2} = $1{,}5 l_{w1}$ (m)

where:

P = 504 N/m^2. The value of P used for ships in restricted service may be reduced, subject to the approval of the Administration;

A = projected lateral area of the portion of the ship and deck cargo above the waterline (m^2),

Z = vertical distance from the centre of A to the centre of the underwater lateral area or approximately to a point at one half the draught (m);

Δ = displacement (t)

g = 9.81 m/s^2

3.2.2.3 The angle of roll (θ_1)[29] referred to in 3.2.2.1.2 should be calculated as follows:

$$\theta_1 = 109 k X_1 X_2 \sqrt{rs} \text{ (degrees)}$$

where:

X_1 = factor as shown in table 3.2.2.3-1

X_2 = factor as shown in table 3.2.2.3-2

k = factor as follows:

- k = 1.0 for a round-bilged ship having no bilge or bar keels
- k = 0.7 for a ship having sharp bilges
- k = as shown in table 3.2.2.3-3 for a ship having bilge keels, a bar keel or both

r = 0.73 ± 0.6 OG/d

with: OG = distance between the centre of gravity and the waterline (m) (+ if the centre of gravity is above the waterline, - if it is below)

d = mean moulded draught of the ship (m)

s = factor as shown in table 3.2.2.3-4

[29] The angle of roll for ships with anti-rolling devices should be determined without taking into account the operation of these devices.

Table 3.2.2.3-1 – *Values of factor* X_1

B/d	X_1
≤2.4	1.0
2.5	0.98
2.6	0.96
2.7	0.95
2.8	0.93
2.9	0.91
3.0	0.90
3.1	0.88
3.2	0.86
3.4	0.82
≥3.5	0.80

Table 3.2.2.3-2 *Values of factor* X_2

C_B	X_2
≤0.45	0.75
0.50	0.82
0.55	0.89
0.60	0.95
0.65	0.97
≥0.70	1.0

Table 3.2.2.3-3 – *Values of factor k*

$\frac{A_k \, x \, 100}{L \, x \, B}$	k
0	1.0
1.0	0.98
1.5	0.95
2.0	0.88
2.5	0.79
3.0	0.74
3.5	0.72
≥4.0	0.70

Table 3.2.2.3-4 *Values of factor s*

T	s
≤6	0.100
7	0.098
8	0.093
12	0.065
14	0.053
16	0.044
18	0.038
≥20	0.035

(Intermediate values in these tables should be obtained by linear interpolation)

Rolling period $T = \frac{2CB}{\sqrt{GM}}$ (s)

where: C = 0.373 + 0.023 (*B/d*) – 0.043 (*L*/100).

The symbols in the above tables and formula for the rolling period are defined as follows:

L = waterline length of the ship (m)

B = moulded breadth of the ship (m)

d = mean moulded draught of the ship (m)

C_B = block coefficient

A_k = total overall area of bilge keels, or area of the lateral projection of the bar keel, or sum of these areas (m^2)

GM = metacentric height corrected for free surface effect (m).

3.3 Effect of free surfaces of liquids in tanks

For all conditions, the initial metacentric height and the stability curves should be corrected for the effect of free surfaces of liquids in tanks in accordance with the following assumptions.

3.3.1 Tanks which are taken into consideration when determining the effect of liquids on the stability at all angles of inclination should include single tanks or combinations of tanks for each kind of liquid (including those for water ballast) which according to the service conditions can simultaneously have free surfaces.

3.3.2 For the purpose of determining this free surface correction, the tanks assumed slack should be those which develop the greatest free surface moment, $M_{f.s.}$, at a 30° inclination when in the 50% full condition.

3.3.3 The values of $M_{f.s.}$ for each tank may be derived from the formula:

$$M_{f.s.} = vb\gamma k\sqrt{\delta}$$

where:

$M_{f.s.}$ is the free surface moment at any inclination (m-t)

v is the tank total capacity (m^3)

b is the tank maximum breadth (m)

γ is the specific weight of liquid in the tank (t/m^3)

δ is equal to $\frac{v}{blh}$ (the tank block coefficient)

h is the tank maximum height (m)

l is the tank maximum length (m)

k is the dimensionless coefficient to be determined from table 3.3.3 according to the ratio b/h. The intermediate values are determined by interpolation.

3.3.4 Small tanks, which satisfy the following condition using the value of k corresponding to the angle of inclination of 30°, need not be included in computation:

$$\frac{vb\gamma k\sqrt{\delta}}{\Delta_{\min}} < 0.01 \text{ m}$$

where:

Δ_{min} = minimum ship displacement in tonnes.

3.3.5 The usual remainder of liquids in the empty tanks is not taken into account in computation.

3.4 Assessment of compliance with stability criteria

3.4.1 For the purpose of assessing in general whether the stability criteria are met, stability curves should be drawn for the main loading conditions intended by the owner in respect of the ship's operations.

3.4.2 If the owner of the ship does not supply sufficiently detailed information regarding such loading conditions, calculations should be made for the standard loading conditions.

Table 3.3.3 - *Values for coefficient k for calculating free surface corrections*

$$k = \frac{\sin\theta}{12}\left(1+\frac{\tan^2\theta}{2}\right)\ x\ b/h$$

where cot $\theta \geq b/h$

$$k = \frac{\cos\theta}{8}\left(1+\frac{\tan\theta}{b/h}\right) - \frac{\cos\theta}{12(b/h)^2}\left(1+\frac{\cot^2\theta}{2}\right)$$

where cot $\theta \leq b/h$

θ / *b/h*	5°	10°	15°	20°	30°	40°	45°	50°	60°	70°	75°	80°	90°	θ / *b/h*
20	0.11	0.12	0.12	0.12	0.11	0.10	0.09	0.09	0.07	0.05	0.04	0.03	0.01	20
10	0.07	0.11	0.12	0.12	0.11	0.10	0.10	0.09	0.07	0.05	0.04	0.03	0.01	10
5	0.04	0.07	0.10	0.11	0.11	0.11	0.10	0.10	0.08	0.07	0.06	0.05	0.03	5
3	0.02	0.04	0.07	0.09	0.11	0.11	0.11	0.10	0.09	0.08	0.07	0.06	0.04	3
2	0.01	0.03	0.04	0.06	0.09	0.11	0.11	0.11	0.10	0.09	0.09	0.08	0.06	2
1.5	0.01	0.02	0.03	0.05	0.07	0.10	0.11	0.11	0.11	0.11	0.10	0.10	0.08	1.5
1	0.01	0.01	0.02	0.03	0.05	0.07	0.09	0.10	0.12	0.13	0.13	0.13	0.13	1
0.75	0.01	0.01	0.02	0.02	0.04	0.05	0.07	0.08	0.12	0.15	0.16	0.16	0.17	0.75
0.5	0.00	0.01	0.01	0.02	0.02	0.04	0.04	0.05	0.09	0.16	0.18	0.21	0.25	0.5
0.3	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.03	0.05	0.11	0.19	0.27	0.42	0.3
0.2	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.04	0.07	0.13	0.27	0.63	0.2
0.1	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.04	0.06	0.14	1.25	0.1

3.5 Standard loading conditions to be examined

3.5.1 *Loading conditions*

The standard loading conditions referred to in the text of the present Code are as follows:

3.5.1.1 For a passenger ship:

.1 ship in the fully loaded departure condition with full stores and fuel and with the full number of passengers with their luggage;

.2 ship in the fully loaded arrival condition, with the full number of passengers and their luggage but with only 10% stores and fuel remaining;

.3 ship without cargo, but with full stores and fuel and the full number of passengers and their luggage;

.4 ship in the same condition as at .3 above with only 10% stores and fuel remaining.

3.5.1.2 For a cargo ship:

.1 ship in the fully loaded departure condition, with cargo homogeneously distributed throughout all cargo spaces and with full stores and fuel;

.2 ship in the fully loaded arrival condition with cargo homogeneously distributed throughout all cargo spaces and with 10% stores and fuel remaining;

.3 ship in ballast in the departure condition, without cargo but with full stores and fuel;

.4 ship in ballast in the arrival condition, without cargo and with 10% stores and fuel remaining.

3.5.1.3 For a cargo ship intended to carry deck cargoes:

.1 ship in the fully loaded departure condition with cargo homogeneously distributed in the holds and with cargo specified in extension and weight on deck, with full stores and fuel;

.2 ship in the fully loaded arrival condition with cargo homogeneously distributed in holds and with a cargo specified in extension and weight on deck, with 10% stores and fuel.

3.5.2 *Assumptions for calculating loading conditions*

3.5.2.1 For the fully loaded conditions mentioned in 3.5.1.2.1, 3.5.1.2.2, 3.5.1.3.1 and 3.5.1.3.2, if a dry cargo ship has tanks for liquid cargo, the effective deadweight in the loading conditions therein described should be distributed according to two assumptions, i.e. with cargo tanks full and with cargo tanks empty.

3.5.2.2 In the conditions mentioned in 3.5.1.1.1, 3.5.1.2.1 and 3.5.1.3.1 it should be assumed that the ship is loaded to its subdivision load line or summer load line or, if intended to carry a timber deck cargo, to the summer timber load line with water ballast tanks empty.

3.5.2.3 If in any loading condition water ballast is necessary, additional diagrams should be calculated taking into account the water ballast. Its quantity and disposition should be stated.

3.5.2.4 In all cases, the cargo in holds is assumed to be fully homogeneous unless this condition is inconsistent with the practical service of the ship.

3.5.2.5 In all cases, when deck cargo is carried, a realistic stowage weight should be assumed and stated, including the height of the cargo.

3.5.2.6 A weight of 75 kg should be assumed for each passenger except that this value may be reduced to not less than 60 kg where this can be justified. In addition, the weight and distribution of the luggage should be determined by the Administration.

3.5.2.7 The height of the centre of gravity for passengers should be assumed equal to:

- **.1** 1.0 m above deck level for passengers standing upright. Account may be taken, if necessary, of camber and sheer of deck;
- **.2** 0.30 m above the seat in respect of seated passengers.

3.5.2.8 Passengers and luggage should be considered to be in the spaces normally at their disposal when assessing compliance with the criteria given in 3.1.2.1 to 3.1.2.4.

3.5.2.9 Passengers without luggage should be considered as distributed to produce the most unfavourable combination of passenger heeling moment and/or initial metacentric height which may be obtained in practice when assessing compliance with the criteria given in 3.1.2.5 and 3.1.2.6, respectively. In this connection, it is anticipated that a value higher than four persons per square metre will not be necessary.

3.6 Calculation of stability curves

3.6.1 *General*

3.6.1.1 Hydrostatic and stability curves should normally be prepared on a designed trim basis. However, where the operating trim or the form and arrangement of the ship are such that change in trim has an appreciable effect on righting arms, such change in trim should be taken into account.

3.6.1.2 The calculations should take into account the volume to the upper surface of the deck sheathing. In the case of wood ships, the dimensions should be taken to the outside of the hull planking.

3.6.2 *Superstructures, deck-houses, etc. which may be taken into account*

3.6.2.1 Enclosed superstructures complying with regulation 3(10)(b) of the 1966 Load Line Convention may be taken into account.

3.6.2.2 The second tier of similarly enclosed superstructures may also be taken into account.

3.6.2.3 Deck-houses on the freeboard deck may be taken into account, provided that they comply with the conditions for enclosed superstructures laid down in regulation 3(10)(b) of the 1966 Load Line Convention.

3.6.2.4 Where deck-houses comply with the above conditions, except that no additional exit is provided to a deck above, such deck-houses should not be taken into account; however, any deck openings inside such deck-houses should be considered as closed even where no means of closure are provided.

3.6.2.5 Deck-houses the doors of which do not comply with the requirements of regulation 12 of the 1966 Load Line Convention should not be taken into account; however, any deck openings inside the deck-house are regarded as closed where their means of closure comply with the requirements of regulations 15, 17 or 18 of the 1966 Load Line Convention.

3.6.2.6 Deck-houses on decks above the freeboard deck should not be taken into account, but openings within them may be regarded as closed.

3.6.2.7 Superstructures and deck-houses not regarded as enclosed can, however, be taken into account in stability calculations up to the angle at which their openings are flooded (at this angle, the static stability curve should show one or more steps, and in subsequent computations the flooded space should be considered non-existent).

3.6.2.8 In cases where the ship would sink due to flooding through any openings, the stability curve should be cut short at the corresponding angle of flooding and the ship should be considered to have entirely lost its stability.

3.6.2.9 Small openings such as those for passing wires or chains, tackle and anchors, and also holes of scuppers, discharge and sanitary pipes should not be considered as open if they submerge at an angle of inclination more than 30°. If they submerge at an angle of 30° or less, these openings should be assumed open if the Administration considers this to be a source of significant flooding.

3.6.2.10 Trunks may be taken into account. Hatchways may also be taken into account, having regard to the effectiveness of their closures.

CHAPTER 4 - SPECIAL CRITERIA FOR CERTAIN TYPES OF SHIPS

4.1 Cargo ships carrying timber deck cargoes

4.1.1 *Scope*

The provisions given hereunder apply to all ships of 24 m in length and over engaged in the carriage of timber deck cargoes. Ships that are provided with and make use of their timber load line should also comply with the requirements of regulations 41 to 45 of the Load Line Convention.

4.1.2 *Definitions*

The following definitions apply for the purposes of the present section:

.1 *timber* means sawn wood or lumber, cants, logs, poles, pulpwood and all other types of timber in loose or packaged forms. The term does not include wood pulp or similar cargo;

.2 *timber deck cargo* means a cargo of timber carried on an uncovered part of a freeboard or superstructure deck. The term does not include wood pulp or similar cargo;[30]

.3 *timber load line* means a special load line assigned to ships complying with certain conditions related to their construction set out in the International Convention on Load Lines and used when the cargo complies with the stowage and securing conditions of the Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 1991 (resolution A.71 5(17))

4.1.3 *Recommended stability criteria*

For ships loaded with timber deck cargoes and provided that the cargo extends longitudinally between superstructures (where there is no limiting superstructure at the after end, the timber deck cargo should extend at least to the after end of the aftermost hatchway)[31] transversely for the full beam of ship after due allowance for a rounded gunwale not exceeding 4% of the breadth of the ship and/or securing the supporting uprights and which remains securely fixed at large angles of heel, the Administration may apply the following criteria which substitute those given in 3.1.2.1 to 3.1.2.4:

.1 The area under the righting lever curve (GZ curve) should not be less than 0.08 metre-radian up to $\theta = 40°$ or the angle of flooding if this angle is less than 40°.

.2 The maximum value of the righting lever (GZ) should be at least 0.25 m.

.3 At all times during a voyage, the metacentric height GM_o should be positive after correction for the free surface effects of liquid in tanks and, where appropriate, the absorption of water by the deck cargo and/or ice accretion on the exposed surfaces. (Details regarding ice accretion are given in chapter

[30] Refer to regulation 42(1) of the 1966 LL Convention.

[31] Refer to regulation 44(2) of the 1966 LL Convention.

5). Additionally, in the departure condition the metacentric height should be not less than 0.10 m.

4.1.4 *Stability booklet*

4.1.4.1* The ship should be supplied with comprehensive stability information which takes into account timber deck cargo. Such information should enable the master, rapidly and simply, to obtain accurate guidance as to the stability of the ship under varying conditions of service. Comprehensive rolling period tables or diagrams have proved to be very useful aids in verifying the actual stability conditions.[32]

4.1.4.2 For ships carrying timber deck cargoes, the Administration may deem it necessary that the master be given information setting out the changes in deck cargo from that shown in the loading conditions when the permeability of the deck cargo is significantly different from 25% (see 4.1.6 below).

4.1.4.3 For ships carrying timber deck cargoes, conditions should be shown indicating the maximum permissible amount of deck cargo, having regard to the lightest stowage rate likely to be met in service.

4.1.5 *Operational measures*

4.1.5.1 The stability of the ship at all times, including during the process of loading and unloading timber deck cargo, should be positive and to a standard acceptable to the Administration. It should be calculated having regard to:

.1 the increased weight of the timber deck cargo due to:
.1.1 absorption of water in dried or seasoned timber, and
.1.2 ice accretion, if applicable (chapter 5);
.2 variations in consumables;
.3 the free surface effect of liquid in tanks; and
.4 weight of water trapped in broken spaces within the timber deck cargo and especially logs.

4.1.5.2 The master should:

.1 cease all loading operations if a list develops for which there is no satisfactory explanation and it would be imprudent to continue loading;
.2 before proceeding to sea, ensure that:
.2.1 the ship is upright;
.2.2 the ship has an adequate metacentric height; and
.2.3 the ship meets the required stability criteria.

4.1.5.3 The masters of ships having a length less than 100 m should also:

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[32] Refer to regulation II-1/22 of the 1974 SOLAS Convention, as amended, and regulation 10(2) of the 1966 LL Convention and the 1988 LL Protocol.

.1 exercise good judgement to ensure that a ship which carries stowed logs on deck should have sufficient additional buoyancy so as to avoid overloading and loss of stability at sea;

.2 be aware that the calculated CM_o in the departure condition may decrease continuously owing to water absorption by the deck cargo of logs and consumption of fuel, water and stores and ensure that the ship has adequate CM_o throughout the voyage;

.3 be aware that ballasting after departure may cause the ship's operating draught to exceed the timber load line. Ballasting and deballasting should be carried out in accordance with the guidance provided in the Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 1991 (resolution A.715(17)).

4.1.5.4 Ships carrying timber deck cargoes should operate, as far as possible, with a safe margin of stability and with a metacentric height which is consistent with safety requirements but such metacentric height should not be allowed to fall below the recommended minimum, as specified in 4.1.3.

4.1.5.5 However, excessive initial stability should be avoided as it will result in rapid and violent motion in heavy seas which will impose large sliding and racking forces on the cargo, causing high stresses on the lashings. Operational experience indicates that metacentric height should preferably not exceed 3% of the breadth in order to prevent excessive accelerations in rolling provided that the relevant stability criteria given in 4.1.3 are satisfied. This recommendation may not apply to all ships and the master should take into consideration the stability information obtained from the ship's stability booklet.

4.1.6 *Calculation of stability curves*

In addition to the provisions given in 3.6, the Administration may allow account to be taken of the buoyancy of the deck cargo, assuming that such cargo has a permeability of 25% of the volume occupied by the cargo. Additional curves of stability may be required if the Administration considers it necessary to investigate the influence of different permeabilities and/or assumed effective height of the deck cargo.

4.1.7 *Loading conditions to be considered*

The loading conditions which should be considered for ships carrying timber deck cargoes are specified in 3.5.1.3. For the purpose of these loading conditions, the ship is assumed to be loaded to the summer timber load line with water ballast tanks empty.

4.1.8 *Assumptions for calculating loading conditions*

The following assumptions are to be made for calculating the loading conditions referred to in 4.1.7: the amount of cargo and ballast should correspond to the worst service condition in which all the relevant stability criteria of 3.1.2.1 to 3.1.2.4 or the optional criteria given in 4.1.3 are met. In the arrival condition, it should be assumed that the weight of the deck cargo has increased by 10% due to water absorption.

4.1.9* *Stowage of timber deck cargoes*

The stowage of timber deck cargoes should comply with the provisions of chapter 3 of the Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 1991 (resolution A.715(17)).[33]

4.2 Fishing vessels

4.2.1 *Scope*

The provisions given hereunder apply to decked seagoing fishing vessels as defined in 1.3.4. The stability criteria given in 4.2.3 and 4.2.4 below should be complied with for all conditions of loading as specified in 4.2.5, unless the Administration is satisfied that operating experience justifies departures therefrom.

4.2.2 *General precautions against capsizing*

Apart from general precautions referred to in sections 2.3 and 2.5, the following measures should be considered as preliminary guidance on matters influencing safety as related to stability:

- **.1** all fishing gear and other large weights should be properly stowed and placed as low as possible;
- **.2** particular care should be taken when pull from fishing gear might have a bad effect on stability, e.g., when nets are hauled by power-block or the trawl catches obstructions on the sea-bed;
- **.3** gear for releasing deck load in fishing vessels carrying catch on deck, e.g., herring, should be kept in good working condition for use when necessary;
- **.4** when the main deck is prepared for the carriage of deck load by division with pound boards, there should be slots between them of suitable size to allow easy flow of water to freeing ports to prevent trapping of water;
- **.5** fish should never be carried in bulk without first being sure that the portable divisions in the holds are properly installed;
- **.6** reliance on automatic steering may be dangerous as this prevents changes to course which may be needed in bad weather;
- **.7** in all conditions of loading, necessary care should be taken to maintain a seaworthy freeboard;

[33] Refer to regulation 44 of the 1966 LL Convention and the 1988 LL Protocol.

.8 particular care should be taken when the pull from fishing gear results in dangerous heel angles. This may occur when fishing gear fastens onto an underwater obstacle or when handling fishing gear, particularly on purse seiners, or when one of the trawl wires tears off. The heel angles caused by the fishing gear in these situations may be eliminated by employing devices which can relieve or remove excessive forces applied through the fishing gear. Such devices should not impose a danger to the vessel through operating in circumstances other than those for which they were intended.

4.2.3* *Recommended general criteria*[34]

4.2.3.1 The general intact stability criteria given in section 3.1.2 (paragraphs 3.1.2.1 to 3.1.2.3) should apply to fishing vessels having a length of 24 m and over, with the exception of requirements on the initial metacentric height GM_o (paragraph 3.1.2.4), which, for fishing vessels, should not be less than 0.35 m for single-deck vessels. In vessels with complete superstructure or vessels of 70 m in length and over the metacentric height may be reduced to the satisfaction of the Administration but in no case should be less than 0.15 m.

4.2.3.2 The adoption by individual countries of simplified criteria which apply such basic stability values to their own types and classes of vessels is recognized as a practical and valuable method of economically judging the stability.

4.2.3.3 Where arrangements other than bilge keels are provided to limit the angle of roll, the Administration should be satisfied that the stability criteria referred to in 4.2.3.1 are maintained in all operating conditions.

4.2.4 *Severe wind and rolling criterion (weather criterion) for fishing vessels*

4.2.4.1 Fishing vessels of 45 m in length and over having large windage area should comply with the provisions of section 3.2 of the Code.

4.2.4.2 For fishing vessels in the length range between 24 m and 45 m the value of wind pressure (see 3.2.2.2) is to be taken from the following table:

h (m)	1	2	3	4	5	6 and over
P (N/m^2)	316	386	429	460	485	504

where h is the vertical distance from the centre of the projected vertical area of the ship above the waterline to the waterline.

4.2.5* *Loading conditions to be considered*[35]

[34] Refer to regulation III/2 of the 1993 Torremolinos Protocol.
[35] Refer to regulation III/7 of the 1993 Torremolinos Protocol.

4.2.5.1 The standard loading conditions referred to in 4.2.1 are as follows:

.1 departure conditions for the fishing grounds with full fuel, stores, ice, fishing gear, etc.;

.2 departure from the fishing grounds with full catch;

.3 arrival at home port with 10% stores, fuel, etc. remaining and full catch;

.4 arrival at home port with 10% stores, fuel, etc. and a minimum catch, which should normally be 20% of full catch but may be up 40% provided the Administration is satisfied that operating patterns justify such a value.

4.2.5.2 Assumptions for calculating loading conditions should be as follows:

.1 allowance should be made for the weight of the wet fishing nets and tackle, etc. on deck;

.2 allowance for icing, where this is anticipated to occur, should be made in accordance with the provisions of section 5.3;

.3 in all cases the cargo should be assumed to be homogeneous unless this is inconsistent with practice;

.4 in conditions referred to in 4.2.5.1.2 and 4.2.5.1.3 deck cargo should be included if such a practice is anticipated;

.5 water ballast should normally only be included if carried in tanks which are specially provided for this purpose.

4.2.6 *Recommendation for an interim simplified stability criterion for decked fishing vessels under 24 m in length*

4.2.6.1 For decked vessels with a length less than 30 m, the following approximate formula for the minimum metacentric height GM_{min} (in metres) for all operating conditions should be used as the criterion:

$$GM_{min} = 0.53 + 2B\left[0.075 - 0.37\left(\frac{f}{B}\right) + 0.82\left(\frac{f}{B}\right)^2 - 0.014\left(\frac{B}{D}\right) - 0.032\left(\frac{l_s}{L}\right)\right]$$

where:

L is the length of the vessel on the waterline in maximum load condition (m)

l_s is the actual length of enclosed superstructure extending from side to side of the vessel (m)

B is the extreme breadth of the vessel on the waterline in maximum load condition (m)

D is the depth of the vessel measured vertically amidships from the base line to the top of the upper deck at side (m)

f is the smallest freeboard measured vertically from the top of the upper deck at side to the actual waterline (m)

The formula is applicable for vessels having:

.1 *f/B* between 0.02 and 0.20;
.2 l_s/L smaller than 0.60;
.3 *B/D* between 1.75 and 2.15;
.4 sheer fore and aft at least equal to or exceeding the standard sheer prescribed in regulation 38(8) of the International Convention on. Load Lines, 1966;
.5 height of superstructure included in the calculation not less than 1.8 m.

For ships with parameters outside of the above limits the formula should be applied with special care.

4.2.6.2 The above formula is not intended as a replacement for the basic criteria given in 4.2.3 and 4.2.4 but is to be used only if circumstances are such that cross curves of stability, KM curve and subsequent GZ curves are not and cannot be made available for judging a particular vessel's stability.

4.2.6.3 The calculated value of GM_{min} should be compared with actual GM values of the vessel in all loading conditions. If a rolling test (see section 7.6), an inclining experiment based on estimated displacement, or another approximate method of determining the actual GM is used, a safety margin should be added to the calculated GM_{min}.

4.3 Special purpose ships

4.3.1 *Application*

The provisions given hereunder apply to special purpose ships, as defined in 1.3.5, of not less than 500 tons gross tonnage. The Administration may also apply these provisions as far as reasonable and practicable to special purpose ships of less than 500 tons gross tonnage.

4.3.2 *Stability criteria*

The intact stability of special purpose ships should comply with the provisions given in 3.1.2 except that the alternative criteria given in 4.5.6.2 which apply to offshore supply vessels may be used for special purpose ships of less than 100 m in length of similar design and characteristics.

4.4* Cargo ships carrying grain in bulk

The intact stability of ships engaged in the carriage of grain should comply with the requirements of the International Code for the Safe Carriage of Grain in Bulk adopted by resolution MSC.23(59).[36]

4.5 Offshore supply vessels

4.5.1 *Application*

4.5.1.1 The provisions given hereunder apply to offshore supply vessels, as defined in 1.3.6, of 24 m in length and over. The alternative stability criteria contained in 4.5.6 apply to vessels of not more than 100 m in length.

4.5.1.2 For a vessel engaged in near-coastal voyages, as defined in 4.5.2, the principles given in 4.5.3 should guide the Administration in the development of its national standards. Relaxations from the requirements of the Code rnay be permitted by an Administration for vessels engaged in near-coastal voyages off its own coasts provided the operating conditions are, in the opinion of that Administration, such as to render compliance with the provisions of the Code unreasonable or unnecessary.

4.5.1.3 Where a ship other than an offshore supply vessel, as defined in 1.3.6, is employed on a similar service, the Administration should determine the extent to which compliance with the provisions of the Code is required.

4.5.2 *Definitions*

Near-coastal voyage means a voyage in the vicinity of the coast of a State as defined by the Administration of that State.

4.5.3 *Principles governing near-coastal voyages*

4.5.3.1 The Administration defining near-coastal voyages for the purpose of the present Code should not impose design and construction standards for a vessel entitled to fly the flag of another State and engaged in such voyages in a manner resulting in a more stringent standard for such a vessel than for a vessel entitled to fly its own flag. In no case should the Administration impose, in respect of a vessel entitled to fly the flag of another State, standards in excess of the Code for a vessel not engaged in near-coastal voyages.

4.5.3.2 With respect to a vessel regularly engaged in near-coastal voyages off the coast of another State the Administration should prescribe design and construction standards for such a vessel at least equal to those prescribed by the Government of the State off whose coast the vessel is engaged, provided such standards do not exceed the Code in respect of a vessel not engaged in near-coastal voyages.

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[36] Refer to chapter VI of the 1974 SOLAS Convention and to part C of chapter VI of the 1974 SOLAS onvention as amended by resolution MSC.22(59).

4.5.3.3 A vessel which extends its voyages beyond a near-coastal voyage should comply with the present Code.

4.5.4 *Constructional precautions against capsizing*

4.5.4.1 Access to the machinery space should, if possible, be arranged within the forecastle. Any access to the machinery space from the exposed cargo deck should be provided with two weathertight closures. Access to spaces below the exposed cargo deck should preferably be from a position within or above the superstructure deck.

4.5.4.2 The area of freeing ports in the side bulwarks of the cargo deck should at least meet the requirements of regulation 27 of the International Convention on Load Lines, 1966. The disposition of the freeing ports should be carefully considered to ensure the most effective drainage of water trapped in pipe deck cargoes or in recesses at the after end of the forecastle. In vessels operating in areas where icing is likely to occur, no shutters should be fitted in the freeing ports.

4.5.4.3 The Administration should give special attention to adequate drainage of pipe stowage positions, having regard to the individual characteristics of the vessel. However, the area provided for drainage of the pipe stowage positions should be in excess of the required freeing port area in the cargo deck bulwarks and should not be fitted with shutters.

4.5.4.4 A vessel engaged in towing operations should be provided with means for quick release of the towing hawser.

4.5.5 *Operational procedures against capsizing*

4.5.5.1 The arrangement of cargo stowed on deck should be such as to avoid any obstruction of the freeing ports or of the areas necessary for the drainage of pipe stowage positions to the freeing ports.

4.5.5.2 A minimum freeboard at the stern of at least $0.005L$ should be maintained in all operating conditions.

4.5.6 *Stability criteria*

4.5.6.1 The stability criteria given in 3.1.2 should apply to all offshore supply vessels except those having characteristics which render compliance with 3.1.2 impracticable.

4.5.6.2 The following equivalent criteria are recommended where a vessel's characteristics render compliance with 3.1.2 impracticable:

.1 The area under the curve of righting levers (GZ curve) should not be less than 0.070 metre-radian up to an angle of 15° when the maximum righting lever (GZ) occurs at 15° and 0.055 metre-radian up to an angle of 300 when the maximum righting lever (GZ) occurs at 30° or above. Where the maximum righting lever (GZ) occurs at angles of

between 15° and 30°, the corresponding area under the righting lever curve should be:
$0.055 + 0.001\ (30° - \theta_{max})$ metre-radian[37]

.2 The area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40°, or between 30° and θ_f if this angle is less than 40°, should be not less than 0.03 metre-radian.

.3 The righting lever (GZ) should be at least 0.20 m at an angle of heel equal to or greater than 30°.

.4 The maximum righting lever (GZ) should occur at an angle of heel not less than 15°.

.5 The initial transverse metacentric height (GM_o) should not be less than 0.15 m.

4.5.6.3 Reference is made also to recommendations contained in section 2.3 and paragraphs 3.1.2.7 to 3.1.2.9.

4.5.7 *Loading conditions*

The standard loading conditions should be as follows:

.1 Vessel in fully loaded departure condition with cargo distributed below deck and with cargo specified by position and weight on deck, with full stores and fuel, corresponding to the worst service condition in which all the relevant stability criteria are met.

.2 Vessel in fully loaded arrival condition with cargo as specified in .1, but with 10% stores and fuel.

.3 Vessel in ballast departure condition, without cargo but with full stores and fuel.

.4 Vessel in ballast arrival condition, without cargo and with 10% stores and fuel remaining.

.5 Vessel in the worst anticipated operating condition.

4.5.8 *Assumptions for calculating loading conditions*

The assumptions for calculating loading conditions should be as follows:

.1 If a vessel is fitted with cargo tanks, the fully loaded conditions of 4.5.7.1 and 4.5.7.2 should be modified, assuming first the cargo tanks full and then the cargo tanks empty.

.2 If in any loading condition water ballast is necessary, additional diagrams should be calculated, taking into account the water ballast, the quantity and disposition of which should be stated in the stability information.

.3 In all cases when deck cargo is carried a realistic stowage weight should be assumed and stated in the stability information, including the height of the cargo and its centre of gravity.

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[37] θ_{max} is the angle of heel in degrees at which the righting lever curve reaches its maximum.

.4 Where pipes are carried on deck, a quantity of trapped water equal to a certain percentage of the net volume of the pipe deck cargo should be assumed in and around the pipes. The net volume should be taken as the internal volume of the pipes, plus the volume between the pipes. This percentage should be 30 if the freeboard amidships is equal to or less than 0.01 5*L* and 10 if the freeboard amidships is equal to or greater than 0.03*L*. For intermediate values of the freeboard amidships the percentage may be obtained by linear interpolation. In assessing the quantity of trapped water, the Administration may take into account positive or negative sheer aft, actual trim and area of operation.

.5 If a vessel operates in zones where ice accretion is likely to occur, allowance for icing should be made in accordance with the provisions of chapter 5.

4.6 Mobile offshore drilling units (MODUs)

4.6.1 *Application*

4.6.1.1 The provisions given hereunder apply to mobile offshore drilling units as defined in 1.3.7, the keels of which are laid or which are at a similar stage of construction on or after I May 1991. For MODUs constructed before that date, the corresponding provisions of chapter 3 of resolution A.414(Xl) should apply.

4.6.1.2 The coastal State may permit any unit designed to a lesser standard than that of this chapter to engage in operations, having taken account of the local environmental conditions. Any such unit should, however, comply with safety requirements which in the opinion of the coastal State are adequate for the intended operation and ensure the overall safety of the unit and the personnel on board.

4.6.2 *Definitions*

For the purposes of this section, the terms used herein have the meanings defined in the following paragraphs:

.1 *coastal State* means the Government of the State exercising administrative control over the drilling operations of the unit;

.2 *mode of operation* means a condition or manner in which a unit may operate or function while on location or in transit. The modes of operation of a unit include the following:

.2.1 *operating conditions* - conditions wherein a unit is on location for the purpose of conducting drilling operations, and combined environmental and operational loadings are within the appropriate design limits established for such operations. The unit may be either afloat or supported on the sea-bed, as applicable;

.2.2 *severe storm conditions* - conditions wherein a unit may be subjected to the most severe environmental loadings for which the unit is designed. Drilling operations are assumed to have been discontinued due to the severity of the environmental loadings, the unit may be either afloat or supported on the sea-bed, as applicable;

.2.3 *transit conditions* - conditions wherein a unit is moving from one geographical location to another.

4.6.3 *Righting moment and heeling moment curves*

4.6.3.1 Curves of righting moments and of wind heeling moments similar to figure 4.6-1 with supporting calculations should be prepared covering the full range of operating draughts, including those in transit conditions, taking into account the maximum deck cargo and equipment in the most unfavourable position applicable. The righting moment curves and wind heeling moment curves should be related to the most critical axes. Account should be taken of the free surface of liquids in tanks.

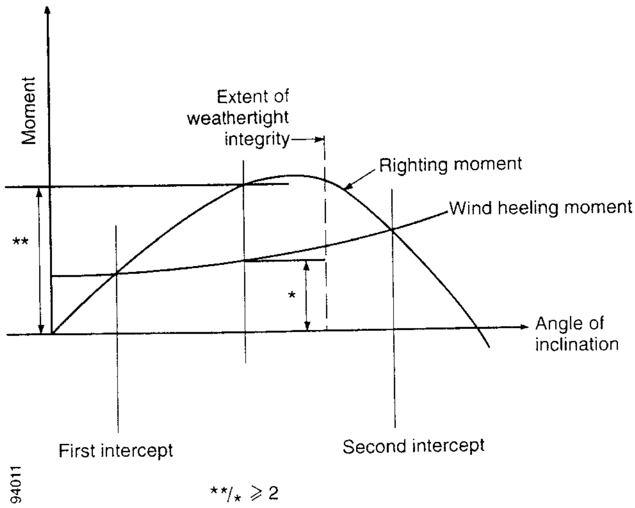

Figure 4.6-1 - *Righting moment and wind heeling moment curves*

4.6.3.2 Where equipment is of such a nature that it can be lowered and stowed, additional wind heeling moment curves may be required and such data should clearly indicate the position of such equipment.

4.6.3.3 The curves of wind heeling moment should be drawn for wind forces calculated by the following formula:

$$F = 0.5 C_s C_H p V^2 A$$

where:

F is the wind force (N)

C_s is the shape coefficient depending on the shape of the structural member exposed to the wind (see table 4.6.3.3-1)

C_H is the height coefficient depending on the height above sea level of the structural member exposed to wind (see table 4.6.3.3-2)

P is the air mass density (1.222 kg/m^3)

V is the wind velocity (m/s)

A is the projected area of all exposed surfaces in either the upright or the heeled condition (m^2)

Table 4.6.3.3-1 – Values of the coefficient C_s

Shape	C_s
Sperical	0.4
Cylindrical	0.5
Large flat surface (hull,deck-house, smooth under deck areas	1.0
Drilling derrick	1.25
Wires	1.2
Exposed beams and girders under deck	1.3
Small parts	1.4
Isolated shapes (crane, beam, etc).	1.5
Clustered deck-houses or similar structures	1.1

Table 4.6.3.3.2 – *Values of the coefficient* C_H

Height above sea level (m)	C_H
0-15.3	1.00
15.3-30.5	1.10
30.5-46.0	1.20
46.0-61.0	1.30
61.0-76.0	1.37
76.0-91.5	1.43
91.5-106.5	1.48
106.5-122.0	1.52
122.0-137.0	1.56
137.0-152.5	1.60
152.5-167.5	1.63
167.5-183.0	1.67
183.0-198.0	1.70
198.0-213.5	1.72
213.5-228.5	1.75
228.5-244.0	1.77
244.0-256.0	1.79
Above 256	1.80

4.6.3.4 Wind forces should be considered from any direction relative to the unit and the value of the wind velocity should be as follows:

.1 In general, a minimum wind velocity of 36 m/s (70 knots) for offshore service should be used for normal operating conditions and a minimum wind velocity of 51.5 m/s (100 knots) should be used for the severe storm conditions.

.2 Where a unit is to be limited in operation to sheltered locations (protected inland waters such as lakes, bays, swamps, rivers, etc.), consideration should be given to a reduced wind velocity of not less than 25.8 m/s (50 knots) for normal operating conditions.

4.6.3.5 In calculating the projected areas to the vertical plane, the area of surfaces exposed to wind due to heel or trim, such as under decks, etc., should be included, using the appropriate shape factor. Open truss work may be approximated by taking 30% of the projected block area of both the front and back section, i.e. 60% of the projected area of one side.

4.6.3.6 In calculating the wind heeling moments, the lever of the wind overturning force should be taken vertically from the centre of pressure of all surfaces exposed to the wind to the centre of lateral resistance of the underwater body of the unit. The unit is to be assumed floating free of mooring restraint.

4.6.3.7 The wind heeling moment curve should be calculated for a sufficient number of heel angles to define the curve. For ship-shaped hulls the curve may be assumed to vary as the cosine function of ship heel.

4.6.3.8 Wind heeling moments derived from wind-tunnel tests on a representative model of the unit may be considered as alternatives to the method given in 4.6.3.3 to 4.6.3.7. Such heeling moment determination should include lift and drag effects at various applicable heel angles.

4.6.4 *Intact stability criteria*

4.6.4.1 The stability of a unit in each mode of operation should meet the following criteria (see also figure 4.6-2):

- **.1** For surface and self-elevating units the area under the righting moment curve to the second intercept or downflooding angle, whichever is less, should be not less than 40% in excess of the area under the wind heeling moment curve to the same limiting angle.
- **.2** For column-stabilized units the area under the righting moment curve to the angle of downflooding should be not less than 30% in excess of the area under the wind heeling moment curve to the same limiting angle.
- **.3** The righting moment curve should be positive over the entire range of angles from upright to the second intercept.

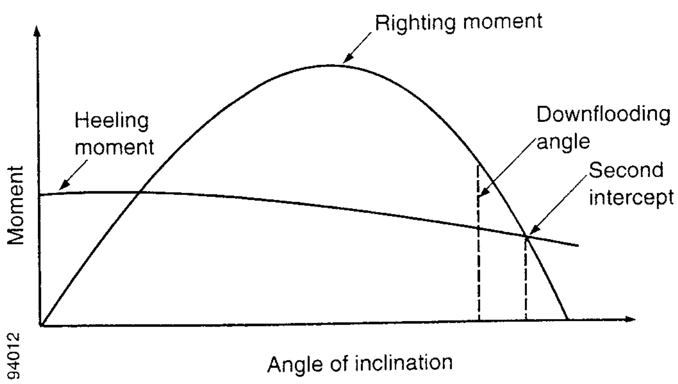

Figure 4.6-2 - *Righting moment and heeling moment curves*

4.6.4.2 Each unit should be capable of attaining a severe storm condition in a period of time consistent with the meteorological conditions. The procedures recommended and the approximate length of time required, considering both operating conditions and transit conditions, should be contained in the operating manual, as referred to in 2.1.2. It should be possible to achieve the severe storm condition without the removal or relocation of solid consumables or other variable load. However, the Administration may permit loading a unit past the point at which solid consumables would have to be removed or relocated to go to severe storm condition under the following conditions, provided the allowable KG requirement is not exceeded:

- **.1** in a geographic location where weather conditions annually or seasonally do not become sufficiently severe to require a unit to go to severe storm condition; or
- **.2** where a unit is required to support extra deckload for a short period of time that is well within the bounds of a favourable weather forecast.

The geographic locations and weather conditions and loading conditions when this is permitted should be identified in the operating manual.

4.6.4.3 Alternative stability criteria may be considered by the Administration provided an equivalent level of safety is maintained and if they are demonstrated to afford adequate positive initial stability. In determining the acceptability of such criteria, the Administration should consider at least the following and take into account as appropriate:

- **.1** environmental conditions representing realistic winds (including gusts) and waves appropriate for world-wide service in various modes of operation;
- **.2** dynamic response of a unit. Analysis should include the results of wind-tunnel tests, wave tank model tests, and non-linear simulation, where appropriate. Any wind and wave spectra used should cover sufficient frequency ranges to ensure that critical motion responses are obtained;
- **.3** potential for flooding taking into account dynamic responses in a seaway;
- **.4** susceptibility to capsizing considering the unit's restoration energy and the static inclination due to the mean wind speed and the maximum dynamic response;
- **.5** an adequate safety margin to account for uncertainties.

An example of alternative criteria for twin-pontoon column-stabilized semi-submersible units is given in section 4.6.5.

4.6.5 *An example of alternative intact stability criteria for twin-pontoon column-stabilized semi-submersible units*

4.6.5.1 The criteria given below apply only to twin-pontoon column-stabilized semi-submersible units in severe storm conditions which fall within the following ranges of parameters:

V_p/V_t is belween 0.48 and 0.58

$A_{wp}/V_c)^{2/3}$ is between 0.72 and 1.00

$l_{wp}/[V_c \times (L_{ptn}/2)]$ is between 0.40 and 0.70

The parameters used in the above equations are defined in paragraph 4.6.5.3.

4.6.5.2 *Intact stability criteria*

The stability of a unit in the survival mode of operation should meet the following criteria:

.1 Capsize criteria

These criteria are based on the wind heeling moment and righting moment curves calculated as shown in section 4.6.3 of the Code at the survival draught. The reserve energy area 'B' must be greater than 10% of the dynamic response area 'A' as shown in figure 4.6-3.'

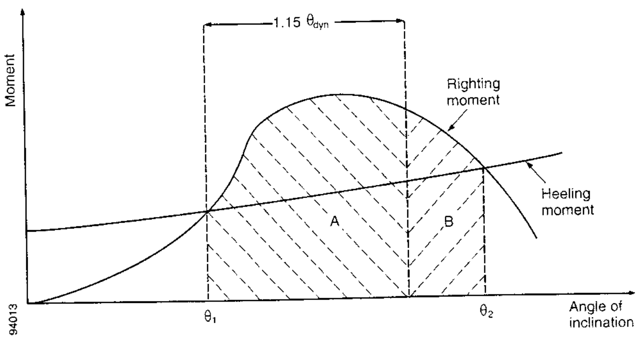

Figure 4.6-3 - *Righting moment and heeling moment curves*

Area 'B'/Area 'A' $\geq$ 0.10

where:

Area 'A' is the area under the righting arm curve measured from θ_1 to ($\theta_1 + 1.15\theta_{dyn}$)

Area 'B' is the area under the righting arm curve measured from ($\theta_1 + 1.15\theta_{dyn}$) to θ_2

θ_1 is the first intercept with the 100 knot wind moment curve

θ_2 is the second intercept with the 100 knot wind moment curve

θ_{dyn} is the dynamic response angle due to waves and fluctuating wind

θ_{dyn} = (10.3 + 1 7.8C)/(1 + GM/(1.46 + 0.28BM))

$C \quad = (L\text{ptn}^{5/3} \text{ x } VCP_{w1} \text{ x } A_w \text{ x } V_p \text{ x } V_c^{1/3})/(l_{wp}^{5/3} \text{ x } V_t)$

Parameters used in the above equations are defined in paragraph 4.6.5.3.

.2 Downflooding criteria

These criteria are based on the physical dimensions of the unit and the relative motion of the unit about a static inclination due to a 75 knot wind measured at the survival draught. The initial downflooding distance (DFD_o) should be greater than the reduction in downflooding distance at the survival draught as shown in figure 4.6-4.

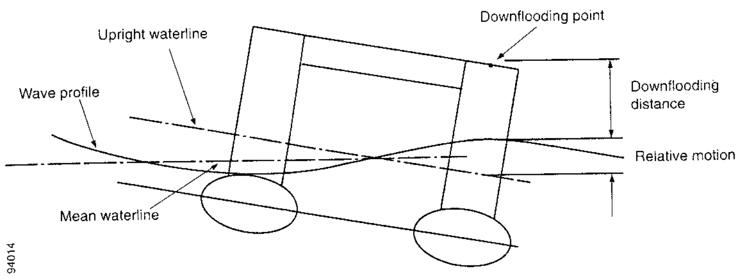

Figure 4.6-4 - *Definition of downflooding distance and relative motion*

$DFD_o - RDFD > 0.0$

where:

DFD_o	is the initial downflooding distance to D_m (m)
$RDFD$	is the reduction in downflooding distance (m) equal to SF (k x QSD_1 + RMW)
SF	is equal to 1.10, which is a safety factor to account for uncertainties in the analysis, such as non-linear effects.
k (correlation factor)	is equal to 0.55 + 0.08(a - 4.0) + 0.056(1.52 - GM) (GM cannot be taken to be greater than 2.44 m)
a	is equal to ($FBDo$/D_m)(S_{ptn} x L_{ccc}/A_{wp} (a cannot be taken to be less than 4.0)
QSD_1	is equal to DFD_o minus quasi-static downflooding distance at θ_1 (m), but not to be taken less than 3.0 m.

RMW	is the relative motion due to waves about θ_1 (m), equal to 9.3 + 0.11 (X - 12.19)
X	is equal to $D_m(V_t/V_p)(A_{wp}^2/l_{wp})(L_{ccc}/L_{ptn})$ (X cannot be taken to be less than 12.19 m)

The parameters used in the above equations are defined in paragraph 4.6.5.3.

4.6.5.3 *Geometric parameters*

A_{wp}	is the waterplane area at the survival draught, including the effects of bracing members as applicable (m^2).
A_w	is the effective wind area with the unit in the upright position (i.e. the product of projected area, shape coefficient and height coefficient) (m^2).
BM	is the vertical distance from the metacentre to the centre of buoyancy with the unit in the upright position (m).
D_m	is the initial survival draught (m).
FBD_o	is the vertical distance side (m).
GM	for paragraph 4.6.5.2.1, GM is the metacentric height measured about the roll or diagonal axis, whichever gives the minimum restoring energy ratio, 'B'/'A'. This axis is usually the diagonal axis as it possesses a characteristically larger projected wind area which influences the three characteristic angles mentioned above.
GM	for paragraph 4.6.5.2.2, is the metacentric height measured about the axis which gives the minimum downlooding distance margin (i.e. generally the direction that gives the largest QSD_1) (m).
l_{wp}	is the waterplane second moment of inertia at the survival draught, including the effects of bracing members as applicable (m^4).
L_{ccc}	is the longitudinal distance between centres of the corner columns (m).
L_{ptn}	is the length of each pontoon (m).
S_{ptn}	is the transverse distance between the centrelines of the pontoons (m).
V_c	is the total volume of all columns from the top of the pontoons to the top of the column structure, except for any volume included in the upper deck (m^3).

V_p is the total combined volume of both pontoons (m^3).

V_t is the total volume of the structures (pontoons, columns and bracings) contributing to the buoyancy of the unit, from its baseline to the top of the column structure, except for any volume inclucled in the upper deck (m^3).

VCP_{w1} is the vertical centre of wind pressure above D_m (m).

4.6.5.4 Capsize criteria assessment form

Input data

GM …..……………..=…………….m
BM …...................................…………………..…=……………..m
VCP_{w1} ....………………….=……………..m
A_w …………..…..………………………………=…………..…m^2
V_t ………………………………………..…..=…….……..…m^3
Vc ……………………………………………=……………..m^3
V_p ……………………………………………=……………..m^3
l_{wp} ……………………………………………=……………..m^4
L_{ptn} .....……………………………………………=……………..m

Determine

θ_1 ……………………………………………=…………..…deg
θ_2 ……………………………………………=…………..…deg

$C = (L_{ptn}{}^{5/3} \text{ x } VCP_{w1} \text{ x } A_w \text{ x } V_p \text{ x } V_c{}^{1/3})/(l_{wp}\ 5/3 \text{ x} V_t)$ =……….….…m^{-1}

$\theta_{dyn} = (10.3 + 1\ 7.8C)/(1.0 + GM/(1.46 + 0.28BM))$…=…..………...deg

Area 'A' ………………………......………………..=…………m-deg

Area 'B' ......…………………………………………..=…………m-deg

Results Reserve energy ratio:

'B'/'A' =…………………..(minimum = 0.10)

GM = ……………….m (KG =……………………m)

Note: The minimum GM is that which produces a 'B'/'A' ratio = 0.10

4.6.5.5 *Downflooding criteria assessment form*

Input data

DFD_o …..……………..=…………….m

FBD_o …....................................…………………….…=……………..m
GM ………..…..…………………………………=…………..…m
D_m ……………………………………………………=……………..m
V_t ………………………………………..…..=…….…….…m^3
V_p ……………………………………………………=……………..m^3
A_{wp} ……………………………………………………=……………..m^2
l_{wp} ……………………………………………………=……………..m^4
L_{ccc} ……………………………………………………=……………..m
L_{ptn} ……………………………………………………=……………..m
S_{ptn} ……………………………………………………=……………..m
SF ……………………………………………………=…………=1.10

Determine

θ_1 ………………………………………………….deg
DFD_1 ……………………………………………………m
QSD_1 = DFD_o - DFD_1 =..…………………………………m

a = $(FBD_o/D_m)\ (S_{ptn} \text{ x } L_{ccc})/A_{wp}$ =…………(a_{min} = 4.0)

k = 0.55 + 0.08(a – 4.0) + 0.056(1.52 – GM) =…….(GM_{max} = 2.44)

X = $D_m(V_t/V_p)(A_{wp}^2/l_{wp})(L_{ccc}/L_{ptn})$ =………………m (X_{min} = 12.19) m

RMW = 9.3 + 0.11 (X - 12.19) =…………………..……m

$RDFD = SF\ (k \text{ x } QSD_1 + RMW)$ = ……………………m

Results Downflooding margin:

$DFD_o – RDFD$ =……………………………(minimum = 0.0 m)

GM =……………………m (KG =…………………m)

Note: The minimum GM is that which produces a downflooding margin

= 0.0 m

4.7 Pontoons

4.7.1 *Application*

The provisions given hereunder apply to seagoing pontoons. A pontoon is considered to be normally:

.1 non-self-propelled;
.2 unmanned;

.3 carrying only deck cargo;
.4 having a block coefficient of 0.9 or greater;
.5 having a breadth/depth ratio of greater than 3.0; and
.6 having no hatchways in the deck except small manholes closed with gasketed covers.

4.7.2 *Stability drawings and calculations*

4.7.2.1 The following information is typical of that required to be submitted to the Administration for approval:
.1 lines drawing;
.2 hydrostatic curves;
.3 cross curves;
.4 report of draught and density readings and calculation of light-ship displacement and longitudinal centre of gravity;
.5 statement of justification of assumed vertical centre of gravity;
.6 simplified stability guidance such as a loading diagram, so that the pontoon may be loaded in compliance with the stability criteria.

4.7.2.2 Concerning the performance of calculations, the following is suggested:
.1 no account should be taken of the buoyancy of deck cargo (unless buoyancy credit for adequately secured timber);
.2 consideration should be given to such factors as water absorption (e.g. timber), trapped water in cargo (e.g. pipes) and ice accretion;
.3 in performing wind heel calculations:
.3.1 the wind pressure should be constant and for general operations be considered to act on a solid mass extending over the length of the cargo deck and to an assumed height above the deck,
.3.2 the centre of gravity of the cargo should be assumed at a point mid-height of the cargo, and
.3.3 the wind lever arm should be taken from the centre of the deck cargo to a point at one half the draught;
.4 calculations should be performed covering the full range of operating draughts;
.5 the downflooding angle should be taken as the angle at which an opening through which progressive flooding may take place is immersed. This would not be an opening closed by a watertight manhole cover or a vent fitted with an automatic closure.

4.7.3 *Intact stability criteria*

4.7.3.1 The area under a righting lever curve up to the angle of maximum righting lever should not be less than 0.08 metre-radian.

4.7.3.2 The static angle of heel due to a uniformly distributed wind load of 0.54 kPa (wind speed 30 m/s) should not exceed an angle corresponding to half the freeboard for the relevant loading condition, where the lever of wind heeling moment is measured from the centroid of the windage area to half the draught.

4.7.3.3 The minimum range of stability should be:

For *L* ≤	100 m	20°
For *L* ≥	150 m	15°
For intermediate length		by interpolation.

4.8 Dynamically supported craft (DSC)

4.8.1 *Application*

4.8.1.1 The provisions given hereunder apply to dynamically supported craft as defined in 1.3.8 which are engaged on voyages between a terminal in one country and a terminal in another country, part or all of which voyages are across areas of water (but not necessarily on routes navigable to ships) through which a ship operating on an international voyage, as defined in regulation 1/2(d) of the 1974 SOLAS Convention, as amended, would proceed. In applying the provisions of this chapter, the Administration should determine whether a craft is a dynamically supported craft as defined in 1.3.8, or whether its characteristics are such that the SOLAS and Load Line Conventions can be applied. For novel types of DSC other than defined in 1.3.9 and 1.3.10, the Administration should determine the extent to which the provisions of this chapter are applicable to those novel types. The contents of this chapter should be applied by Administrations through more detailed national regulations based on a comprehensive coverage of the provisions contained therein*.

4.8.1.2 The provisions in this chapter apply to DSC which:

.1 carry more than 12 passengers but not more than 450 passengers with all passengers seated;

.2 do not proceed in the course of their voyage more than 100 nautical miles from a place of refuge; and

.3 may be provided, within the limits of subparagraphs .1 and .2, with special category spaces intended to carry motor vehicles with fuel in their tanks.

The provisions given below may be extended to a DSC which is intended to carry passengers and cargo or solely cargo or to a craft which exceeds the limits specified in .1 to .3. In such cases, the Administration should determine the extent to which the provisions of the Code are applicable to

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* *Note:* As the Code of Safety for Dynamically Supported Craft (resolution A.373(X)) has undergone a revision, the provisions given here are of an interim nature. In particular, such factors as the increase in the number of passengers carried on board and new types of DSC are among major changes introduced into a new code. When the revision of the Intact Stability Code is undertaken, the standards for such craft will be replaced by the provisions of the High Speed Craft (HSC) Code adopted by the Maritime Safety Committee of the Organization by resolution MSC.36(63).

these craft and, if necessary, develop additional requirements providing the appropriate safety level for such craft.

4.8.2 *General provisions*

4.8.2.1 A craft should be provided with:

.1 stability characteristics and stabilization systems adequate for safety when the craft is operated in the non-displacement mode and during the transient mode; and

.2 buoyancy and stability characteristics adequate for safety where the craft is operated in the displaced mode both in the intact condition and the damaged condition.

4.8.2.2 If a craft operates in zones where ice accretion is likely to occur, the effect of icing should be taken into account in the stability calculations in accordance with section 5.5.

4.8.3 *Definitions*

For the purpose of this chapter, unless expressly defined otherwise, the following definitions apply:

.1 *length (L)* means length of the rigid hull measured on the design waterline in the displacement mode;

.2 *breadth (B)* means breadth of the broadest part of the rigid hull measured on the design waterline in the displacement mode;

.3 *design waterline* means the waterline corresponding to the loaded displacement of the craft when stationary;

.4 *weathertight* means that water will not penetrate into the craft in any wind and wave conditions up to those specified as critical design conditions;

.5 *skirt* means a downwardly extending, flexible structure used to contain or divide an air cushion;

.6 *fully submerged foil* means a foil having no lift components piercing the surface of the water in the foil-borne mode.

4.8.4 *Intact buoyancy*

4.8.4.1 The craft should have a designed reserve of buoyancy when floating in seawater of not less than 100% at the maximum operational weight. The Administration may require a larger reserve of buoyancy to permit the craft to operate in any of its intended modes. The reserve of buoyancy should be calculated by including only those compartments which are:

.1 watertight;

.2 considered by the Administration to have scantlings and arrangements adequate to maintain their watertight integrity; and

.3 situated below a datum, which may be a watertight deck or equivalent structure watertight longitudinally and transversely and from at least part of which the passengers would be disembarked in an emergency.

4.8.4.2 Means should be provided for checking the watertight integrity of buoyancy compartments. The inspection procedures adopted and the frequency at which they are carried out should be to the satisfaction of the Administration.

4.8.4.3 Where entry of water into structures above the datum as defined in 4.8.4.1.3 would significantly influence the stability and buoyancy of the craft, such structures should be of adequate strength to maintain the weathertight integrity or be provided with adequate drainage arrangements. A combination of both measures may be adopted to the satisfaction of the Administration. The means of closing of all openings in such structures should be such as to maintain the weathertight integrity.

4.8.5 *Intact stability*

4.8.5.1 The stability of a craft in the displacement mode should be such that, when in still water conditions, the inclination of the craft from the horizontal would not exceed 8^{o} in any direction under all permitted cases of loading and uncontrolled passenger movements as may occur. A calculation of the dynamic stability should be made with respect to critical design conditions.

4.8.5.2 For guidance of the Administration, methods relating to the verification of the stability of hydrofoil boats fitted with surface-piercing foils and fully submerged foils are outlined in 4.8.7.

4.8.6 *Stability of the craft in the non-displacement mode*

4.8.6.1 The Administration should be satisfied that, when operating in the non-displacement and transient modes within approved operational limitations, the craft will, after a disturbance causing roll, pitch, heave or any combination thereof, return to the original attitude.

4.8.6.2 The roll and pitch stability of each craft in the non-displacement mode should be determined experimentally prior to its entering commercial service and be recorded.

4.8.6.3 Where craft are fitted with surface-piercing structure or appendages, precautions should be taken against dangerous attitudes or inclinations and loss of stability subsequent to a collision with a submerged or floating object.

4.8.6.4 The Administration should be satisfied that the structures and components provided to sustain operation in the non-displacement mode should, in the event of specified damage or failure, provide adequate residual stability in order that the craft may continue safe operation to the nearest place where the passengers and crew could be placed in safety, provided caution is exercised in handling.

4.8.6.5 In designs where periodic use of cushion deformation is employed as a means of assisting craft control or periodic use of cushion air exhausting to atmosphere for purposes of craft manoeuvring, the effects upon cushion-borne stability should be determined, and the limitations on the use by virtue of craft speed or attitude should be established.

4.8.7 *Methods relating to the intact stability investigation of hydrofoil boats*

The stability of these craft should be considered in the hull-borne, transient and foil-borne modes. The stability investigation should also take into account the effects of external forces. The following procedures are outlined for guidance in dealing with stability.

4.8.7.1 *Surface-piercing hydrofoils*

4.8.7.1.1. Hull-borne mode

4.8.7.1.1.1 Stability

The stability should be sufficient to satisfy 4.8.5.

4.8.7.1.1.2 Heeling moment due to turning

The heeling moment developed during manoeuvring of the craft in the displacement mode may be derived from the following formula:

$$M_R = \frac{0.196 V_o^2 \Delta KG}{L}$$

where:

M_R = moment of heeling (kN m)

V_o = speed of the craft in the turn (m/s)

Δ = displacement (t)

KG = height of the centre of gravity above keel (m)

L = length of the craft on the waterline (m)

This formula is applicable when the ratio of the radius of the turning circle to the length of the craft is 2 to 4.

4.8.7.1.1.3 Relationship between the capsizing moment and heeling moment to satisfy the weather criterion

The stability of the hydrofoil boat in the displacement mode can be checked for compliance with the weather criterion K as follows:

$$K = \frac{M_C}{M_V} \geq 1$$

where:

M_c = minimum capsizing moment as determined when account is taken of rolling

M_v = dynamically applied heeling moment due to the wind pressure

4.8.7.1.1.4 Heeling moment due to wind pressure

This heeling moment M_v is a product of wind pressure P_w, the windage area A_v and the lever of windage area Z.

M_v = 0,001 $P_V A_v Z$ (kN m)

The value of the heeling moment is taken as constant during the whole period of heeling.

The windage area A_v is considered to include the projections of the lateral surfaces of the hull, superstructure and various structures above the waterline. The windage area lever Z is the vertical distance to the centre of windage form the waterline and the position of the centre of windage may be taken as the centre of the area.

The values of the wind pressure (in Pa) associated with Force 7 Beaufort scale depending on the position of the centre of windage area are given in table 4.8.7.1.1.4.

Table 4.8.7.1.1.4 - *Typical wind pressures for Beaufort scale 7; 100 nautical miles from land*

Z above waterline (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
P_v(PA)	46	46	50	53	56	58	60	62	64

Note: These values may not be applicable in all areas

4.8.7.1.1.5 Evaluation of the minimum capsizing moment M_c in the displacement mode

The minimum capsizing moment is determined from the static and dynamic stability curves, taking rolling into account.

4.8.7.1.1.5.1 When the static stability curve is used, M_c is determined by equating the areas under the curves of the capsizing and righting moments (or levers) taking rolling into account - as indicated by figure 4.8.7-1, where θ_z is the amplitude of roll and MK is a line drawn parallel to the abscissa axis such that the shaded areas S_1, and S_2 are equal.

M_c = OM, if the scale of ordinates represents moments

M_c = OM x displacement, if the scale of ordinates represents levers

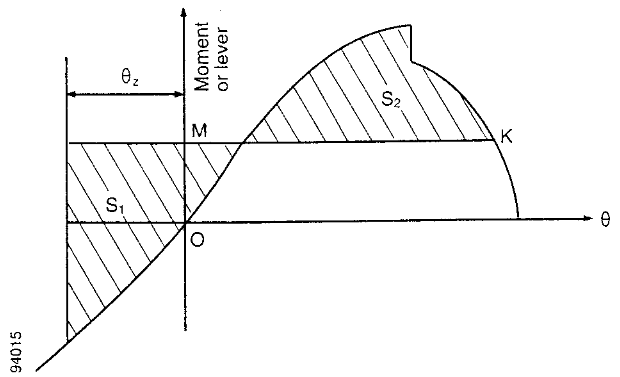

Figure 4.8.7-1

4.8.7.1.1.5.2 When the dynamic stability curve is used, first an auxiliary point A should be determined. For this purpose the amplitude of heeling is plotted to the right along the abscissa axis and a point A' is found (see figure 4.8.7-2). A line AA' is drawn parallel to the abscissa axis equal to the double amplitude of heeling (AA'= 20_z) and the required auxiliary point A is found. A tangent AC to the dynamic stability curve is drawn.

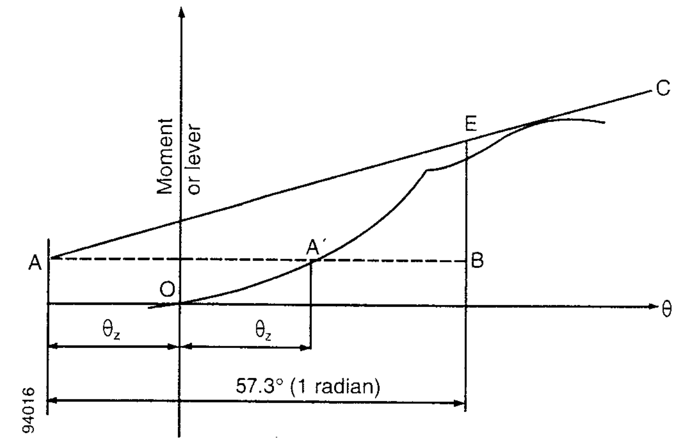

Figure 4.8.7-2 *Dynamic stability curve*

From the point A the line AB is drawn parallel to the abscissa axis and equal to 1 radian (57.3°). From the point B a perpendicular is drawn to intersect with the tangent in point E. The distance $\overline{BE}$ equal to the capsizing moment if measured along the ordinate axis of the dynamic stability curve. If, however, the dynamic stability levers are plotted along this axis, $\overline{BE}$ is then the capsizing lever and in this case the capsizing moment M_c is determined by multiplication of ordinate $\overline{BE}$ in metres by the corresponding displacement in tonnes.

$$M_c = 9.81\ \Delta\ \overline{BE}\ \text{(kN m)}$$

4.8.7.1.1.5.3 The amplitude of rolling θ_z is determined by means of model and full-scale tests in irregular seas as a maximum amplitude of rolling of 50 oscillations, of a craft travelling at 90° to the wave direction in sea state for the worst design condition. If such data are lacking the amplitude is assumed to be equal to 15°.

4.8.7.1.1.5.4 The effectiveness of the stability curves should be limited to the angle of flooding.

4.8.7.1.2 Stability in the transient and foil-borne modes

4.8.7.1.2.1 The stability should satisfy the provisions of 4.8.6 of this chapter.

4.8.7.1.2.2.1 The stability in the transient and foil-borne modes should be checked for all cases of loading for the intended service of the craft.

4.8.7.1.2.2.2 The stability in the transient and foil-borne modes may be determined either by calculation or on the basis of data obtained from model experiments and should be verified by full-scale tests by the imposition of a series of known heeling moments by off-centre ballast weights, and recording the heeling angles produced by these moments. When taken in the hull-borne, take-off, steady foil-borne and settling to hull-borne modes, these results will provide an indication of the values of the stability in the various situations of the craft during the transient condition.

4.8.7.1.2.2.3 The time to pass from the hull-borne mode to foil-borne mode and vice versa should be established. This period of time should not exceed two minutes.

4.8.7.1.2.2.4 The angle of heel in the foil-borne mode caused by the concentration of passengers at one side should not exceed 8°. During the transient mode the angle of heel due to the concentration of passengers on one side should not exceed 12°. The concentration of passengers should be determined by the Administration, having regard to the guidance given in 4.8.8.

4.8.7.1.2.3 One of the possible methods of assessing foil-borne metacentric height (GM) in the design stage for a particular foil configuration is given in figure 4.8.7-3.

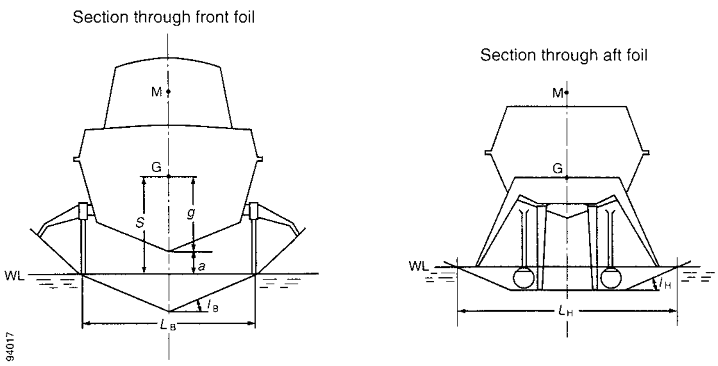

Figure 4.8.7-3

$$GM = n_B \left(\frac{L_B}{2\tan/_B} - S \right) + n_H \left(\frac{L_H}{2\tan/_H} - S \right)$$

where:

n_B = percentage of hydrofoil load borne by front foil

n_H = percentage of hydrofoil load borne by aft foil

L_B = clearance width of front foil

L_H = clearance width of aft foil

a = clearance between bottom of keel and water

g = height of centre of gravity above bottom of keel

l_B = angle at which front foil is inclined to horizontal

l_H = angle at which aft foil is inclined to horizontal

4.8.7.2 *Fully submerged hydrofoils*

4.8.7.2.1 Hull-borne mode

4.8.7.2.1.1 The stability in the hull-borne mode should be sufficient to satisfy the requirements given in 4.8.5.

4.8.7.2.1.2 Paragraphs 4.8.7.1.1.2 to 4.8.7.1.1.5 of this section are appropriate to this type of craft in the hull-borne mode.

4.8.7.2.2 Transient mode

4.8.7.2.2.1 The stability should be examined by the use of verified computer simulations to evaluate the craft's motions, behaviour and responses under the normal conditions and limits of operation and under the influence of any malfunction.

4.8.7.2.2.2 The stability conditions resulting from any potential failures in the systems or operational procedures during the transient stage which could prove hazardous to the craft's watertight integrity and stability should be examined.

4.8.7.2.3 Foil-borne mode

The stability of the craft in the foil-borne mode should be in compliance with 4.8.6 and 4.8.7.2.2.

4.8.7.2.4 Paragraphs 4.8.7.1.2.2.1 to 4.8.7.1.2.2.4 should be applied to this type of craft as appropriate and any computer simulations or design calculations should be verified by full-scale tests.

4.8.8 *Passenger loading*

4.8.8.1 A mass of 75 kg should be assumed per passenger except that this value may be reduced to not less than 60 kg where this can be justified. In addition, the mass and distribution of the luggage should be to the satisfaction of the Administration.

4.8.8.2 The height of the centre of gravity for passengers should be assumed equal to:

.1 1 m above deck level for passengers standing upright. Account may be taken, if necessary, of camber or sheer of deck.

.2 0.30 m above the seat in respect of seated passengers.

4.8.8.3 Passengers and luggage should be considered to be in the space normally at their disposal.

4.8.8.4 Passengers should be considered as distributed to produce the most unfavourable combination of passenger heeling moment and/or initial metacentric height which may be obtained in practice. In this connection, it is anticipated that a value higher than four persons per square metre will not be necessary.

4.9 Containerships greater than 100 m

4.9.1 *Application*

These requirements apply to containerships greater than 100 m as defined in 1.3.12. They may also be applied to other cargo ships with considerable flare or large waterplane areas. The Administration may apply the following criteria instead of those in paragraphs 3.1.2.1 to 3.1.2.4.

4.9.2 *Intact stability*

4.9.2.1 The area under the righting lever curve (GZ curve) should not be less than 0.009/C metre-radian up to $\theta = 30°$ angle of heel and not less than 0.016/C metre-radian up to $\theta = 40°$ or the angle of flooding θ_f (as defined in 3.1.2) if this angle is less than 40°.

4.9.2.2 Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40° or between 30° andθ_f if this angle is less than 40°, should not be less than 0.006/C metre-radian.

4.9.2.3 The righting lever GZ should be at least 0.033/C m at an angle of heel equal or greater than 30°.

4.9.2.4 The maximum righting lever GZ should be at least 0.042/C m.

4.9.2.5 The total area under the righting lever curve (GZ curve) up to the angle of flooding θ_f should not be less than 0.029/C metre-radian.

4.9.2.6 In the above criteria the form factor C should be calculated using the formula and figure 4.9-1:

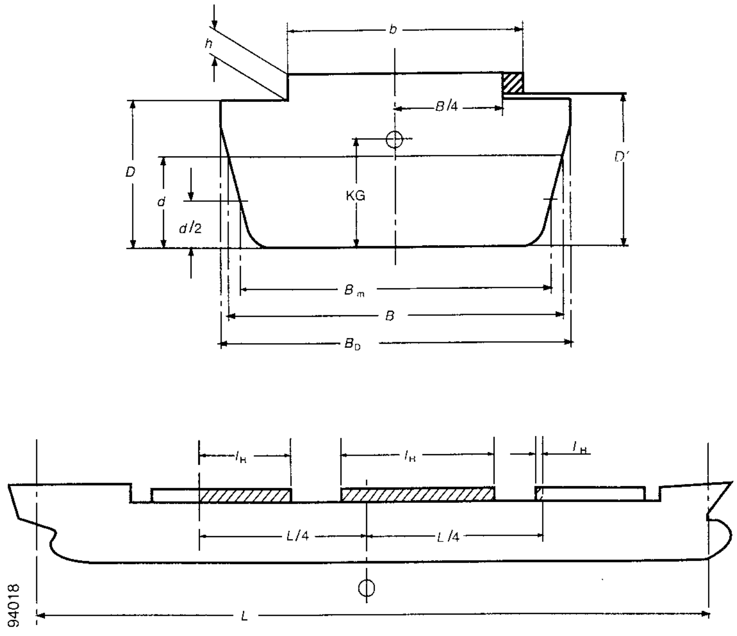

Figure 4.9-1

$$C = \frac{dD'}{B_m^2} - \sqrt{\frac{d}{\mathrm{KG}}\left(\frac{C_B}{C_W}\right)}^{2}\sqrt{\frac{100}{L}}$$

where:

d = mean draught (m)

D' = $D + h\left(\frac{2b - B_D}{B_D}\right)\left(\frac{2\sum l\mathrm{H}}{L}\right)$ as defined in figure 4.9-1

D = moulded depth of the ship (m)

B = moulded breadth of the ship (m)

KG = height of the centre of gravity above the keel (m); not to be taken as less than d

C_B = block coefficient

C_w = waterplane coefficient.

4.9.3 The use of electronic loading and stability computers is encouraged in determining the ship's trim and stability during different operational conditions.

CHAPTER 5 - ICING CONSIDERATIONS

5.1 General

5.1.1 For any ship operating in areas where ice accretion is likely to occur, adversely affecting a ship's stability, icing allowances should be included in the analysis of conditions of loading.

5.1.2 Administrations are advised to take icing into account and are permitted to apply national standards where environmental conditions are considered to warrant a higher standard than those recommended in the following sections.

5.2 Cargo ships carrying timber deck cargoes

5.2.1* The master should establish or verify the stability of his ship for the worst service condition, having regard to the increased weight of deck cargo due to water absorption and/or ice accretion and to variations in consumables.[38]

5.2.2 When timber deck cargoes are carried and it is anticipated that some formation of ice will take place, an allowance should be made in the arrival condition for the additional weight.

5.3 Fishing vessels

The calculations of loading conditions for fishing vessels (see section 4.2.5) should, where appropriate, include allowance for ice accretion, in accordance with the following provisions.

5.3.1* *Allowance for ice accretion*[39]

For vessels operating in areas where ice accretion is likely to occur, the following icing allowance should be made in the stability calculations:

- **.1** 30 kg per square metre on exposed weather decks and gangways;
- **.2** 7.5 kg per square metre for projected lateral area of each side of the vessel above the water plane;
- **.3** the projected lateral area of discontinuous surfaces of rail, sundry booms, spars (except masts) and rigging of vessels having no sails and the projected lateral area of other small objects should be computed by increasing the total projected area of continuous surfaces by 5% and the static moments of this area by 10%.

Vessels intended for operation in areas where ice is known to occur should be:

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[38] Refer to regulation 44(10) of the 1966 Load Line Convention and regulation 44(7) of the 1988 Load Line Protocol.

[39] Refer to regulation III/8 of the 1993 Torremolinos Protocol.

.1 designed to minimize the accretion of ice; and

.2 equipped with such means for removing ice as the Administration may require; for example, electrical and pneumatic devices, and/or special tools such as axes or wooden clubs for removing ice from bulwarks, rails and erections.

5.3.2 *Guidance relating to ice accretion*

In the application of the above standards the following icing areas should apply:

.1 the area north of latitude 65°30´N between longitude 28°W and the west coast of Iceland; north of the north coast of Iceland; north of the rhumb line running from latitude 66°N, longitude 15°W to latitude 73°30´N, longitude 15°E, north of latitude 73°30´N between longitude 15°E and 35°E, and east of longitude 35° E, as well as north of latitude 56° in the Baltic Sea;

.2 the area north of latitude 43°N bounded in the west by the North American coast and the east by the rhumb line running from latitude 43°N, longitude 48°W to latitude 63°N, longitude 28°W and thence along longitude 28°W;

.3 all sea areas north of the North American Continent, west of the areas defined in .1 and .2;

.4 the Bering and Okhotsk Seas and the Tartary Strait during the icing season; and

.5 south of latitude 60°.

A chart to illustrate the areas is attached at the end of this chapter.

For vessels operating in areas where ice accretion may be expected:

.1 within the areas defined in .1, 3, .4 and .5 known to having icing conditions significantly different from those described in 5.3.1, ice accretion requirements of one half to twice the required allowance may be applied;

.2 within the area defined in .2, where ice accretion in excess of twice the allowance required by 5.3.1 may be expected, more severe requirements than those given in 5.3.1 may be applied.

5.3.3 *Brief survey of the causes of ice formation and its influence upon the seaworthiness of the vessel*

5.3.3.1 The skipper of a fishing vessel should bear in mind that ice formation is a complicated process which depends upon meteorological conditions, condition of loading and behaviour of the vessel in stormy weather as well as on the size and location of superstructures and rigging. The most common cause of ice formation is the deposit of water droplets on the vessel's structure. These droplets come from spray driven from wave crests and from ship-generated spray.

5.3.3.2 Ice formation may also occur in conditions of snowfall, sea fog (including arctic sea smoke), a drastic fall in ambient temperature, as well as from the freezing of drops of rain on impact with the vessel's structure.

5.3.3.3 Ice formation may sometimes be caused or accentuated by water shipped on board and retained on deck.

5.3.3.4 Intensive ice formation generally occurs on stem, bulwark and bulwark rail, front walls of superstructures and deck-houses, hawse holes, anchors, deck gear, forecastle deck and upper deck, freeing ports, aerials, stays, shrouds, masts and spars.

5.3.3.5 It should be borne in mind that the most dangerous areas as far as ice formation is concerned are the sub-Arctic regions.

5.3.3.6 The most intensive ice formation takes place when wind and sea come from ahead. In beam and quartering winds, ice accumulates quicker on the windward side of the vessel, thus leading to a constant list which is extremely dangerous.

5.3.3.7 Listed below are meteorological conditions causing the most common type of ice formation due to spraying of a vessel. Examples of the weight of ice formation on a typical fishing vessel of displacement in the range 100 tonnes to 500 tonnes are also given. For larger vessels the weight will be correspondingly greater.

5.3.3.8 Slow accumulations of ice take place:

.1 at ambient temperature from -1°C to -30°C and any wind force;

.2 at ambient temperature -4°C and lower and wind force from 0 to 9 m/s;

.3 under the conditions of precipitation, fog or sea mist followed by a drastic fall of the ambient temperature.

Under all these conditions the intensity of ice accumulation may not exceed 1.5 t/h.

5.3.3.9 At ambient temperature of -4°C to -8°C and wind force 10 to 15 m/s, rapid accumulation of ice takes place. Under these conditions the intensity of ice accumulation can lie within the range 1.5 to 4 t/h.

5.3.3.10 Very fast accumulation of ice takes place:

.1 at ambient temperature of -4°C and lower and wind forces of 16 m/s and over;

.2 at ambient temperature -9°C and lower and wind force 10 to 15 m/s.

Under these conditions the intensity of ice accumulation can exceed 4 t/h.

5.3.3.11 The skipper should bear in mind that ice formation adversely affects the seaworthiness of the vessel as ice formation leads to:

.1 an increase in the weight of the vessel due to accumulation of ice on the vessel's surfaces which causes the reduction of freeboard and buoyancy;
.2 a rise of the vessel's centre of gravity due to the high location of ice on the vessel's structures with corresponding reduction in the level of stability;
.3 an increase of windage area due to ice formation on the upper parts of the vessel and hence an increase in the heeling moment due to the action of the wind;
.4 a change of trim due to uneven distribution of ice along the vessel's length;
.5 the development of a constant list due to uneven distribution of ice across the breadth of the vessel;
.6 impairment of the manoeuvrability and reduction of the speed of the vessel.

5.3.4 Operational procedures related to ensuring a fishing vessel's endurance in conditions of ice formation are given in annex 2.

5.4 Offshore supply vessels 24 m to 100 m in length

For vessels operating in areas where ice accretion is likely to occur:
.1 no shutters should be fitted in the freeing ports;
.2 with regard to operational precautions against capsizing, reference is made to the recommendations for skippers of fishing vessels on ensuring a vessel's endurance in conditions of ice formation, as given in paragraph 5.3.3 and in annex 2.

5.5 Dynamically supported craft

5.5.1 Account should be taken of the effect of icing on the stability calculations. An example of established practice for ice accretion allowances is given in paragraphs 5.3.1 and 5.3.2 for the guidance of Administrations.

5.5.2 Information should be provided in respect of the assumptions made in calculating the conditions of the craft in each of the circumstances set out in paragraphs 5.3.1 and 5.3.2 for the following:
.1 duration of the voyage in terms of the period spent in reaching the destination and returning to port;
.2 consumption rates during the voyage for fuel, water, stores and other consumables
.

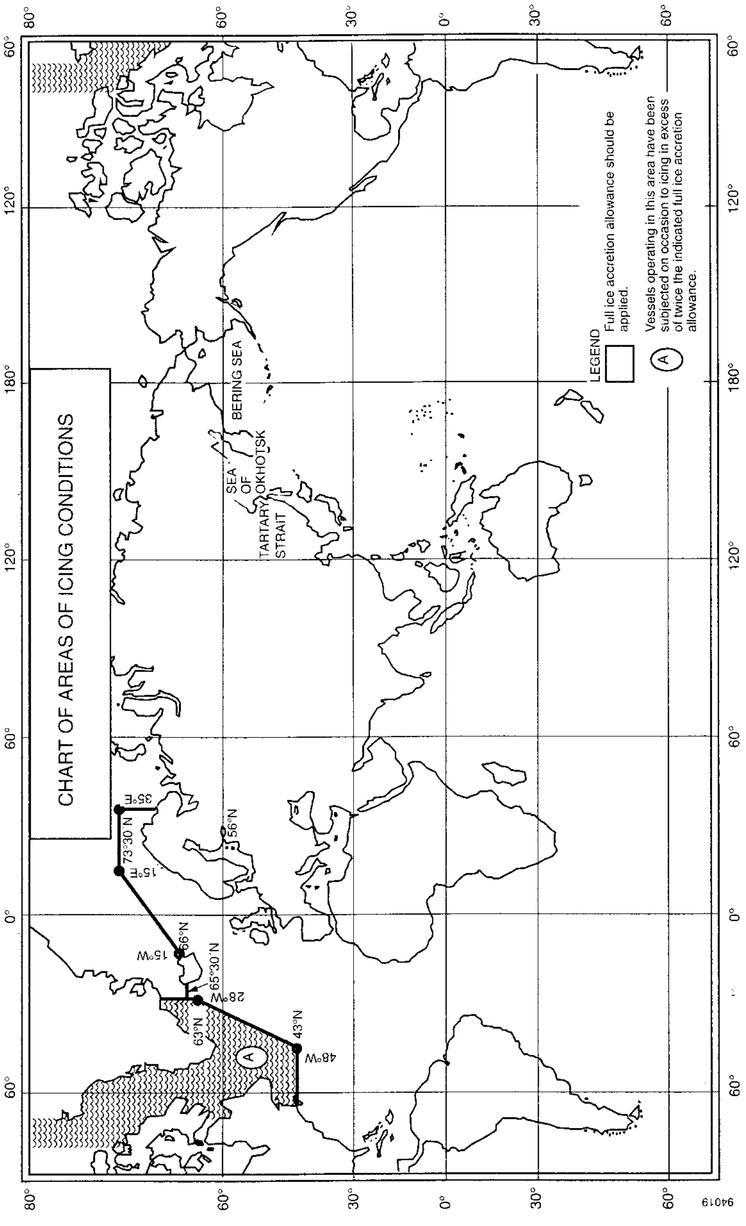


CHART OF AREAS OF ICING CONDITIONS
LEGEND
Full ice accretion allowance should be applied.
Vessels operating in this area have been subjected on occasion to icing in excess of twice the indicated full ice accretion allowance.
BERING SEA
SEA OF OKHOTSK
TARTARY STRAIT
35°E
73°30 N
15°E
56°N
66°N
15°W
65°30 N
28°W
63°N
43°N
48°W
94019

CHAPTER 6 - CONSIDERATIONS FOR WATERTIGHT INTEGRITY

6.1 Hatchways

6.1.1* Cargo and other hatchways in ships to which the International Convention on Load Lines, 1966, applies should comply with regulations 13, 14, 15, 16 and 26(4) of this Convention.

6.1.2* Hatchways in fishing vessels to which the 1993 Torremolinos Protocol applies should comply with regulations II/5 and II/6 of this Protocol.

6.1.3 In decked fishing vessels of 12 m in length and over but less than 24 m in length hatchways should comply with the following:

.1 All hatchways should be provided with covers and those which may be opened during fishing operations should normally be arranged near to the vessel's centreline.

.2 For the purpose of strength calculations it should be assumed that hatchway covers other than wood are subject to static load of 10 kN/m^2 or the weight of cargo intended to be carried on them, whichever is the greater.

.3 Where covers are constructed of mild steel, the maximum stress according to 6.1.3.2 multiplied by 4.25 should not exceed the minimum ultimate strength of the material. Under these loads the deflections should not be more than 0.0028 times the span.

.4 Covers made of materials other than mild steel or wood should be at least of equivalent strength to those made of mild steel and their construction should be of sufficient stiffness to ensure weathertightness under the loads specified in 6.1.3.2.

.5 Covers should be fitted with clamping devices and gaskets or other equivalent arrangements sufficient to ensure weathertightness.

.6 The use of wooden hatchway covers is generally not recommended in view of the difficulty of rapidly securing their weathertightness. However, where fitted they should be capable of being secured weathertight.

.7 The finished thickness of wood hatchway covers should include an allowance for abrasion due to rough handling. In any case, the finished thickness of these covers should be at least 4 mm for each 100 mm of unsupported span subject to a minimum of 40 mm and the width of their bearing surfaces should be at least 65 mm.

.8 The height above deck of hatchway coamings on exposed parts of the working deck should be at least 300 mm for vessels of 12 m in length and at least 600 mm for vessels of 24 m in length. For vessels of intermediate length the minimum height should be obtained by linear interpolation.

The height above deck of hatchway coamings on exposed parts of the superstructure deck should be at least 300 mm.

.9 Where operating experience has shown justification and on approval of the competent authority the height of hatchway coamings, except those which give direct access to machinery spaces may be reduced from the height as specified in 6.1.3.8 or the coamings may be omitted entirely, provided that efficient watertight hatch covers other than wood are fitted. Such hatchways should be kept as small as practicable and the covers should be permanently attached by hinges or equivalent means and be capable of being rapidly closed or battened down.

6.2 Machinery space openings

6.2.1* In ships to which the International Convention on Load Lines, 1966, applies machinery space openings should comply with regulation 17.

6.2.2* In fishing vessels to which the 1993 Torremolinos Protocol should be met:

.1 Machinery space openings should be framed and enclosed by casings of a strength equivalent to the adjacent superstructure. External access openings therein should be fitted with doors complying with the requirements of regulation II/4 of the Protocol or, in vessels less than 24 m in length, with hatch covers other than wood complying with the requirements of 6.1.3 of this chapter.

.2 Openings other than access openings should be fitted with covers of equivalent strength to the unpierced structure, permanently attached thereto and capable of being closed weathertight

6.2.3 In offshore supply vessels, access to the machinery space should, if possible, be arranged within the forecastle. Any access to the machinery space from the exposed cargo deck should be provided with two weathertight closures. Access to spaces below the exposed cargo deck should preferably be from a position within or above the superstructure deck.

6.3 Doors

6.3.1* In passenger ships to which the International Convention for the Safety of Life at Sea, 1974, applies, doors should comply with regulations II-1/15 and 18 of this Convention.

6.3.2* In ships to which the International Convention on Load Lines, 1966, applies, doors should comply with regulation 12 of this Convention.

6.3.3* In fishing vessels to which the 1993 Torremolinos Protocol applies, doors should comply with regulation II/2 and regulation II/4 of this Protocol.

6.3.4 In decked fishing vessels of 12 m in length and over but less than 24 m in length:

.1 Watertight doors may be of the hinged type and should be capable of being operated locally from each side of the door. A notice should be attached to the door on each side stating that the door should be kept closed at sea.

.2 All access openings in bulkheads of enclosed deck erections, through which water could enter and endanger the vessel, should be fitted with doors permanently attached to the bulkhead, framed and stiffened so that the whole structure is of equivalent strength to the unpierced structure, and weathertight when closed, and means should be provided so that they can be operated from each side of the bulkhead.

.3 The height above deck of sills in those doorways, companionways, deck erections and machinery casings situated on the working deck and on superstructure decks which give direct access to parts of that deck exposed to the weather and sea should be at least equal to the height of hatchway coamings as specified in 6.1.3.8.

.4 Where operating experience has shown justification and on approval of the competent authority, the height above deck of sills in the doorways specified in 6.3.4.3 except those giving direct access to machinery spaces, may be reduced to not less than 150 mm on superstructure decks and not less than 380 mm on the working deck for vessels 24 m in length, or not less than 150 mm on the working deck for vessels of 12 m in length. For vessels of intermediate length the minimum acceptable reduced height for sills in doorways on the working deck should be obtained by linear interpolation.

6.4 Cargo ports and other similar openings

6.4.1* Cargo ports and other similar openings in ships to which the International Convention on Load Lines, 1966, applies should comply with regulation 21 of this Convention.

6.4.2* Openings through which water can enter the vessel and fish flaps on stern trawlers in fishing vessels to which the 1993 Torremolinos Protocol applies should comply with regulation II/3 of this Protocol.

6.5 Sidescuttles, window scuppers, inlets and discharges

6.5.1 * In passenger ships to which the International Convention for the Safety of Life at Sea, 1974, applies, openings in shell plating below the margin line should comply with regulation II-I/14 of this Convention. Watertight integrity above the margin line should comply with regulation II-1/17 of this Convention.

6.5.2* In ships to which the International Convention on Load lines, 1966, applies, scuppers, inlets and discharges should comply with regulation 22 and sidescuttles should comply with regulation 23 of this Convention.

6.5.3* In fishing vessels to which the 1993 Torremolinos Protocol applies, sidescuttles and windows should comply with regulation II/12 and inlets and discharges should comply with regulation II/13 of this Protocol.

6.5.4 In decked fishing vessels of 12 m in length and over but less than 24 m in length, sidescuttles, windows and other openings and inlets and discharges should comply with the following:

.1 Sidescuttles to spaces below the working deck and to enclosed spaces on the working deck should be fitted with hinged deadlights capable of being closed watertight.

.2 Sidescuttles should be fitted in a position such that their sills are above a line drawn parallel to the working deck at side having its lowest point 500 mm above the deepest operating waterline.

.3 Sidescuttles, together with their glasses and deadlights, should be of substantial construction to the satisfaction of the competent authority.

.4 Skylights leading to spaces below the working deck should be of substantial construction and capable of being closed and secured weathertight, and with provision for adequate means of closing in the event of damage to the inserts. Skylights leading to machinery spaces should be avoided as far as practicable.

.5 Toughened safety glass or suitable permanently transparent material of equivalent strength should be fitted in all wheelhouse windows exposed to the weather. The means of securing windows and the width of the bearing surfaces should be adequate, having regard to the window material used. Openings leading to spaces below deck from a wheelhouse whose windows are not provided with the protection required by 6 should be fitted with a weathertight closing appliance.

.6 Deadlights or a suitable number of storm shutters should be provided where there is no other method of preventing water from entering the hull through a broken window or sidescuttle.

.7 The competent authority may accept sidescuttles and windows without deadlights in side or aft bulkheads of deck erections located on or above the working deck if satisfied that the safety of the vessel will not be impaired.

.8 The number of openings in the sides of the vessel below the working deck should be the minimum compatible with the design and proper working of the vessel and such openings should be provided with closing arrangements of adequate strength to ensure watertightness and the structural integrity of the surrounding structure.

.9 Discharges led through the shell either from spaces below the working deck or from spaces within deck erections should be fitted with efficient and accessible means for preventing water from passing inboard. Normally each separate discharge should have an automatic nonreturn valve with a positive means of closing it from a readily accessible position. Such a valve is not required if the competent authority considers that the entry of water into the vessel through the opening is not likely to lead to dangerous flooding and that the thickness of the pipe is sufficient.

The means for operating the valve with a positive means of closing should be provided with an indicator showing whether the valve is open or closed. The open inboard end of any discharge system should be above the deepest operating waterline at an angle of heel satisfactory to the competent authority.

.10 In machinery spaces main and auxiliary sea inlets and discharges essential for the operation of machinery should be controlled locally. Controls should be readily accessible and should be provided with indicators showing whether the valves are open or closed. Suitable warning devices should be incorporated to indicate leakage of water into the space.

.11 Fittings attached to the shell and all valves should be of steel, bronze or other ductile material. All pipes between the shell and valves should be of steel, except that in vessels constructed of material other than steel, other suitable materials may be used.

6.6 Other deck openings

6.6.1* Miscellaneous openings in freeboard and superstructure decks in ships to which the international Convention on Load Lines, 1966, applies should comply with regulation 18 of this Convention.

6.6 .2* In decked fishing vessels of 12 m and over where it is essential for fishing operations, flush deck scuttles of the screw, bayonet or equivalent type and manholes may be fitted provided these are capable of being closed watertight and such devices should be permanently attached to the adjacent structure. Having regard to the size and disposition of the openings and the design of the closing devices, metal-to-metal closures may be fitted if they are effectively watertight. Openings other than hatchways, machinery space openings, manholes and flush scuttles in the working or superstructure deck should be protected by enclosed structures fitted with weathertight doors or their equivalent. Companionways should be situated as close as practicable to the centreline of the vessel.[40]

6.7 Ventilators, air pipes and sounding devices

[40] Refer to regulation II/8 of the 1993 Torremolinos Protocol.

6.7.1* Ventilators in ships to which the International Convention on Load Lines, 1966, applies should comply with regulation 19 and air pipes should comply with regulation 20 of this Convention.

6.7.2* Ventilators in fishing vessels to which the 1993 Torremolinos Protocol applies should comply with regulation II/9 and air pipes should comply with regulation II/10 of this Protocol. Sounding devices should comply with regulation II/11 of this Protocol.

6.7.3 Ventilators and air pipes in fishing vessels of 12 m in length and over but less than 24 m in length should comply with the following:

.1 Ventilators should have coamings of substantial construction and should be capable of being closed weathertight by devices permanently attached to the ventilator or adjacent structure. Ventilators should be arranged as close to the vessel's centreline as possible and, where practicable, should extend through the top of a deck erection or companionway.

.2 The coamings of ventilators should be as high as practicable. On the working deck the height above deck of coamings of ventilators, other than machinery space ventilators, should be not less than 760 mm and on superstructure decks not less than 450 mm. When the height of such ventilators may interfere with the working of the vessel their coaming heights may be reduced to the satisfaction of the competent authority. The height above deck of machinery space ventilator openings should be to the satisfaction of the competent authority.

.3 Closing appliances need not be fitted to ventilators the coamings of which extend more than 2.5 m above the working deck or more than 1.0 m above a deck-house top or superstructure deck.

.4 Where air pipes to tanks or other spaces below deck extend above the working or superstructure decks the exposed parts of the pipes should be of substantial construction and, as far as is practicable, located close to the vessel's centreline and protected from damage by fishing or lifting gear. Openings of such pipes should be protected by efficient means of closing, permanently attached to the pipe or adjacent structure, except that where the competent authority is satisfied that they are protected against water trapped on deck, these means of closing may be omitted.

.5 Where air pipes are situated near the side of the vessel their height above deck to the point where water may have access below should be at least 760 mm on the working deck and at least 450 mm on the superstructure deck. The competent authority may accept reduction of the height of an air pipe to avoid interference with the fishing operations.

6.7.4 In offshore supply vessels air pipes and ventilators should comply with the following:

.1 Air pipes and ventilators should be fitted in protected positions in order to avoid damage by cargo during operations and to minimize the possibility of flooding. Air pipes on the exposed cargo and forecastle decks should be fitted with automatic closing devices.

.2 Due regard should be given to the position of machinery space ventilators. Preferably they should be fitted in a position above the superstructure deck, or above an equivalent level if no superstructure deck is fitted.

6.8 Freeing ports

6.8.1* Where bulwarks on the weather portion of freeboard or superstructure decks or, in fishing vessels, working decks form wells, freeing ports should be arranged along the length of the bulwark as to ensure that the deck is freed of water most rapidly and effectively. Lower edges of freeing ports should be as near the deck as practicable.[41]

6.8.2* In ships to which the International Convention on Load Lines, 1966, applies freeing ports should comply with regulation 24 of this Convention, which is as follows:

.1 Except as provided in subparagraphs.2 and 3, the minimum freeing port area (A) on each side of the ship for each well on the freeboard deck should be that given by the following formulae in cases where the sheer in way of the well is standard or greater than standard. The minimum area for each well on superstructure decks should be one-half of the area given by the formulae.

Where the length of bulwark (l) in the well is 20 m or less,

$A = 0.7 + 0.035l$ square metres;

where l exceeds 20 metres,

$A = 0.07l$ square metres;

(in no case should l be taken greater than $0.7L$).

If the bulwark is more than 1.2 m in average height the required area should be increased by 0.004 square metres per metre of length of well for each 0.1 m difference in height. If the bulwark is less than 0.9 m in average height, the required area may be decreased by 0.004 square metres per metre of length of well for each 0.1 m difference in height.

.2 In ships with no sheer the calculated area should be increased by 50%. Where the sheer is less than the standard, the percentage should be obtained by interpolation.

[41] Refer to regulation 24(5) of the 1966 LL Convention and regulation II/14(4) of the 1993 Torremolinos Protocol.

.3 Where a ship is fitted with a trunk which does not comply with the requirements of regulation 36(1)(e) of the international Convention on Load Lines, 1966, or where continuous or substantially continuous hatchway side coamings are fitted between detached superstructures the minimum area of the freeing port openings should be calculated from the following table:

Breadth of hatchway or trunk in relation to the breadth of ship	Area of freeing ports in relation to the total area of the bulwarks
40% or less 75% or more	20% 10%

The area of freeing ports at intermediate breadths should be obtained by linear interpolation.

.4 In ships having superstructures which are open at either or both ends, adequate provision for freeing the space within such superstructures should be provided to the satisfaction of the Administration.

.5 Two-thirds of the freeing port area required should be provided in the half of the well nearest the lowest point of the sheer curve.

.6 All such openings in the bulwarks should be protected by rails or bars spaced approximately 230 mm apart. If shutters are fitted to freeing ports, ample clearance should be provided to prevent jamming. Hinges should have pins or bearings of non-corrodible material. If shutters are fitted with securing appliances, these appliances should be of approved construction.

6.8.3* In decked fishing vessels of 12 m in length and over, freeing ports should comply with the following:[42]

.1 The minimum freeing port area (A) in square metres, on each side of the vessel for each well on the working deck, should be determined in relation to the length (l) and height of bulwark in the well as follows:

.1.1 $A = \text{K} \times l$

where: K = 0.07 for vessels of 24 m in length and over

K = 0.035 for vessels of 12 m in length;

for intermediate lengths the value of K should be obtained by linear interpolation (l need not be taken as greater than 70% of the vessel's length).

.1.2 Where the bulwark is more than 1.2 m in average height, the required area should be increased by 0.004 square metres per metre of length of well for each 0.1 m difference in height.

[42] Refer to regulation II/4 of the 1993 Torremolinos Protocol.

.1.3 Where the bulwark is less than 0.9 m in average height, the required area may be decreased by 0.004 square metres per metre of length of well for each 0.1 m difference in height.

.2 The freeing port area calculated according to .1 should be increased where the Administration or competent authority considers that the vessel's sheer is not sufficient to ensure rapid and effective freeing of the deck of water.

.3 Subject to the approval of the Administration or competent authority, the minimum freeing port area for each well on the superstructure deck should be not less than one-half the area (A) given in .1 except that where the superstructure deck forms a working deck for fishing operations the minimum area on each side should be not less than 75% of the area (A).

.4 Freeing ports should be so arranged along the length of bulwarks as to provide the most rapid and effective freeing of the deck from water. Lower edges of freeing ports should be as near the deck as practicable.

.5 Pound boards and means for stowage and working the fishing gear should be arranged so that the effectiveness of the freeing ports will not be impaired or water trapped on deck and prevented from easily reaching the freeing ports. Pound boards should be so constructed that they can be locked in position when in use and will not hamper the discharge of shipped water.

.6 Freeing ports over 0.3 m in depth should be fitted with bars spaced not more than 0.23 m nor less than 0.15 m apart or provided with other suitable protective arrangements. Freeing port covers, if fitted, should be of approved construction. If devices are considered necessary for locking freeing port covers during fishing operations they should be to the satisfaction of the competent authority and easily operable from a readily accessible position.

.7 In vessels intended to operate in areas subject to icing, covers and protective arrangements for freeing ports should be capable of being easily removed to restrict ice accumulation. Size of opening and means provided for removal of these protective arrangements should be to the satisfaction of the competent authority.

.8 In addition, in fishing vessels of 12 m in length and above but less than 24 m in length where wells or cockpits are fitted in the working deck or superstructure deck with their bottoms above the deepest operating waterline, efficient non-return means of drainage overboard should be provided. Where bottoms of such wells or cockpits are below the deepest operating waterline, drainage to the bilges should be provided.

6.8.4 In offshore supply vessels the Administration should give special attention to adequate drainage of pipe stowage positions, having regard to the individual characteristics of the vessel. However, the area provided for drainage of the pipe stowage positions should be in excess of the required freeing port area in the cargo deck bulwark and should not be fitted with shutters.

6.9 Miscellaneous

6.9.1 Ships engaged in towing operations should be provided with means for quick release of the towing hawser.

CHAPTER 7 - DETERMINATION OF LIGHT-SHIP DISPLACEMENT AND CENTRES OF GRAVITY

7.1 Application

7.1.1* Every passenger ship regardless of size and every cargo ship having a length, as defined in the International Convention on Load Lines, 1966, of 24 m and upwards should be inclined upon its completion and the elements of its stability determined.[19]

7.1.2* Where any alterations are made to a ship so as to materially affect the stability, the ship should be re-inclined.[43]

7.1.3* At periodic intervals not exceeding five years, a light-weight survey should be carried out on all passenger ships to verify any changes in light-ship displacement and longitudinal centre of gravity. The ship should be re-inclined whenever, in comparison with the approved stability information, a deviation from the light-ship displacement exceeding 2% or a deviation of the longitudinal centre of gravity exceeding 1% of L is found, or anticipated.[19]

7.1.4* The Administration may allow the inclining test of an individual ship as required by paragraph 7.1.1 to be dispensed with provided basic stability data are available from the inclining test of a sister ship and it is shown to the satisfaction of the Administration that reliable stability information for the exempted ship can be obtained from such basic data.[19]

7.1.5* The Administration may allow the inclining test of an individual ship or class of ships especially designed for the carriage of liquids or ore in bulk to be dispensed with when reference to existing data for similar ships clearly indicates that due to the ship's proportions and arrangements more than sufficient metacentric height will be available in all probable loading conditions[19].

7.1.6 The inclining test prescribed is adaptable for ships with a length below 24 m if special precautions are taken to ensure the accuracy of the test procedure.

[43] Refer to regulation II-1/22 of the 1974 SOLAS Convention, as amended.

7.2 Definitions

For the purpose of this chapter, unless expressly provided otherwise:

.1 *Certification of the test weights* is the verification of the weight marked on a test weight. Test weights should be certified using a certificated scale. The weighing should be performed close enough in time to the inclining test to ensure the measured weight is accurate.

.2 *Draught* is the vertical distance from the moulded baseline to the waterline.

.3 *The inclining test* involves moving a series of known weights, normally in the transverse direction, and then measuring the resulting change in the equilibrium heel angle of the ship. By using this information and applying basic naval architecture principles, the ship's vertical centre of gravity (VCG) is determined.

.4 *Light-ship* condition is a ship complete in all respects, but without consumables, stores, cargo, crew and effects, and without any liquids on board except that machinery and piping fluids, such as lubricants and hydraulics, are at operating levels.

.5 *A light-weight survey* involves taking an audit of all items which should be added, deducted or relocated on the ship at the time of the inclining test so that the observed condition of the ship can be adjusted to the light-ship condition. The weight, longitudinal, transverse and vertical location of each item should be accurately determined and recorded. Using this information, the static waterline of the ship at the time of the inclining test as determined from measuring the freeboard or verified draught marks of the ship, the ship's hydrostatic data, and the seawater density, the light-ship displacement and longitudinal centre of gravity (LCG) can be obtained. The transverse centre of gravity (TCG) may also be determined for mobile offshore drilling units (MODUs) and other ships which are asymmetrical about the centreline or whose internal arrangement or outfitting is such that an inherent list may develop from off-centre weight.

7.3 Preparations for the inclining test

7.3.1 *Notification of the Administration*

Written notification of the inclining test should be sent to the Administration as it requires or in due time before the test. An Administration representative should be present to witness the inclining test and the test results be submitted for review.

The responsibility for making preparations, conducting the inclining test and light-weight survey, recording the data, and calculating the results rests with the shipyard, owner or naval architect. While compliance with the procedures outlined herein will facilitate an expeditious and accurate inclining test, it is recognized that alternative procedures or arrangements may be equally efficient. However, to minimize risk of delay, it is recommended that all such variances be submitted to the Administration for review prior to the inclining test.

7.3.1.1 *Details of notification*

Written notification should provide the following information as the Administration may require:

.1 identification of the ship by name and shipyard hull number, if applicable;

.2 date, time, and location of the test;

.3 inclining weight data:

.3.1 type;

.3.2 amount (number of units and weight of each);

.3.3 certification;

.3.4 method of handling (i.e. sliding rail or crane);

.3.5 anticipated maximum angle of heel to each side;

.4 pendulums - approximate location and length (if a substitution is desired, an inclinometer or other measuring device may be substituted for one of the two required pendulums, prior approval should be obtained from the Administration. The Administration might require that the devices be used in addition to the pendulums on one or more inclinings to verify their accuracy before allowing actual substitution for a pendulum);

.5 approximate trim;

.6 condition of tanks;

.7 estimated weights to deduct, to complete, and to relocate in order to place the ship in its true light-ship condition;

.8 detailed description of any computer software to be used to aid in calculations during the inclining test;

.9 name and phone number of the person responsible for conducting the inclining test.

7.3.2 *General condition of the ship*

7.3.2.1 A ship should be as complete as possible at the time of the inclining test. The test should be scheduled to minimize the disruption in the ship's delivery date or its operational commitments.

7.3.2.2 The amount and type of work left to be completed (weights to be added) affect the accuracy of the light-ship characteristics, so good judgement should be used. If the weight or centre of gravity of an item to be added cannot be determined with confidence, it is best to conduct the inclining test after the item is added.

7.3.2.3 Temporary material, tool boxes, staging, sand, debris, etc., on board should be reduced to absolute minimum before the inclining test. Excess crew or personnel not directly involved in the inclining test should be removed from on board the ship before the test.

7.3.2.4 Decks should be free of water. Water trapped on deck may shift and pocket in a fashion similar to liquids in a tank. Any rain, snow or ice accumulated on the ship should be removed prior to the test.

7.3.2.5 The anticipated liquid loading for the test should be included in the planning for the test. Preferably, all tanks should be empty and clean, or completely full. The number of slack tanks should be kept to an absolute minimum. The viscosity of the fluid, the depth of the fluid and the shape of the tank should be such that the free surface effect can be accurately determined.

7.3.2.6 The ship should be moored in a quiet, sheltered area free from extraneous forces such as propeller wash from passing vessels, or sudden discharges from shore-side pumps. The tide conditions and the trim of the ship during the test should be considered. Prior to the test, the depth of water should be measured and recorded in as many locations as are necessary to ensure that the ship will not contact the bottom. The water's specific gravity should be accurately recorded. The ship should be moored in a manner to allow unrestricted heeling. The access ramps should be removed. Power lines, hoses, etc., connected to shore should be at a minimum, and kept slack at all times.

7.3.2.7 The ship should be as upright as possible and have sufficient draught so that any abrupt changes in the waterplane will be avoided as the ship is inclined from side to side. A deviation from design trim of up to 1% of *L* is normally acceptable when using hydrostatic data calculated at design trim. Otherwise, the hydrostatic data should be calculated for the actual trim. Caution should be exercised when applying the "one per cent rule of thumb" to ensure that excessive error, as would result from a significant change in the waterplane area during heeling, is not introduced into the stability calculations. With inclining weights in the initial position, up to one-half degree of list is acceptable.

7.3.2.8 The total weight used should preferably be sufficient to provide a minimum inclination of two degrees and a maximum of four degrees of heel to each side. However, a minimum inclination of one degree to each side may be accepted for large ships. Test weights should be compact and of such a configuration that the VCG (vertical centre of gravity) of the weights can be accurately determined. Each weight should be marked with an identification number and its weight. Recertification of the test weights should be carried out prior to the inclining. A crane of sufficient capacity and reach, or some other means, should be available during the inclining test to shift weights on the deck in an expeditious and safe manner. Water ballast is generally not acceptable as inclining weight. However, water ballast transfer may be permitted when it is absolutely impractial to incline using solid weights if acceptable to the Administration.

7.3.2.9 The use of three pendulums is recommended but a minimum of two should be used to allow identification of bad readings at any one pendulum station. They should each be located in an area protected from the wind. The pendulums should be long enough to give a measured deflection, to each side of upright, of at least 15 cm. To ensure recordings from individual instruments are kept separate, it is suggested that the pendulums be physically located as far apart as practical.

The use of an inclinometer or U-tube should be considered in each separate case. It is recommended that inclinometers or other measuring devices only be used in conjunction with at least one pendulum.

7.3.2.10 Efficient two-way communications should be provided between central control and the weight handlers and between central control and each pendulum station. One person at a central control station should have complete control over all personnel involved in the test.

7.4 Plans required

The person in charge of the inclining test should have available a copy of the following plans at the time of the inclining test:

.1 lines plan;
.2 curves of form (hydrostatic curves) or hydrostatic data;
.3 general arrangement plan of decks, holds, inner bottoms, etc.
.4 capacity plan showing capacities and vertical and longitudinal centres of gravity of cargo spaces, tanks, etc.;
.5 tank sounding tables;
.6 draught mark locations; and
.7 docking drawing with keel profile and draught mark corrections (if available).

7.5 Test procedure

7.5.1 Procedures followed in conducting the inclining test and light-weight survey should be in accordance with the recommendations laid out in annex 1 to this Code.

7.5.1.1 Freeboard/draught readings should be taken to establish the position of the waterline in order to determine the displacement of the ship at the time of the inclining test. It is recommended that at least five freeboard readings, approximately equally spaced, be taken on each side of the ship or that all draught marks (forward, midship and aft) be read on each side of the ship. Draught/freeboard readings should be read immediately before or immediately after the inclining test.

7.5.1.2 The standard test employs eight distinct weight movements. Movement No. 8, a recheck of the zero point, may be omitted if a straight line plot is achieved after Movement No. 7. If a straight line plot is achieved after the initial zero and six weight movements, the inclining test is complete and the second check at zero may be omitted. If a straight line plot is not achieved, those weight movements that did not yield acceptable plotted points should be repeated or explained.

7.5.2 A copy of the inclining data should be forwarded to the Administration along with the calculated results of the inclining test in an acceptable report format, if required.

7.5.3 All calculations performed during the inclining test and in preparation of an inclining test report may be carried out by a suitable computer program. Output generated by such a program may be used for presentation of all or partial data and calculations included in the test report if it is clear, concise, well documented, and generally consistent in form and content with Administration requirements.

7.6 Determination of ship's stability by means of rolling period tests (for ships up to 70 m in length)

7.6.1 Recognizing the desirability of supplying to masters of small ships instructions for a simplified determination of initial stability, attention was given to the rolling period tests. Studies on this matter showed that the rolling period test may be recommended as a useful means of approximately determining the initial stability of small ships when it is not practicable to give approved loading conditions or other stability information, or as a supplement to such information.

7.6.2 Investigations comprising the evaluation of a number of inclining and rolling tests according to various formulae showed that the following formula gave the best results and it has the advantage of being the simplest.

$$GM_o = \left(\frac{fB}{T_r}\right)^2$$

where

f = factor for the rolling period (rolling coefficient) as given in 7.6.4;

B = breadth of the ship in metres;

T_r = time for a full rolling period in seconds (i.e. for one oscillation "to and fro" port – starboard – port, or vice versa).

7.6.3 The factor f is of the greatest importance and the data from the above tests were used for assessing the influence of the distribution of the various masses in the whole body of the loaded ship.

7.6.4 For coasters of normal size (excluding tankers) and fishing vessels, the following average values were observed:

	f values
Emty ship or ship or ship carrying ballast	$f \approx 0.88$
Ship fully loaded and with liquids in tanks comprising the following percentage of the total load on board (i.e. cargo, liquids, stores, etc):	
20% of total load	$f \approx 0.78$
10% of total load	$f \approx 0.75$
5% of total load	$f \approx 0.73$
Double-boom shrimp fishing boats	$f \approx 0.95$
Deep sea fishing boats	$f \approx 0.80$
Boats with a live fish well	$f \approx 0.60$

The stated values are mean values. Generally, observed *f* values were within ± 0.05 of those given above.

7.6.5 The above *f* values were based upon a series of limited tests and, therefore, Administrations should re-examine these in the light of any different circumstances applying to their own ships.

7.6.6 It should be noted that the greater the distance of masses from the rolling axis, the greater the rolling coefficient will be. Therefore it can be expected that:

.1 the rolling coefficient for an unloaded ship, i.e. for a hollow body, will be higher than that for a loaded ship; and

.2 the rolling coefficient for a ship carrying a great amount of bunkers and ballast - both groups are usually located in the double bottom, i.e. far away from the rolling axis - will be higher than that of the same ship having an empty double bottom.

7.6.7 The above recommended rolling coefficients were determined by tests with ships in port and with their consumable liquids at normal working levels; thus, the influences exerted by the vicinity of the quay, the limited depth of water and the free surfaces of liquids in service tanks are covered.

7.6.8 Experiments have shown that the results of the rolling test method get increasingly less reliable the nearer they approach GM values of 0.20 m and below.

7.6.9 For the following reasons, it is not generally recommended that results be obtained from rolling oscillations taken in a seaway:

.1 exact coefficients for, tests in open waters are not available;

.2 the rolling periods observed may not be free oscillations but forced oscillations due to seaway;

.3 frequently, oscillations are either irregular or only regular for too short an interval of time to allow accurate measurements to be observed; and

.4 specialized recording equipment is necessary.

7.6.10 However, sometimes it may be desirable to use the ship's period of roll as a means of approximately judging the stability at sea. If this is done, care should be taken to discard readings which depart appreciably from the majority of other observations. Forced oscillations corresponding to the sea period and differing from the natural period at which the ship seems to move should be disregarded. In order to obtain satisfactory results, it may be necessary to select intervals when the sea action is least violent and it may be necessary to discard a considerable number of observations.

7.6.11 In view of the foregoing circumstances, it needs to be recognized that the determination of the stability by means of the rolling test in disturbed waters should only be regarded as a very approximate estimation.

7.6.12 The formula given in paragraph 7.6.2 can be reduced to:

$$GM_o = \frac{F}{T_r^2}$$

and the Administration should determine the F value(s) for each ship.

7.6.13 The determination of the stability can be simplified by giving the master permissible rolling periods, in relation to the draughts, for the appropriate value(s) of F considered necessary.

7.6.14 The initial stability may also be more easily determined graphically by using the sample nomogram (figure 7.6.14) as described below:

.1 The values for B and f are marked in the relevant scales and connected by a straight line (1). This straight line intersects the vertical line mm at the point M.

.2 A second straight line (2) which connects this point M and the point on the T_r scale corresponding with the determined rolling period intersects the GM scale at the requested value.

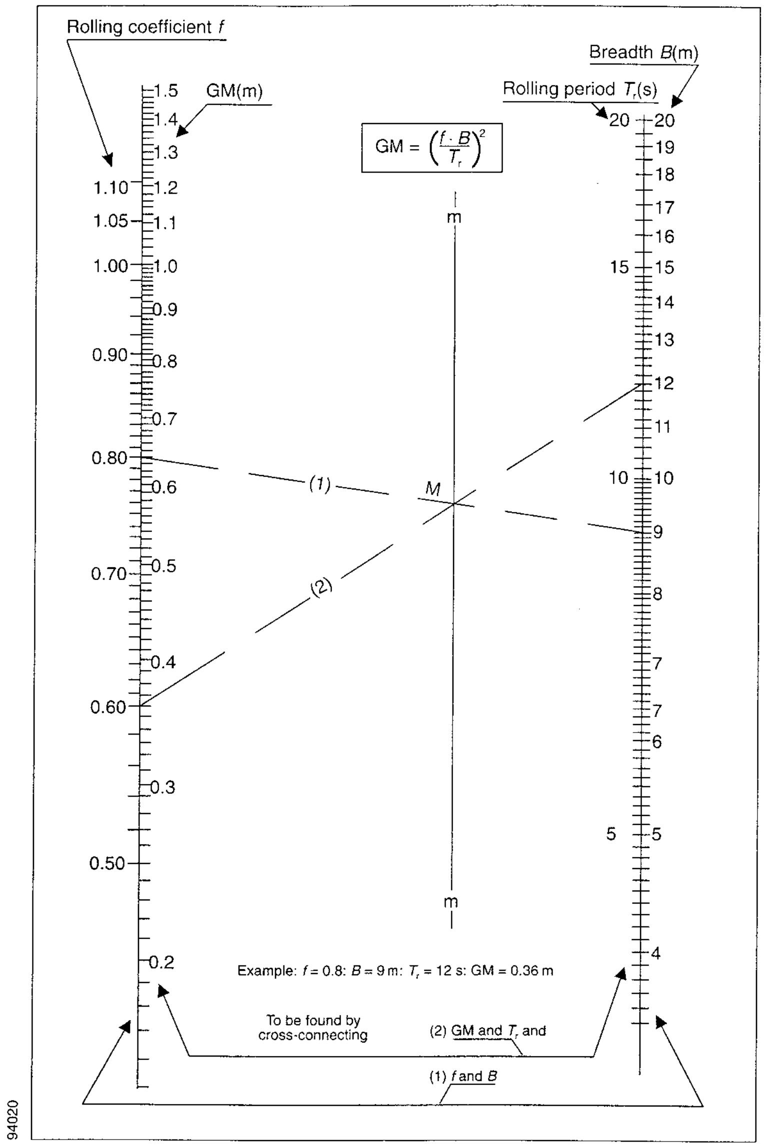
7.6.15 Section 7.6.16 shows an example of a recommended form in which these instructions might be presented by each Administration to the masters. it is considered that each Administration should recommend the F value or values to be used.

7.6.16 Test procedure

7.6.16.1 The rolling period required is the time for one complete oscillation of the ship and to ensure the most accurate results in obtaining this value the following precautions should be observed:

.1 The test should be conducted with the ship in harbour, in smooth water with the minimum interference from the wind and tide.

.2 Starting with the ship at the extreme end of a roll to one side (say port) and the ship about to move towards the upright, one complete oscillation will have been made when the ship has moved right across to the other extreme side (i.e. starboard) and returned to the original starting point and is about to commence the next roll.



Rolling coefficient f
GM(m)
Breadth B(m)
Rolling period T_r(s)
$GM = \left(\frac{f \cdot B}{T_r}\right)^2$
m
M
(1)
(2)
Example: $f = 0.8$: $B = 9$ m: $T_r = 12$ s: GM = 0.36 m
To be found by cross-connecting
(2) GM and T_r and
(1) f and B
94020

Figure 7.6.14

.3 By means of a stop-watch, the time should be taken for not less than about five of these complete oscillations; the counting of these oscillations should begin when the ship is at the extreme end of a roll. After allowing the roll to completely fade away, this operation should be repeated at least twice more. If possible, in every case the same number of complete oscillations should be timed to establish that the readings are consistent, i.e. repeating themselves within reasonable limits. Knowing the total time for the total number of oscillations made, the mean time for one complete oscillation can be calculated.

.4 The ship can be made to roll by rhythmically lifting up and putting down a weight as far off the middle-line as possible; by pulling on the mast with a rope; by people running athwartships in unison; or by any other means. However, and this is most important, as soon as this forced rolling has commenced, the means by which it has been induced should be stopped and the ship allowed to roll freely and naturally. If rolling has been induced by lowering or raising a weight it is preferable that the weight is moved by a dockside crane. if the ship's own derrick is used, the weight should be placed on the deck, at the middle-line, as soon as the rolling is established.

.5 The timing and counting of the oscillations should only begin when it is judged that the ship is rolling freely and naturally, and only as much as is necessary to accurately count these oscillations.

.6 The mooring should be slack and the ship "breasted off" to avoid making any contact during its rolling. To check this, and also to get some idea of the number of oscillations that can be reasonably counted and timed, a preliminary rolling test should be made before starting to record actual times.

.7 Care should be taken to ensure that there is a reasonable clearance of water under the keel and at the sides of the ship.

.8 Weights of reasonable size which are liable to swing (e.g. a lifeboat), or liable to move (e.g. a drum), should be secured against such movement. The free surface effects of slack tanks should be kept as small as is practicable during the test and the voyage.

7.6.16.2 *Limitations to the use of this method*

7.6.16.2.1 A long period of roll, corresponding to a GM_o of 0.20 m or below, indicates a condition of low stability. However, under such circumstances, accuracy in determination of the actual value of GM_o is reduced.

7.6.16.2.2 If, for some reason, these rolling tests are carried out in open, deep but smooth waters, inducing the roll, for example, by putting over the helm, then the GM_o calculated by using the method and coefficient of paragraph 7.6.16.1 above should be reduced by [*figure to be estimated by the Administration*] to obtain the final answer.

7.6.16.2.3 The determination of stability by means of the rolling test in disturbed waters should only be regarded as a very approximate estimation. If such a test is performed, care should be taken to discard readings which depart appreciably from the majority of other observations. Forced oscillations corresponding to the sea period and differing from the natural period at which the vessel seems to move should be disregarded. In order to obtain satisfactory results, it may be necessary to select intervals when the sea action is least violent and it may be necessary to discard a considerable number of observations.

7.7 Inclining test for MODUs

7.7.1 An inclining test should be required for the first unit of a design, when as near to completion as possible, to determine accurately the light-ship data (weight and position of centre of gravity).

7.7.2 For successive units which are identical by design, the light-ship data of the first unit of the series may be accepted by the Administration in lieu of an inclining test, provided the difference in light-ship displacement or position of centre of gravity due to weight changes for minor differences in machinery, Outfitting or equipment, confirmed by the results of a deadweight survey, are less than 1% of the values of the light-ship displacement and principal horizontal dimensions as determined for the first of the series. Extra care should be given to the detailed weight calculation and comparison with the original unit of a series of column-stabilized, semi-submersible types as these, even though identical by design, are recognized as being unlikely to attain an acceptable similarity of weight or centre of gravity to warrant a waiver of the inclining test.

7.7.3 The results of the inclining test, or of a deadweight survey and an inclining experiment adjusted for weight differences, should be indicated in the Operating Manual.

7.7.4 A record of all changes to machinery, structure, outfit and equipment that affect the light-ship data should be maintained in the Operating Manual or a light-ship data alterations log and be taken into account in daily operations.

7.7.5 For column-stabilized units, a deadweight survey should be conducted at intervals not exceeding five years. Where the deadweight survey indicates a change from the calculated light-ship displacement in excess of 1% of the operating displacement, an inclining test should be conducted.

7.7.6 An inclining test or a deadweight survey should be carried out in the presence of an officer of the Administration, or a duly authorized person or representative of an approved organization.

7.8 Stability test for pontoons

An inclining experiment is not normally required for a pontoon, provided a conservative value of the lightship vertical centre of gravity (KG) is assumed for the stability calculations. The KG can be assumed at the level of the main deck although it is recognized that a lesser value could be acceptable if fully documented. The light-ship displacement and longitudinal centre of gravity should be determined by calculation based on draught and density readings.

Annex 1

Detailed guidance for the conduct of an inclining test

Contents

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4.2 Freeboard/draught readings
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1 Introduction

This annex supplements the inclining standards put forth in chapter 7 of this Code.This annex contains important detailed procedures for conducting an inclining test in order to ensure that valid results are obtained with maximum precision at a minimal cost to owners, shipyards and the Administration. A complete understanding of the correct procedures used to perform an inclining test is imperative in order to ensure that the test is conducted properly and so that results can be examined for accuracy as the inclining experiment is conducted.

2 Preparations for the inclining test

2.1 *Free surface and tankage*

2.1.1 If there are liquids on board the ship when it is inclined, whether in the bilges or in the tanks, they will shift to the low side when the ship heels. This shift of liquids will exaggerate the heel of the ship. Unless the exact weight and distance of liquid shifted can be precisely calculated, the metacentric height (GM) calculated from the inclining test will be in error. Free surface should be minimized by emptying the tanks completely and making sure all bilges are dry; or by completely filling the tanks so that no shift of liquid is possible. The latter method is not the optimum because air pockets are difficult to remove from between structural members of a tank, and the weight and centre of the liquid in a full tank should be accurately determined in order to adjust the light-ship values accordingly. When tanks must be left slack, it is desirable that the sides of the tanks be parallel vertical planes and the tanks be regular in shape (i.e. rectangular, trapezoidal, etc.) when viewed from above, so that the free surface moment of the liquid can be accurately determined. For example, the free surface moment of the liquid in a tank with parallel vertical sides can be readily calculated by the formula:

Free surface moment (m-t) = $lb^3/12Q$

where:

l = length of tank (m)
b = breadth of tank (m)
Q = specific volume of liquid in tank (m^3/t)
(Measure Q directly with a hydrometer).

$$\text{Free surface correction (m)} = \frac{\Sigma(FSM(1) + FSM(2) + ... + FSM(x))}{\Delta}$$

where:

FSM = free surface momentg (m-t)

Δ = displacement (t)

Free surface correction is independent of the height of the tank in the ship, location of the tank, and direction of heel. As the width of the tank increases, the value of free surface moment increases by the third power. The distance available for the liquid to shift is the predominant factor. This is why even the smallest amount of liquid in the bottom of a wide tank or bilge is normally unacceptable and should be removed prior to the inclining experiment. Insignificant amounts of liquids in V-shaped tanks or voids (e.g. a chain locker in the bow), where the potential shift is negligible, may remain if removal of the liquid would be difficult or would cause extensive delays.

2.1.2 *Free surface and slack tanks* - The number of slack tanks should normally be limited to one port/starboard pair or one centreline tank of the following:

.1 fresh water reserve feed tanks;
.2 fuel/diesel oil storage tanks;
.3 fuel/diesel oil day tanks;
.4 lube oil tanks;

.5 sanitary tanks; or
.6 potable water tanks.

To avoid pocketing, slack tanks should normally be of regular (i.e. rectangular, trapezoidal, etc.) cross section and be 20% to 80% full if they are deep tanks and 40% to 60% full if they are double-bottom tanks. These levels ensure that the rate of shifting of liquid remains constant throughout the heel angles of the inclining test. If the trim changes as the ship is inclined, then consideration should also be given to longitudinal pocketing. Slack tanks containing liquids of sufficient viscosity to prevent free movement of the liquids, as the ship is inclined (such as bunker at low temperature), should be avoided since the free surface cannot be calculated accurately. A free surface correction for such tanks should not be used unless the tanks are heated to reduce viscosity. Communication between tanks should never be allowed. Cross connections, including those via manifolds, should be closed. Equal liquid levels in slack tank pairs can be a warning sign of open cross connections. A bilge, ballast, and fuel oil piping plan can be referred to, when checking for cross connection closures.

2.1.3 *Pressed-up tanks* - "Pressed up" means completely full with no voids caused by trim or inadequate venting. Anything less than 100% full, for example the 98% condition regarded as full for operational purposes, is not acceptable. Preferably, the ship should be rolled from side to side to eliminate entrapped air before taking the final sounding. Special care should be taken when pressing fuel oil tanks to prevent accidental pollution. An example of a tank that would appear "pressed up", but actually contains entrapped air, is shown in figure AI-2.1.3.

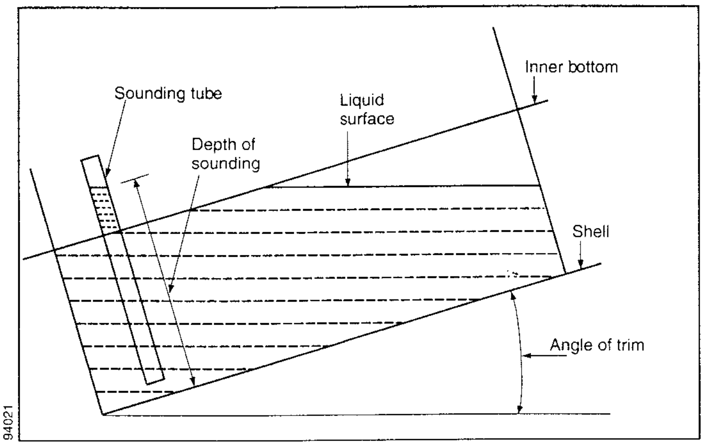

Figure A1-2.1.3

2.1.4 *Empty tanks* - It is generally not sufficient to simply pump tanks until suction is lost. Enter the tank after pumping to determine if final stripping with portable pumps or by hand is necessary. The exceptions are very narrow tanks or tanks where there is a sharp deadrise, since free surface would be negligible. Since all empty tanks should be inspected, all manholes should be open and the tanks well ventilated and certified as safe for entry. A safe testing device should be on hand to test for sufficient oxygen and minimum toxic levels. A certified marine chemist's certificate certifying that all fuel oil and chemical tanks are safe for human entry should be available, if necessary.

2.2 *Mooring arrangements*

The importance of good mooring arrangements cannot be overemphasized. The arrangement selection will be dependent upon many factors. Among the most important are depth of water, wind, and current effects. Whenever possible the ship should be moored in a quiet, sheltered area free from extraneous forces such as propeller wash from passing vessels, or sudden discharges from shore-side pumps. The depth of water under the hull should be sufficient to ensure that the hull will be entirely free of the bottom. The tide conditions and the trim of the ship during the test should be considered. Prior to the test, the depth of water should be measured and recorded in as many locations as necessary to ensure the ship will not contact the bottom. If marginal, the test should be conducted during high tide or the ship moved to deeper water.

2.2.1 The ship should be held by lines at the bow and the stern, attached to temporary padeyes installed as close as possible to the centreline of the ship and as near the waterline as practical. If temporary padeyes are not feasible then lines can be secured to bollards and/or cleats on the deck. This arrangement requires that the lines be slackened when the ship is heeled away from the dock. The preferred arrangement is with the ship lying in a slip where it can be moored as shown in figure M-2.2.1. In this case, the lines can be kept taut to hold the ship in place, yet allow unrestricted heeling. Note, however, that wind and/or current may cause a superimposed heeling moment to act on the ship throughout the test. For steady conditions this will not affect the results. Gusty wind or uniformly varying wind and/or current will cause these superimposed heeling

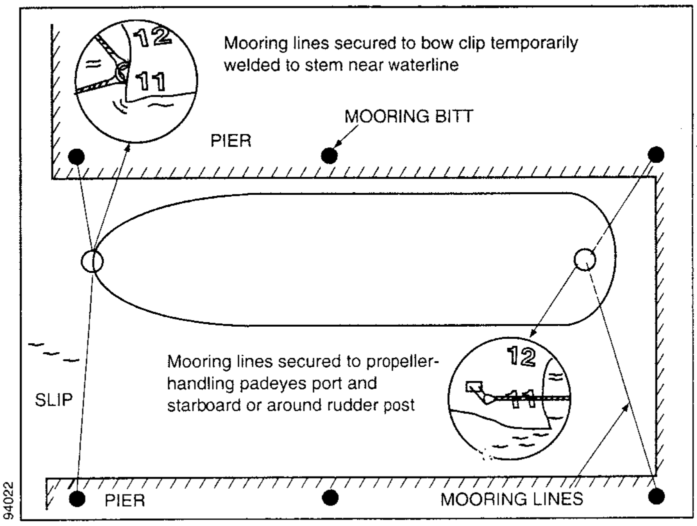

Figure A1-2.2.1

moments to change, which may require additional test points to obtain a valid test. The need for additional test points can be determined by plotting test points as they are obtained.

2.2.2 Where the ship can be moored to one side only, it is good practice to supplement the bow and stern lines with two spring lines in order to maintain positive control of the ship, as shown in figure A1-2.2.2. The leads of the spring lines should be as long as practicable. Cylindrical camels should be provided between the ship and the dock. All lines should be slack, with the ship free of the pier and camels, when taking readings.

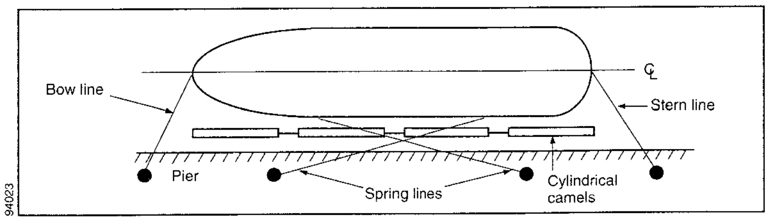

Figure A1-2.2.2

2.2.2.1 If the ship is held off the pier by the combined effect of the wind and current, and the bow and stern lines are secured at centreline near the waterline, they can be taut. This is essentially the same as the preferred arrangement described in 2.2.1 above. As in 21.2.1 above, varying wind and/or current will cause some distortion of the plot.

2.2.2.2 If the ship is pressed against the camels by wind and/or current, all lines should be slack. The cylindrical camels will prevent binding but again there will be an unavoidable superimposed heeling moment due to the ship bearing against the camels. This condition should be avoided but, when used, consideration should be given to pulling the ship free of the dock and camels and letting the ship drift as readings are taken.

2.2.2.3 Another acceptable arrangement is where the combined wind and current are such that the ship may be controlled by only one line at either the bow or the stern. In this case the control line need not be attached near the waterline, but it should be led from on or near the centreline of the ship. With all lines but one slack, the ship is free to veer with the wind and/or current as readings are taken. This can sometimes be troublesome because varying wind and/or current can cause distortion of the plot.

2.2.2.4 Alternative mooring arrangements should be considered if submitted for review prior to the test. Such arrangements should ensure that the ship will be free to list without restraint for a sufficient period of time to allow the pendulums to damp out motion so that the readings can be recorded.

2.2.3 If a floating crane is used for handling inclining weights, it should not be moored to the ship.

2.3 *Test weights*

2.3.1 Weights, such as porous concrete, that can absorb significant amounts of moisture should only be used if they are weighed just prior to the inclining test or if recent weight certificates are presented. Each weight should be marked with an identification number and its weight. For small ships, drums completely filled with water may be used. Drums should normally be full and capped to allow accurate weight control. In such cases, the weight of the drums should be verified in the presence of the Administration representative using a recently calibrated scale.

2.3.2 Heeling the ship by liquid transfer should only be adopted when large ships with high GMs make solid weight transfer impracticable.

2.3.3 Precautions should be taken to ensure that the decks are not overloaded during weight movements. If deck strength is questionable then a structural analysis should be performed to determine if existing framing can support the weight.

2.3.4 Generally, the test weights should be positioned as far outboard as possible on the upper deck. The test weights should be on board and in place prior to the scheduled time of the inclining test.

2.3.5 Where water ballast is permitted, the following should be complied with:

.1 inclining tanks should be wall-sided and free of large stringers (air pockets).
.2 tanks should be directly opposite to maintain ship's trim.
.3 specific gravity of ballast water should be measured and recorded.
.4 pipe lines to inclining tanks should be full.
.5 all ballast valves should be closed prior to the test. Strict valve control should be maintained during the test. If the water is transferred through manifolds or valve boxes, all valves to the branches not used should be tagged or locked to prevent opening during the test.
.6 all inclining tanks should be manually sounded before and after each shift.
.7 calculations should account for the change of the VCG during test.
.8 accurate sounding/ullage tables should be provided.

2.4 *Pendulums*

2.4.1 The pendulums should be long enough to give a measured deflection, to each side of upright, of at least 15 cm. Generally, this will require a pendulum length of at least 3 m. It is recommended that pendulum lengths of 4-6 m be used. Usually, the longer the pendulum the greater the accuracy of the test; however, if excessively long pendulums are used on a tender ship the pendulums may not settle down and the accuracy of the pendulums would then be questionable. If the pendulums are of different lengths, the possibility of collusion between station recorders is avoided.

2.4.2 On smaller ships, where there is insufficient headroom to hang long pendulums, the 15 cm deflection should be obtained by increasing the test weight so as to increase the heel. On most ships the typical inclination is between one and four degrees.

2.4.3 The pendulum wire should be piano wire or other monofilament material. The top connection of the pendulum should afford unrestricted rotation of the pivot point. An example is that of a washer with the pendulum wire attached suspended from a nail.

2.4.4 A trough filled with a liquid should be provided to dampen oscillations of the pendulum after each weight movement. It should be deep enough to prevent the pendulum weight from touching the bottom. The use of a winged plumb bob at the end of the pendulum wire can also help to dampen the pendulum oscillations in the liquid.

2.4.5 The battens should be smooth, light-coloured wood, 1 to 2 cm thick, and should be securely fixed in position so that an inadvertent contact will not cause them to shift. The batten should be aligned close to the pendulum wire but not in contact with it.

2.4.6 A typical satisfactory arrangement is shown in figure A1-2.4.6. The pendulums may be placed in any location on the ship, longitudinally and transversely. The pendulums should be in place prior to the scheduled time of the inclining test.

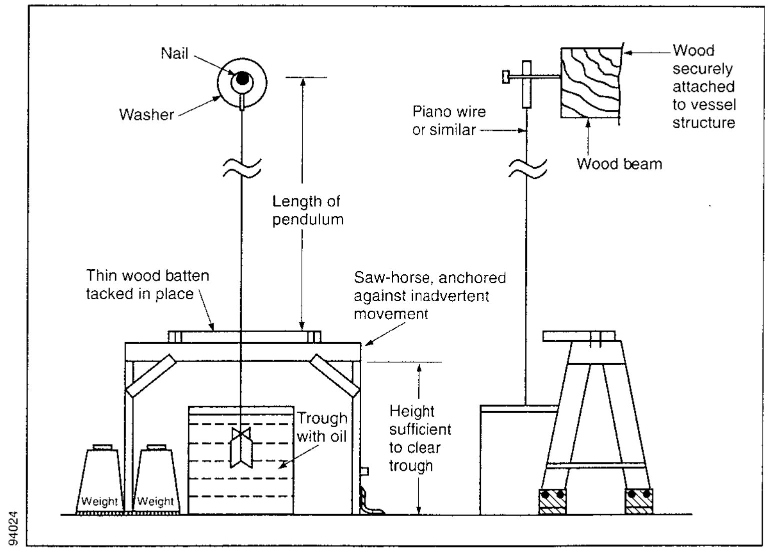

Figure A1-2.4.6

2.4.7 It is recommended that inclinometers or other measuring devices only be used in conjunction with at least one pendulum.

2.4.8 Where a U-tube is used, the following should be complied with:

.1 the ends of the device should be securely positioned as far outboard as possible.

.2 arrangements should be made for recording all readings at both ends. For easy reading and checking for air pockets clear plastic tube or hose should be used throughout.

.3 the horizontal distance between ends should be sufficient to obtain a level difference of at least 15 cm between the upright and the maximum inclination to each side.

3 Equipment required

Besides the physical equipment necessary such as the inclining weights, pendulums, small boat, etc., the following are necessary and should be provided by or made available to the person in charge of the inclining:

.1 engineering scales for measuring pendulum deflections (rules should be subdivided sufficiently to achieve the desired accuracy);

.2 sharp pencils for marking pendulum deflections;

.3 chalk for marking the various positions of the inclining weights;
.4 a sufficiently long measuring tape for measuring the movement of the weights and locating different items on board;
.5 a sufficiently long sounding tape for sounding tanks and taking freeboard readings;
.6 one or more well maintained specific gravity hydrometers with range sufficient to cover 0.999 to 1.030, to measure the specific gravity of the water in which the ship is floating (a hydrometer for measuring specific gravity of less than 1.000 may be needed in some locations);
.7 other hydrometers as necessary to measure the specific gravity of any liquids on board;
.8 graph paper to plot inclining moments versus tangents;
.9 a straight edge to draw the measured waterline on the lines drawing;
.10 a pad of paper to record data;
.11 an explosion-proof testing device to check for sufficient oxygen and absence of lethal gases in tanks and other closed spaces such as voids and cofferdams;
.12 a thermometer; and
.13 draught tubes (if necessary).

4 Test procedure

The inclining experiment, the freeboard/draught readings and the survey may be conducted in any order and still achieve the same results. If the person conducting the inclining test is confident that the survey will show that the ship is in an acceptable condition and there is the possibility of the weather becoming unfavourable, then it is suggested that the inclining be performed first and the survey last. If the person conducting the test is doubtful that the ship is complete enough for the test, it is recommended that the survey be performed first since this could invalidate the entire test, regardless of the weather conditions. It is very important that all weights, the number of people on board, etc., remain constant throughout the test.

4.1 *Initial walk through and survey*

The person responsible for conducting the inclining test should arrive on board the ship well in advance of the scheduled time of the test to ensure that the ship is properly prepared for the test. If the ship to be inclined is large, a preliminary walk through may need to be done the day preceding the actual incline. To ensure the safety of personnel conducting the walk through, and to improve the documentation of surveyed weights and deficiencies, at least two persons should make the initial walk through. Things to check include: all compartments are open, clean, and dry, tanks are well ventilated and gas-free, movable or suspended items are secured and their position documented, pendulums are in place, weights are on board and in place, a crane or other method for moving weights is available, and the necessary plans and equipment are available. Before beginning the inclining test, the person conducting the test should:

.1 consider the weather conditions. The combined adverse effect of wind, current and sea may result in difficulties or even an invalid test due to the following:

.1.1 inability to accurately record freeboards and draughts;

.1.2 excessive or irregular oscillations of the pendulums;

.1.3 variations in unavoidable superimposed heeling moments.

In some instances, unless conditions can be sufficiently improved by moving the ship to a better location, it may be necessary to delay or postpone the test. Any significant quantities of rain, snow, or ice should be removed from the ship before the test. If bad weather conditions are detected early enough and the weather forecast does not call for improving conditions, the Administration representative should be advised prior to departure from the office and an alternative date scheduled;

.2 make a quick overall survey of the ship to make sure the ship is complete enough to conduct the test and to ensure that all equipment is in place. An estimate of items which will be outstanding at the time of the inclining test should be included as part of any test procedure submitted to the Administration. This is required so that the Administration representative can advise the shipyard/naval architect if in their opinion the ship will not be sufficiently complete to conduct the incline and that it should be rescheduled. If the condition of the ship is not accurately depicted in the test procedure and at the time of the inclining test the Administration representative considers that the ship is in such condition that an accurate incline cannot be conducted, the representative may refuse to accept the incline and require that the incline be conducted at a later date;

.3 enter all empty tanks after it is determined that they are well ventilated and gas-free to ensure that they are dry and free of debris. Ensure that any pressed-up tanks are indeed full and free of air pockets. The anticipated liquid loading for the incline should be included in the procedure required to be submitted to the Administration;

.4 survey the entire ship to identify all items which need to be added to the ship, removed from the ship, or relocated on the ship to bring the ship to the light-ship condition. Each item should be clearly identified by weight and vertical and longitudinal location. If necessary, the transverse location should also be recorded. The inclining weights, the pendulums, any temporary equipment and dunnage, and the people on board during the inclining test are all among the weights to be removed to obtain the light-ship condition. The person calculating the light-ship characteristics from the data gathered during the incline and survey and/or the person reviewing the inclining test may not have been present during the test and should be able to determine the exact location of the items from the data recorded and the ship's drawings. Any tanks containing liquids should be accurately sounded and the soundings recorded;

.4.1 it is recognized that the weight of some items on board, or that are to be added, may have to be estimated. If this is necessary, it is in the best interest of safety to be on the safe side when estimating, so the following rules of thumb should be followed:

.4.1.1 when estimating weights to be added:
- estimate high for items to be added high in the ship.
- estimate low for items to be added low in the ship.

.4.1.2 when estimating weights to be removed:
- estimate low for items to be removed from high in the ship
- estimate high for items to be removed from low in the ship.

.4.1.3 when estimating weights to be relocated:
- estimate high for items to be relocated to a higher point in the ship.
- estimate low for items to be relocated to a lower point in the ship.

4.2 *Freeboard/draught readings*

4.2.1 Freeboard/draught readings should be taken to establish the position of the waterline in order to determine the displacement of the ship at the time of the inclining test. It is recommended that at least five freeboard readings, approximately equally spaced, be taken on each side of the ship or that all draught marks (forward, midship, and aft) be read on each side of the ship. Draught mark readings should be taken to assist in determining the waterline defined by freeboard readings, or to verify the vertical location of draught marks on ships where their location has not been confirmed. The locations for each freeboard reading should be clearly marked. The longitudinal location along the ship should be accurately determined and recorded since the (moulded) depth at each point will be obtained from the ship's lines. All freeboard measurements should include a reference note clarifying the inclusion of the coaming in the measurement and the coaming height.

4.2.2 Draught and freeboard readings should be read immediately before or immediately after the inclining test. Weights should be on board and in place and all personnel who will be on board during the test, including those who will be stationed to read the pendulums, should be on board and in location during these readings. This is particularly important on small ships. If readings are made after the test, the ship should be maintained in the same condition as during the test. For small ships, it may be necessary to counterbalance the list and trim effects of the freeboard measuring party. When possible, readings should be taken from a small boat.

4.2.3 A small boat should be available to aid in the taking of freeboard and draught mark readings. It should have low freeboard to permit accurate observation of the readings.

4.2.4 The specific gravity of the flotation water should be determined at this time. Samples should be taken from a sufficient depth of the water to ensure a true representation of the flotation water and not merely surface water, which could contain fresh water from run-off of rain. A hydrometer should be placed in a water sample and the specific gravity read and recorded. For large ships, it is recommended that samples of the flotation water be taken forward, midship, and aft and the readings averaged. For small ships, one sample taken from midships should be sufficient. The temperature of the water should be taken and the measured specific gravity corrected for deviation from the standard, if necessary. A correction to water specific gravity is not necessary if the specific gravity is determined at the inclining experiment site. Correction is necessary if specific gravity is measured when sample temperature differs from the temperature at the time of the inclining (e.g., if check of specific gravity is done at the office).

4.2.5 A draught mark reading may be substituted for a given freeboard reading at that longitudinal location if the height and location of the mark have been verified to be accurate by a keel survey while the ship was in dry-dock.

4.2.6 A device, such as a draught tube, can be used to improve the accuracy of freeboard/draught readings by damping out wave action.

4.2.7 The dimensions given on a ship's lines drawing are normally moulded dimensions. In the case of depth, this means the distance from the inside of the bottom shell to the inside of the deck plate. In order to plot the ship's waterline on the lines drawing, the freeboard readings should be converted to moulded draughts. Similarly, the draught mark readings should be corrected from extreme (bottom of keel) to moulded (top of keel) before plotting. Any discrepancy between the freeboard/draught readings should be resolved.

4.2.8 The mean draught (average of port and starboard readings) should be calculated for each of the locations where freeboard/draught readings are taken and plotted on the ship's lines drawing or outboard profile to ensure that all readings are consistent and together define the correct waterline. The resulting plot should yield either a straight line or a waterline which is either hogged or sagged. If inconsistent readings are obtained, the freeboards/draughts should be retaken.

4.3 *The incline*

4.3.1 Prior to any weight movements the following should be checked:

.1 the mooring arrangement should be checked to ensure that the ship is floating freely. (This should be done just prior to each reading of the pendulums).

.2 the pendulums should be measured and their lengths recorded. The pendulums should be aligned so that when the ship heels, the wire will be close enough to the batten to ensure an accurate reading but will not come into contact with the batten. The typical satisfactory arrangement is shown in figure 2.4.6.

.3 the initial position of the weights is marked on the deck. This can be done by tracing the outline of the weights on the deck.

.4 the communications arrangement is adequate.

.5 all personnel are in place.

4.3.2 A plot should be run during the test to ensure that acceptable data are being obtained. Typically, the abscissa of the plot will be heeling moment (weight times distance) and the ordinate will be the tangent of the heel angle (deflection of the pendulum divided by the length of the pendulum). This plotted line does not necessarily pass through the origin or any other particular point for no single point is more significant than any other point. A linear regression analysis is often used to fit the straight line. The weight movements shown in figure A1-4.3.2-1 give a good spread of points on the test plot.

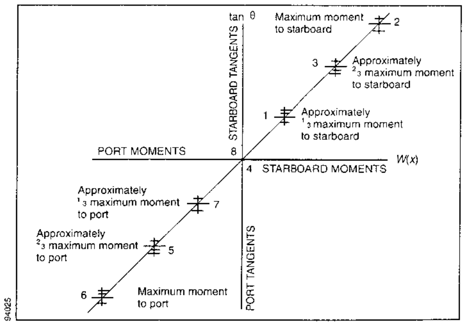

Figure A1-4.3.2-1

Plotting all of the readings for each of the pendulums during the inclining experiment aids in the discovery of bad readings. Since $W(x)/\tan\theta$ should be constant, the plotted line should be straight. Deviations from a straight line are an indication that there were other moments acting on the ship during the inclining. These other moments should be identified, the cause corrected, and the weight movements repeated until a straight line is achieved. Figures A1-4.3.2-2 through A1-4.3.2-5 illustrate examples of how to detect some of these other moments during the inclining, and a recommended solution for each case. For simplicity, only the average of the readings is shown on the inclining plots.

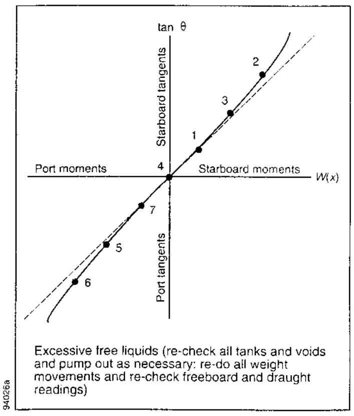

Figure A1-4.3.2-2

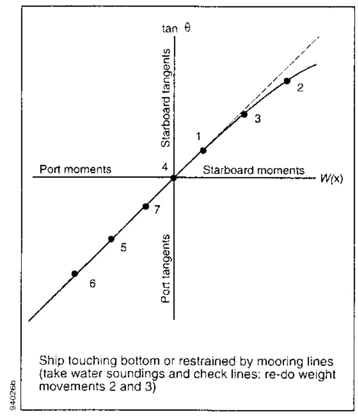

Figure A1-4.3.2-3

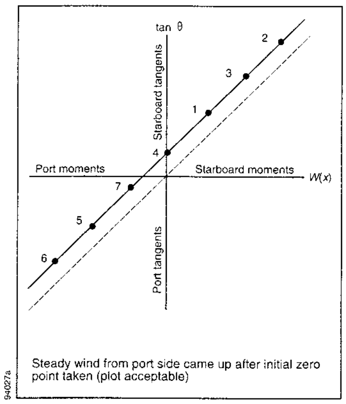

Figure A1-4.3.2-4

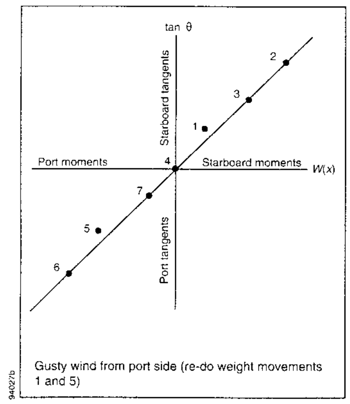

Figure A1-4.3.2-5

4.3.3 Once everything and everyone is in place, the zero position should be obtained and the remainder of the experiment conducted as quickly as possible, while maintaining accuracy and proper procedures, in order to minimize the possibility of a change in environmental conditions during the test.

4.3.4 Prior to each pendulum reading, each pendulum station should report to the control station when the pendulum has stopped swinging. Then, the control station will give a "standby" warning and then a "mark" command. When "mark" is given, the batten at each position should be marked at the location of the pendulum wire. If the wire was oscillating slightly, the centre of the oscillations should be taken as the mark. If any of the pendulum readers does not think the reading was a good one, the reader should advise the control station and the point should be retaken for all pendulum stations. Likewise, if the control station suspects the accuracy of a reading, it should be repeated for all the pendulum stations. Next to the mark on the batten should be written the number of the weight movement, such as zero for the initial position and one through seven for the weight movement

4.3.5 Each weight movement should be made in the same direction, normally transversely, so as not to change the trim of the ship. After each weight movement, the distance the weight was moved (centre to centre) should be measured and the heeling moment calculated by multiplying the distance by the amount of weight moved. The tangent is calculated for each pendulum by dividing the deflection by the length of the pendulum. The resultant tangents are plotted on the graph. Provided there is good agreement among the pendulums with regard to the tan θ value, the average of the pendulum readings may be graphed instead of plotting each of the readings.

4.3.6 Inclining data sheets should be used so that no data are forgotten and so that the data are clear, concise, and consistent in form and format. Prior to departing the ship, the person conducting the test and the Administration representative should initial each data sheet as an indication of their concurrence with the recorded data.

Annex 2

Recommendations for skippers of fishing vessels on ensuring a vessel's endurance in conditions of ice formation

1 Prior to departure

1.1 Firstly, the skipper should, as in the case of any voyages in any season, ensure that the vessel is generally in a seaworthy condition, giving full attention to basic requirements such as:

- **.1** loading of the vessel within the limits prescribed for the season (paragraph 1.2.1 below);
- **.2** weathertightness and reliability of the devices for closing cargo and access hatches, outer doors and all other openings in the decks and superstructures of the vessel and the watertightness of the sidescuttles and of ports or similar openings in the sides below the freeboard deck to be checked;
- **.3** condition of the freeing ports and scuppers as well as operational reliability of their closures to be checked;
- **.4** emergency and life-saving appliances and their operational reliability;
- **.5** operational reliability of all external and internal communication equipment;
- **.6** condition and operational reliability of the bilge and ballast pumping systems

1.2 Further, with special regard to possible ice accretion, the skipper should:

.1 consider the most critical loading condition against approved stability documents with due regard to fuel and water consumption, distribution of supplies, cargoes and fishing gear and with allowance for possible ice accretion;

.2 be aware of the danger in having supplies and fishing gear stored on open weatherdeck spaces due to their large ice accretion surface and high centre of gravity;

.3 ensure that a complete set of warm clothing for all members of the crew is available on the vessel as well as a complete set of hand tools and other appliances for combating ice accretion, a typical list thereof for small vessels is shown in section 4 of this annex;

.4 ensure that the crew is acquainted with the location of means for combating ice accretion, as well as the use of such means, and that drills are carried out so that members of the crew know their respective duties and have the necessary practical skills to ensure the vessel's endurance under conditions of ice accretion;

.5 acquaint himself with the meteorological conditions in the region of fishing grounds and en route to the place of destination; study the synoptical maps of this region and weather forecasts; be aware of warm currents in the vicinity of the fishing grounds, of the nearest coastline relief, of the existence of protected bays and of the location of icefields and their boundaries;

.6 acquaint himself with the timetable of the radio stations transmitting weather forecasts and warnings of the possibility of ice accretion in the area of the relevant fishing grounds.

2 At sea

2.1 During the voyage and when the vessel is on the fishing grounds the skipper should keep himself informed on all long-term and short-term weather forecasts and should arrange for the following systematic meteorological observations to be systematically recorded:

.1 temperatures of the air and of the sea surface;

.2 wind direction and force;

.3 direction and height of waves and sea state;

.4 atmospheric pressure, air humidity;

.5 frequency of splashing per minute and the intensity of ice accumulation on different parts of the vessel per hour.

2.2 All observed data should be recorded in the vessel's log-book. The skipper should compare the weather forecasts and icing charts with actual meteorological conditions, and should estimate the probability of ice formation and its intensity.

2.3 When the danger of ice formation arises, the following measures should be taken without delay:

.1 all the means of combating ice formation should be ready for use;

.2 all the fishing operations should be stopped, the fishing gear should be taken on board and placed in the under-deck spaces. If this cannot be done all the gear should be fastened for storm conditions on its prescribed place. It is particularly dangerous to leave the fishing gear suspended since its surface for ice formation is large and the point of suspension is generally located high;

.3 barrels and containers with fish, packing, all gear and supplies located on deck as well as portable mechanisms should be placed in closed spaces as low as possible and firmly lashed;

.4 all cargoes in holds and other compartments should be placed as low as possible and firmly lashed;

.5 the cargo booms should be lowered and fastened;

.6 deck machinery, hawser reels and boats should be covered with duck covers;

.7 lifelines should be fastened on deck;

.8 freeing ports fitted with covers should be brought into operative condition, all objects located near scuppers and freeing ports and preventing water drainage from deck should be taken away;

.9 all cargo and companion hatches, manhole covers, weathertight outside doors in superstructures and deck-houses and portholes should be securely closed in order to ensure complete weathertightness of the vessel, access to the weather deck from inner compartments should be allowed only through the superstructure deck;

.10 a check should be carried out as to whether the amount of water ballast on board and its location is in accordance with that recommended in "Stability guidance to skippers"; if there is sufficient freeboard, all the empty bottom tanks fitted with ballast piping should be filled with seawater;

.11 all fire-fighting, emergency and life-saving equipment should be ready for use;

.12 all drainage systems should be checked for their effectiveness;

.13 deck lighting and searchlights should be checked;

.14 a check should be carried out to make sure that each member of the crew has warm clothing;

.15 reliable two-way radiocommunication with both shore stations and other vessels should be established; radio calls should be arranged for set times.

2.4 The skipper should seek to take the vessel away from the dangerous area, keeping in mind that the lee edges of icefields, areas of warm currents and protected coastal areas are a good refuge for the vessel during weather when ice formation occurs.

2.5 Small fishing vessels on fishing grounds should keep nearer to each other and to larger vessels.

2.6 It should be remembered that the entry of the vessel into an icefield presents certain danger to the hull, especially when there is a high sea swell. Therefore the vessel should enter the icefield at a right angle to the icefield edge at low speed without inertia. It is less dangerous to enter an icefield bow to the wind. If a vessel must enter an icefield with the wind on the stern, the fact that the edge of the ice is more dense on the windward side should be taken into consideration. It is important to enter the icefield at the point where the ice floes are the smallest.

3 During ice formation

3.1 If in spite of all measures taken the vessel is unable to leave the dangerous area, all means available for removal of ice should be used as long as it is subjected to ice formation.

3.2 Depending on the type of vessel, all or many of the following ways of combating ice formation may be used:

.1 removal of ice by means of cold water under pressure;
.2 removal of ice with hot water and steam;
.3 breaking up of ice with ice crows, axes, picks, scrapers, or wooden sledge-hammers and clearing it with shovels.

3.3 When ice formation begins, the skipper should take into account the recommendations listed below and ensure their strict fulfilment:

.1 report immediately ice formation to the shipowner and establish with him constant radiocommunication;
.2 establish radiocommunication with the nearest vessels and ensure that it is maintained;
.3 do not allow ice formation to accumulate on the vessel, immediately take steps to remove from the vessel's structures even the thinnest layer of ice and ice sludge from the upper deck;
.4 check constantly the vessel's stability by measuring the roll period of the vessel during ice formation. If the rolling period increases noticeably, immediately take all possible measures in order to increase the vessel's stability;
.5 ensure that each member of the crew working on the weather deck is warmly dressed and wears a safety line securely attached to the guardrail;
.6 bear in mind that the work of the crew on ice clearing entails the danger of frost-bite. For this reason it is necessary to make sure that the men working on deck are replaced periodically;
.7 keep the following structures and gears of the vessel first free from ice:
- aerials
- running and navigational lights
- freeing ports and scuppers
- life-saving craft
- stays, shrouds, masts and rigging
- doors of superstructures and deck-houses
- windlass and hawse holes;

.8 remove the ice from large surfaces of the vessel, beginning with the upper structures (such as bridges, deckhouses, etc.), because even a small amount of ice on them causes a drastic worsening of the vessel's stability;

.9 when the distribution of ice is not symmetrical and a list develops, the ice must be cleared from the lower side first. Bear in mind that any correction of the list of the vessel by pumping fuel or water from one tank to another may reduce stability during the process when both tanks are slack;

.10 when a considerable amount of ice forms on the bow and a trim appears, ice must be quickly removed. Water ballast may be redistributed in order to decrease the trim;

.11 clear ice from the freeing ports and scuppers in due time in order to ensure free drainage of the water from the deck;

.12 check regularly for water accumulation inside the hull;

.13 avoid navigating in following seas since this may drastically worsen the vessel's stability;

.14 register in the vessel's log-book the duration, nature and intensity of ice formation, amount of ice on the vessel, measures taken to combat ice formation and their effectiveness;

.15 if, in spite of all the measures taken to ensure the vessel's endurance in conditions of ice formation, the crew is forced to abandon the vessel and embark on life-saving craft (lifeboats, rafts) then, in order to preserve their lives, it is necessary to do all possible to provide all the crew with warm clothing or special bags as well as to have a sufficient number of lifelines and bailers for speedy bailing out of water from the life-saving craft.

4 List of equipment and hand tools

A typical list of equipment and hand tools required for combating ice formation:
5 ice crows or crowbars;
5 axes with long handles;
5 picks;
5 metal scrapers;
5 metal shovels;
3 wooden sledge-hammers;
3 fore and aft lifelines to be rigged each side of the open deck fitted with travellers to which lizards can be attached.

Safety belts with spring hooks should be provided for not less than 50% of the members of the crew (but not less than 5 sets), which can be attached to the lizards.

Notes: (1) The number of hand tools and life-saving appliances may be increased, at the shipowners’ discretion.

(2) Hoses which may be used for ice combating should be readily available on board.

RESOLUTION A.752(18)
Adopted on 4 November 1993

GUIDELINES FOR EVALUATION, TESTING AND APPLICATION OF LOW-LOCATION LIGHTING ON PASSENGER SHIPS

1 SCOPE

1.1 These guidelines cover the approval, installation and maintenance of low-location lighting (LLL) required by the regulations II-2/28, paragraph 1.10 and II-2/41-2, paragraph 4.7 of the 1974 SOLAS Convention, as amended, on all passenger ships carrying more than 36 passengers, to readily identify the passengers' route of escape when the normal emergency lighting is less effective due to smoke.

2 GENERAL

2.1 In addition to the emergency lighting required by regulations II-1/42 and III/11.5 of the 1974 SOLAS Convention, as amended, the means of escape, including stairways and exits, should be marked by LLL at all points of the escape route, including angles and intersections. In addition, all escape route signs and fire equipment location markings should be of photoluminescent material, or marked by lighting, or a combination of both.

2.2 The supplementary emergency lighting for ro-ro passenger ships required by regulation II-1/42-1 of the 1974 SOLAS Convention, as amended, may be accepted to form partly or wholly the LLL system provided that such a system complies with the requirements of these guidelines.

2.3 The LLL system should function at all times for at least 60 min after its activation. Entire systems, including those that are automatically activated or continuously operating, are to be capable of being manually activated by a single action from the continuously manned central control station.

3 DEFINITIONS

3.1 *Low-location lighting (LLL)* - Electrically powered lighting or photoluminescent indicators placed at points of the escape route to readily identify all routes of escape.

3.2 *Photoluminescent (PL) system* - An LLL system which uses PL material. Photoluminescent material contains a chemical (example: zinc sulphide) that has the quality of storing energy when illuminated by visible light. The PL material emits light which becomes visible when the ambient light source is less effective. Without the light source to re-energize it, the PL material gives off the stored energy for a period of time with diminishing luminance.

3.3 *Electrically powered (EP) system* - An LLL system which requires electrical power for its operation, such as systems using incandescent bulbs, light-emitting diodes, electroluminescent strips or lamps, electrofluorescent lamps, etc.

4 PARTICULARS

4.1 The Administration should ensure that the LLL systems meet the requirements of international standards acceptable to the Organization.[44]

4.2 In all passageways, the LLL should be continuous, except as interrupted by corridors and cabin doors, in order to provide a visible delineation along the escape route. Systems tested to an international standard[1] to demonstrate a visible delineation without being continuous should also be acceptable. The LLL should be installed at least on one side of the corridor, either on the bulkhead within 300 mm of the deck, or on the deck within 150 mm of the bulkhead. In corridors more than two metres wide, LLL should be installed on both sides.

4.3 In dead-end corridors, LLL should have arrows placed at intervals of no more than 1 m, or equivalent direction indicators, pointing away from the dead end.

4.4 In all stairways, LLL should be installed on at least one side at a height less than 300 mm above the steps, which will make the location of each step readily identifiable to any person standing above and below that step. Low-location lighting should be installed on both sides if the width of the stairway is two metres or more. The top and bottom of each set of stairs should be identified to show that there are no further steps.

4.5 IMO symbols should be incorporated into the LLL which directs the passengers to the muster stations required by regulation III/24 of the 1974 SOLAS Convention, as amended.

4.6 In all passenger cabins a placard explaining the LLL system should be installed on the inside of the cabin door. It should also have a diagram showing the location of, and the way to, the two closest exits with respect to the cabin.

4.7 Materials used in the manufacture of LLL products should not contain radioactive or toxic materials.

5 DOORS

5.1 Low-location lighting should lead to the exit door handle. To prevent confusion, no other doors should be similarly marked.

5.2 Sliding fire doors and watertight doors should be marked with an LLL sign showing how the door opens.

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[44] Pending the development of international standards acceptable to the Organization, national standards as prescribed by the Administration should be applied.

6 SIGNS AND MARKINGS

6.1 All escape route signs and fire equipment location marking should be of photoluminescent material or marked by lighting and fitted in the lower 300 mm of the bulkhead. The dimensions of such signs and markings are to be commensurate with the rest of the LLL system.

6.2 Low-location lighting exit signs should be provided at all exits. The signs should be located within the lower 300 mm on the side of the exit doors where the handle is located.

6.3 All signs should contrast in colour to the background (bulkhead or deck) on which they are installed.

7 PHOTOLUMINESCENT SYSTEMS

7.1 Except where noted, PL strips should be no less than 75 mm wide. Photoluminescent strips having a width less than that stated herein should be used only if their luminance is increased proportionally to compensate for their width.

7.2 Photoluminescent materials should provide at least 15 mcd/m^2 measured 10 min after the removal of all external illuminating sources. The system should continue to provide luminance values greater than 2 mcd/m^2 for 60 min.

7.3 Any PL system materials should be provided with not less than the minimum level of ambient light necessary to charge the PL material to meet the above luminance requirements.

8 ELECTRICALLY POWERED SYSTEMS

8.1 Electrically powered systems should be connected to the emergency switchboard required by regulation II-1/42 of the 1974 SOLAS Convention, as amended, so as to be powered by the main source of electrical power under normal circumstances and also by the emergency source of electrical power when the latter is in operation. Alternatively, for existing ships only, EP systems may be connected to the main lighting system, provided independent batteries provide a backup of at least 60 min and are charged from the main lighting system. Performance of the system while powered by batteries should meet all the requirements stated herein.

8.2 Where electrically powered systems are installed, the following standards of luminance are to be applied:

- **.1** the active parts of electrically powered systems should have a minimum luminance of 10 cd/m^2;
- **.2** the point sources of miniature incandescent lamps should provide not less than 150 mcd mean spherical intensity with a spacing of not more than 100 mm between lamps;

.3 the point sources of light-emitting-diode systems should have a minimum peak intensity of 35 mcd. The angle of half-intensity cone should be appropriate to the likely track directions of approach and viewing. Spacing between lamps should be no more than 300 mm; and

.4 for electroluminescent systems, these should function for 60 min from the instant when the main power supply to which it was required to be connected by paragraph 8.1 is removed.

8.3 All EP systems should be arranged so that the failure of any single light, lighting strip, or battery will not result in the marking being ineffective.

8.4 Electrically powered systems should meet the relevant requirements for emergency luminaires in the current edition of publication 598-22-2 published by the International Electrotechnical Commission (IEC) when tested at a reference ambient temperature of 40°C.

8.5 Electrically powered systems should meet the requirements for vibration and electromagnetic interference in the current edition of publication 945 published by the IEC.

8.6 Electrically powered systems should provide a minimum degree of ingress protection of at least IP 55 in accordance with publication 529 published by the IEC.

9 MAINTENANCE

9.1 All LLL systems should be visually examined and checked at least once a week and a record kept. All missing, damaged or inoperable LLL should be replaced.

9.2 All LLL systems should have their luminance tested at least once every five years. Readings should be taken on site. If the luminance for a particular reading does not meet the requirement of these guidelines, readings should be taken in at least ten locations equally spaced apart in the space. If more than 30% of the readings do not meet the requirements of these guidelines, the LLL should be replaced. If between 20% and 30% of the readings do not meet the requirements of these guidelines, the LLL should be checked again in one year or may be replaced.

RESOLUTION A.754(18)

Adopted on 4 November 1993

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

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APPENDIX - TESTING OF WINDOWS, FIRE DAMPERS, PIPE PENETRATIONS AND CABLES TRANSITS

INTRODUCTION

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FIRE RESISTANCE TESTS FOR ”A”, ”B” and ”F” CLASS DIVISIONS[45]

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

[45] 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.

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.

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 design 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:	steel	65 ± 5 x 65 ± 5 x 6 ± 1 mm
at 600 mm		aluminium	100 ± 5 x 75 ± 5 x 9 ± 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:	steel	100 ± 5 x 70 ± 5 x 8 ± 1 mm
- at 600 mm:	aluminium	150 ± 5 x 100 ± 5 x 9 ± 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^{o}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^{o}C unless it can be shown by the fire test that materials having melting points below 850^{o}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^{o}C);
- specific heat at ambient temperature;
- thermal conductivity at ambient temperature.

The density of each material used in the test specimen should be within ± 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 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 x 60 mm x thickness of the material, should be weighed (initial conditioned weight W_1) and then heated in a ventilated oven at a temperature of 105 ± 2°C for 24 h and reweighed when cooled (W_2). However, gypsum based, cementatious and similar materials should be dried at a temperature of 55 ± 5°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 ± 20°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/m^3 and 2400 kg/m^3. 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 mm 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 m^2 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 x 2.0 ± 0.5 mm thick non-combustible insulating pad. The pad material should have a density of 900 ± 100 kg/m^3.

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 mm^2 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 overlayed 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 positioned for a bulkhead at 0.75 height of the specimen, and positioned 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 positioned 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 positioned 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, 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 x 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 ± 5°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 ± 10°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 (°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:

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

where:

$d = (A - A_s) \times 1/A_s \times 100$, 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 ± 100°C.

8.3.2 Furnace pressure

8.3.2.1 A linear pressure gradient exists over the height of 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 thermocouple 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 drawing.

.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 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, side scuttles 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 1 1/2 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, that 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 in 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:

Width[46)] or diameter of the duct coaming or spigot	Minimum thickness of

[46] Width means the greater of the two cross-sectional dimensions.

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 A 1.

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 in 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 for 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 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 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.

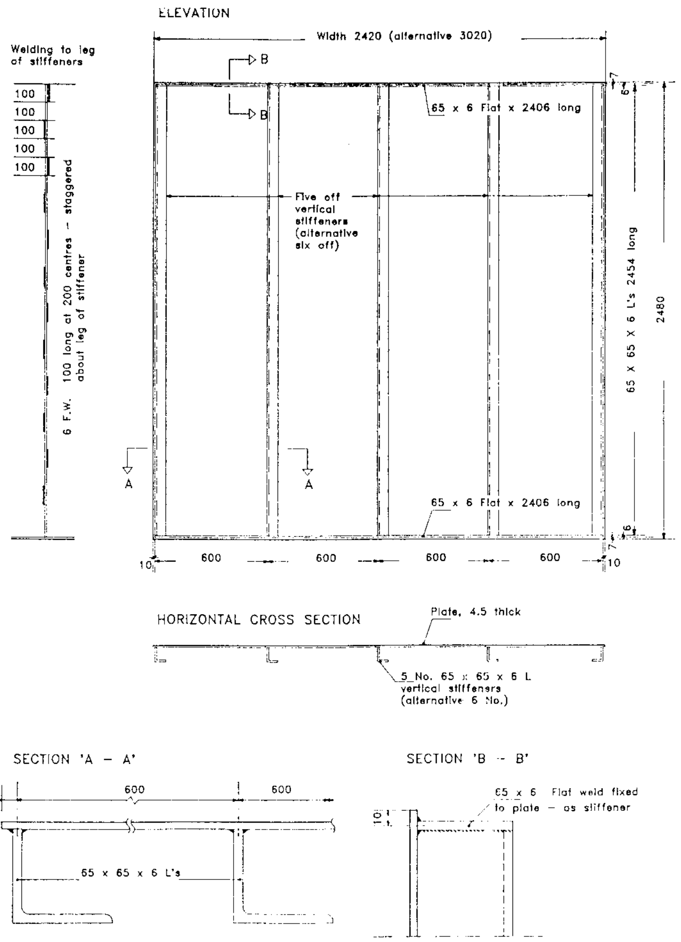


FIGURE 1
STRUCTURAL STEEL CORE FOR 'A' CLASS BULKHEAD AND 'B' CLASS LINING

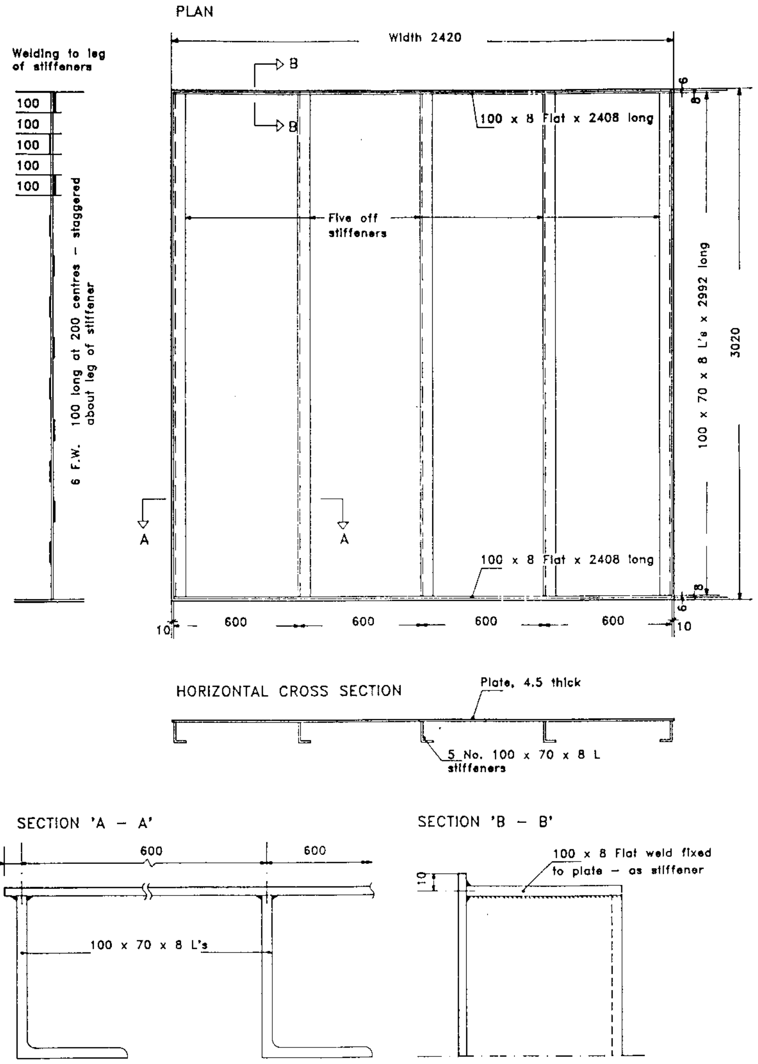
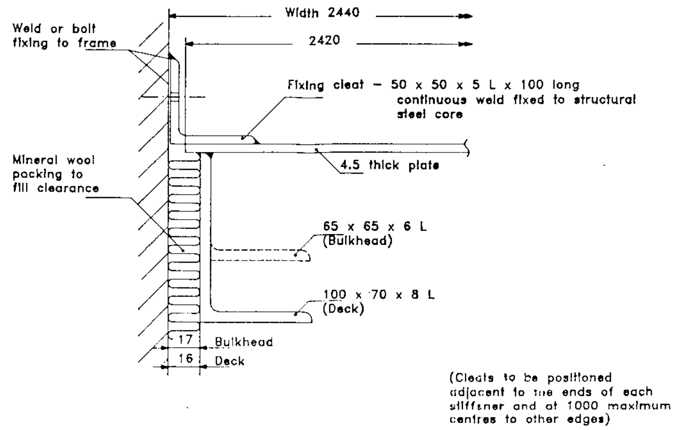


FIGURE 2

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)

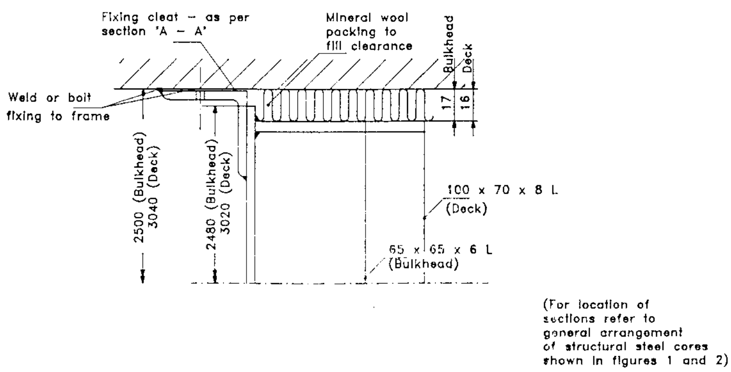
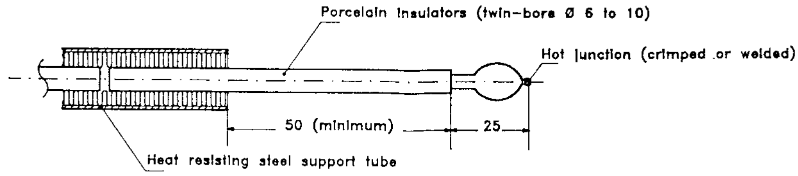


FIGURE 3
CONNECTION BETWEEN RESTRAINT FRAME AND STRUCTURAL STEEL CORE

Bare wire thermocouple assembly



Stainless steel sheated thermocouple assembly

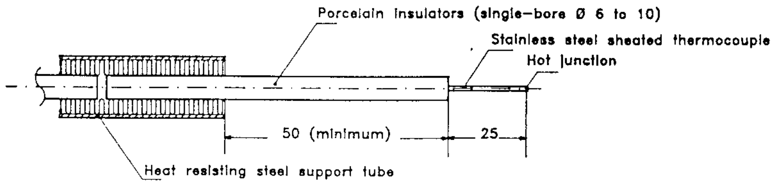
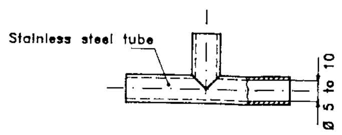


FIGURE 4
FURNACE THERMOCOUPLE ASSEMBLY

Type 1 – 'T' shaped sensor



Note : Tee branches should be horizontally oriented

Type 2 – Tube sensor

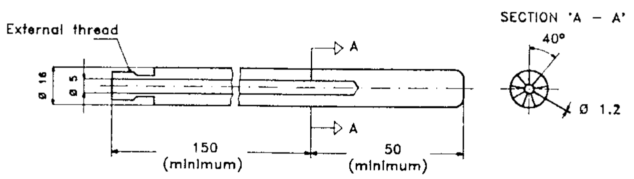
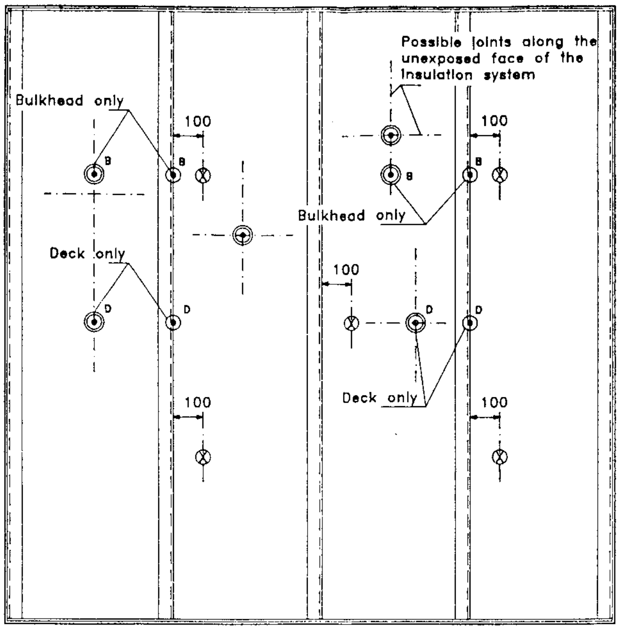


FIGURE 5
PRESSURE SENSING HEADS



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

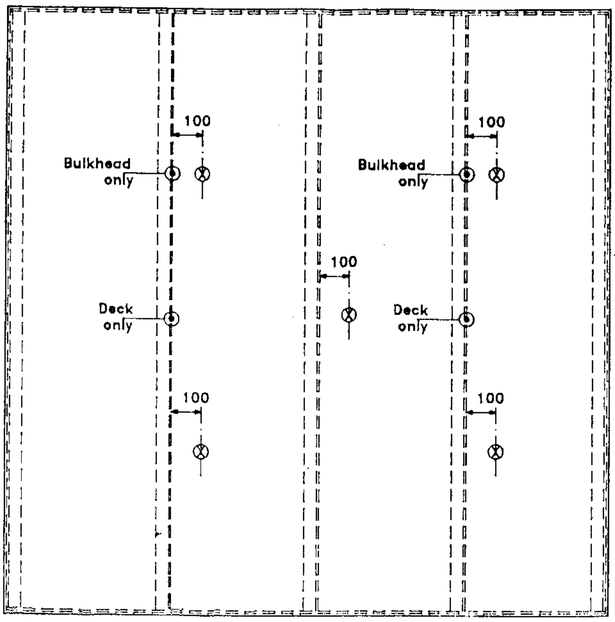
⊙ Thermocouples used for maximum temperature rise

◎ 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

FIGURE 7
POSITION OF UNEXPOSED FACE THERMOCOUPLES FOR 'A' CLASS DIVISION – INSULATED FACE TO THE LABORATORY



⊗ 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

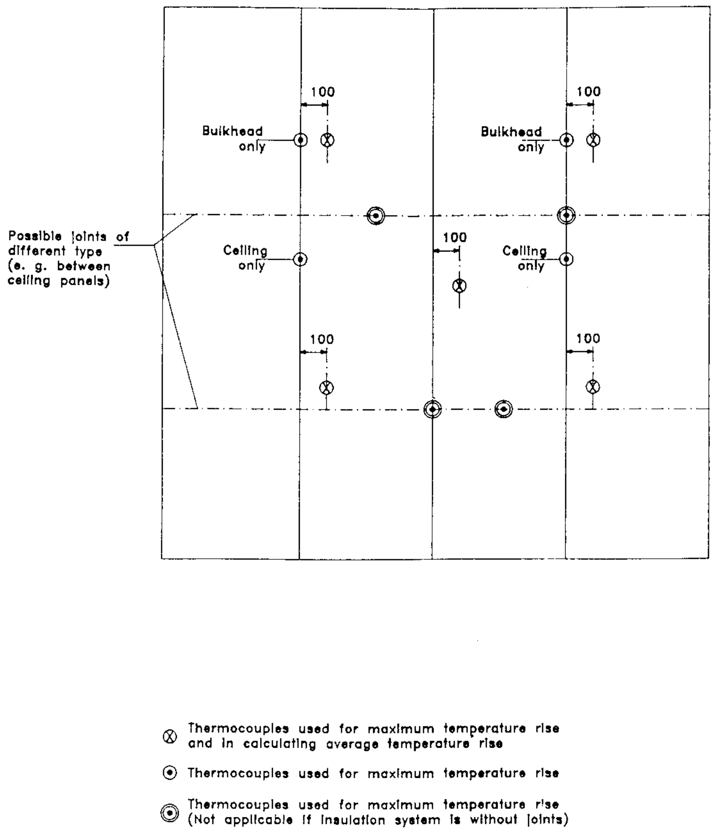
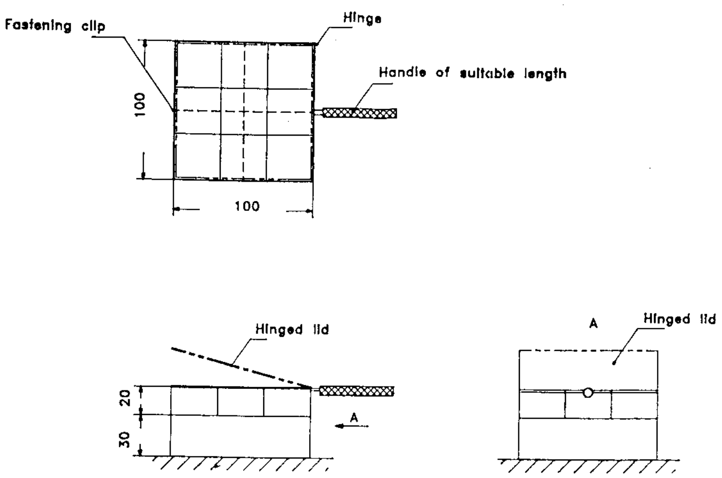


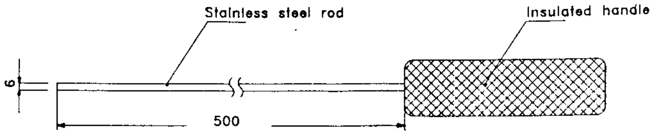
FIGURE 9
POSITION OF UNEXPOSED FACE THERMOCOUPLES FOR 'B' AND 'F' CLASS DIVISION



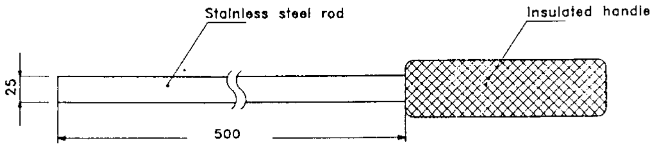
Material list :

1. Main framework manufactured from Ø 1.5 wire
2. Supporting wire Ø 0.5 for cotton pad

FIGURE 10
COTTON PAD HOLDER



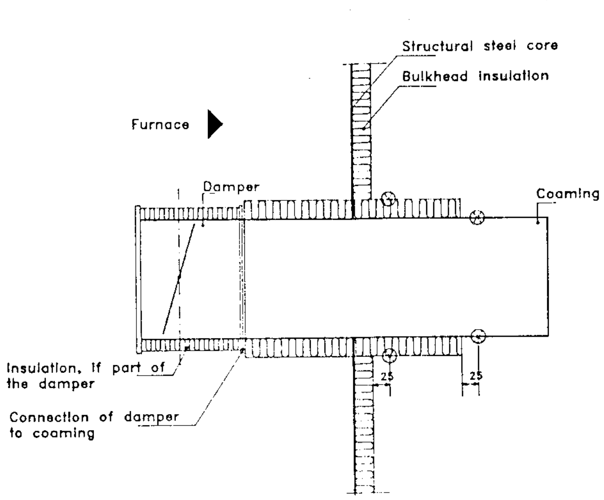
The 6 mm diameter gap gauge



The 25 mm diameter gap gauge

FIGURE 11
GAP GUAGES

Bulkhead specimen



Deck specimen

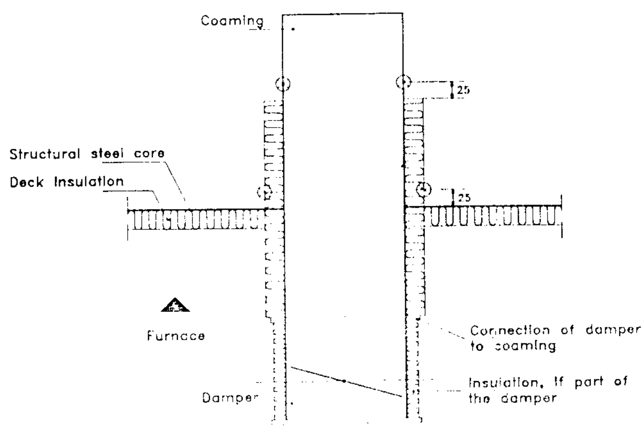


FIGURE A1
FIRE DAMPERS – INSULATION ON TEST SPECIMENS AND POSITION OF UNEXPOSED FACE THERMOCOUPLES

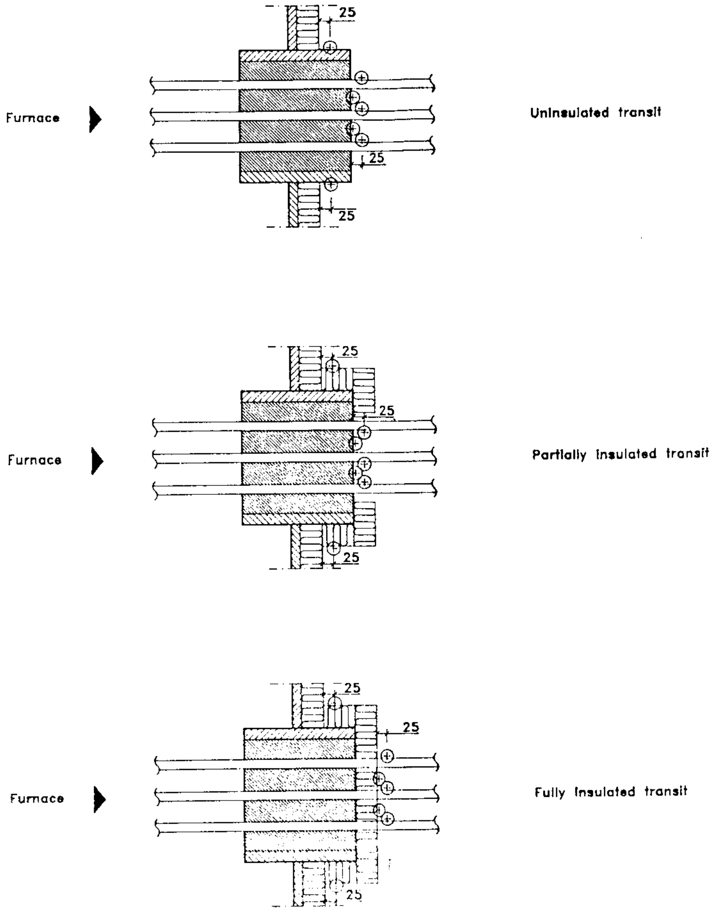


FIGURE A2
CABLE TRANSITS - POSITION OF UNEXPOSED FACE THERMOCOUPLES (SHOWN FOR BULKHEAD)

ASSEMBLY RESOLUTION A.756(18)

Adopted 4 November 1993

ANNEX

GUIDELINES ON THE INFORMATION TO BE PROVIDED WITH FIRE CONTROL PLANS AND BOOKLETS REQUIRED BY SOLAS REGULATIONS II-2/20 AND 41-2

Regulations II-2/20, paragraph 4 and regulation 41-2, paragraph 1.1, require certain information to be provided in the fire control plans on board ships carrying more than 36 passengers regarding their present safety standards.

In addition to complying with SOLAS regulation II-2/20.1, the information as prescribed below should be provided with the fire control plans from 1 October 1994 on board all ships carrying more than 36 passengers and be available at all times:

.1 Ship's keel laying date and application of the SOLAS Conventions and amendments. Original method (I, II, III or with or without sprinklers etc.) of fire safety construction, as applicable.

.2 Which additional fire safety measures, if any, were applied.

.3 Dates and description of any modifications to the ship which in any way alter its fire safety.

.4 If the information required by .3 is not available for modifications carried out before 1 October 1994, the fire safety method (I, II, III or the SOLAS Convention and amendments thereto) as presently used in the ship should be at least stated. Where more than one method or a combination of methods is used in different locations of the ship, this should be specified.

In ships carrying more than 36 passengers constructed on or after 1 October 1994, the symbols in the fire control plans are recommended to be in accordance with IMO resolution A.654(16) "Graphical symbols for fire control plans".

RESOLUTION A.757(18)
Adopted on 4 November 1993

STANDARDS FOR THE CALCULATION OF THE WIDTH OF STAIRWAYS FORMING MEANS OF ESCAPE ON PASSENGER SHIPS

1 Scope

1.1 These standards should be used when applying regulation II-2/28.1.5.1 of the 1974 SOLAS Convention as amended by resolution MSC.27(61).

1.2 It should be recognized that the evacuation routes to the embarkation deck may include a muster station. In this case consideration should be given to the fire-protection requirements and sizing of corridors and doors from the stairway enclosure to the muster station and from the muster station to the embarkation deck using these guidelines noting that evacuation of persons from muster stations to embarkation positions will be carried out in small controlled groups.

1.3 It is the intention that the calculation method should consider evacuation from enclosed spaces within each main vertical zone individually and take into account all of the persons using the stairway enclosures in each zone, even if they enter that stairway from another main vertical zone.

1.4 For each main vertical zone the calculation should be completed for the night time (case 1) and day time (case 2) and the largest dimension from either case used for determining the stairway width for each deck under consideration.

1.5 The calculation method determines the stairway width at each deck level taking into account the three consecutive stairways leading into the stairway under consideration.

2 Calculation of the stairway widths

2.1 In considering the design of stairway widths for each individual case which allow for the timely flow of persons evacuating to the muster stations from adjacent decks above and below, the following calculation method should be used (see figures 1 and 2):

when joining two decks:
$W = (N_1 + N_2) \times 10$ mm;

when joining three decks:
$W = (N_1 + N_2 + 0.5N_3) \times 10$ mm;

when joining four decks:
$W = (N_1 + N_2 + 0.5N_3 + 0.25N_4) \times 10$ mm;

when joining five or more decks the width of the stairways should be determined by applying the above formula for four decks to the deck under consideration and to the consecutive deck,

where:

W = the required tread width between handrails of the stairway. The calculated value of "W" may be reduced where available landing area "S" is provided in stairways at the deck level defined by substracting "P" from "Z", such that:

P = S x 3.0 persons/m^2; $P_{max} = 0.25$ Z

where:

Z = the total number of persons expected to be evacuated on the deck being considered;

P = the number of persons taking temporary refuge on the stairway landing, which may be substracted from "Z" to a maximum value of P = 0.25 Z (to be rounded down to the nearest whole number);

S = the surface area (m^2) of the landing, minus the surface area necessary for the opening of doors and minus the surface area necessary for accessing the flow on stairs (see figure 1);

N = the total number of persons expected to use the stairway from each consecutive deck under consideration; N_1 is for the deck with the largest number of persons using that stairway; N_2 is taken for the deck with the next highest number of persons directly entering the stairway flow such that when sizing the stairway width at each deck level, $N_1 > N_2 > N_3 > N_4$ (see figure 2). These decks are assumed to be on or upstream (i.e. away from the embarkation deck) of the deck being considered.

2.2 The stairway should not decrease in width in the direction of evacuation to the muster station, except in the case of several muster stations in one main vertical zone the stairway width should not decrease in the direction of the evacuation to the most distant muster station.

2.3 Where the passengers and crew are held at a muster station which is not at the survival craft embarkation position the dimensions of stairway width and doors from the muster station to this position should be based on the number of persons in the controlled groups. The width of these stairways and doors need not exceed 1,500 mm unless larger dimensions are required for evacuation of these spaces under normal conditions.

3 Initial distribution of persons on board

3.1 The calculations of stairway widths should be based upon the crew and passenger load on each deck. Occupant loads should be as rated by the designer for passenger and crew accommodation spaces, service spaces, control spaces and machinery spaces. For the purpose of the calculation the maximum capacity of a public space should be defined by either of the following two values: the number of seats or similar arrangements, or the number obtained by assigning 2 m^2 of gross deck surface area to each person.

3.2 The dimensions of the means of escape should be calculated on the basis of the total number of persons expected to escape by the stairway and through doorways, corridors and landing (see figure 3). Calculations should be made separately for the two cases of occupancy of the spaces specified below. For each component part of the escape route, the dimension taken should not be less than the largest dimension determined for each case:

Case 1 Passengers in cabins with maximum berthing capacity fully occupied;

members of the crew in cabins occupied to 2/3 of maximum berthing capacity; and
service spaces occupied by 1/3 of the crew.

Case 2 Passengers in public spaces occupied to 3/4 of maximum capacity;

members of the crew in public spaces occupied to 1/3 of maximum capacity;

service spaces occupied by 1/3 of the crew; and

crew accommodation occupied by 1/3 of the crew.

3.3 The maximum number of persons contained in a vertical zone including persons entering stairways from another main vertical zone should not be assumed to be higher than the maximum number of persons authorized to be carried on board for the calculation of the stairway widths only.

4 Additional notations

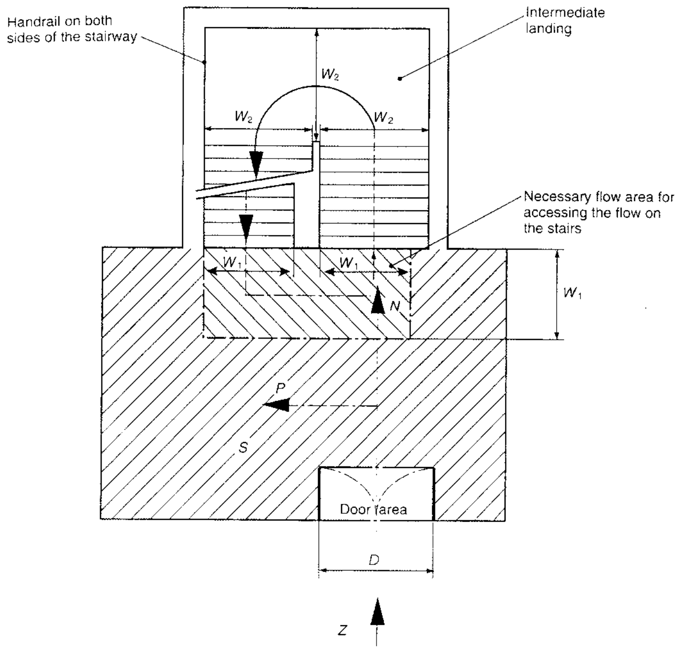
4.1 The aggregate width of stairway exit doors to the muster station should not be less than the aggregate width of stairways serving this deck.

4.2 The area of landings at each deck level required by regulation II-2/28.1.5.5 should be based on the total number of persons (Z) expected to be evacuated in accordance with regulation II-2/28.1.5.5 and should be considered prior to the calculation of the stairway width "W".

4.3 Means of escape plans should be provided indicating the following:
.1 the number of crew and passengers in all normally occupied spaces;
.2 the number of crew and passengers expected to escape by the stairway and through doorways, corridors and landing;
.3
.4 primary and secondary means of escape;
.5 widths of stairways, doors, corridors and landing areas.

4.4 Means of escape plans should be accompanied by detailed calculations for determining the width of escape stairways, doors, corridors and landing areas.

Figure 1 – Landing calculation or stairway width reduction



P = S x 3 persons /m^2 = the number of persons taking refuge on the landing to a maximum of P = 0.25 Z;

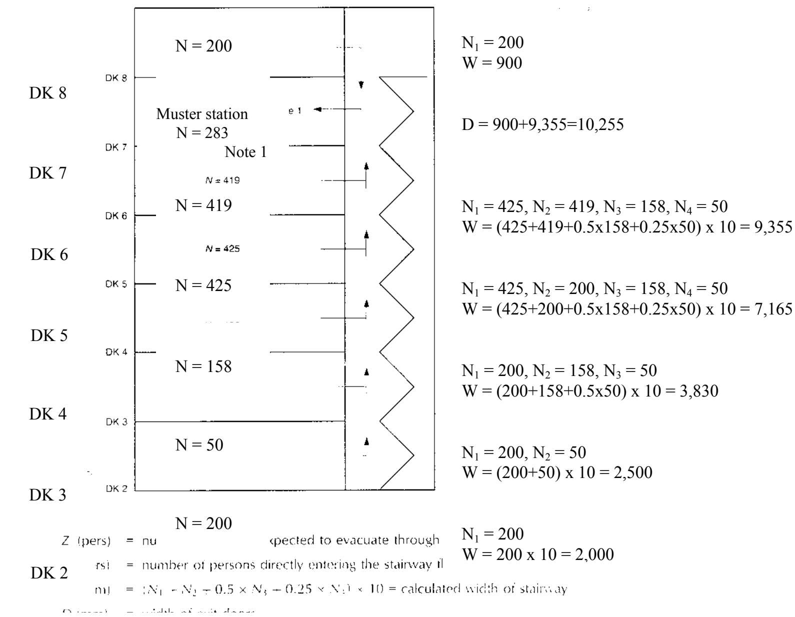
N = Z - P = the number of persons directly entering the stairway flow from a given deck;

Z = number of persons to be evacuated from the deck considered;

S = available landing area (m^2) after subtracting the surface area necessary for movement and subtracting the space taken by the door swing area. Landing area is a sum of flow area, credit area and door area;

D = width of exit doors to the stairway landing area (mm)

Figure 2 – Minimum stairway width (W) calculation example



Z (pers) = number of persons expected to evacuate through the stairway

N (pers) = number of persons directly entering the stairway flow from a given deck

W (mm) = $(N_1 + N_2 + 0.5 \times N_3 + 0.25 \times N_4) \times 10$ = calculated width of stairway

D (mm) = width of exit doors

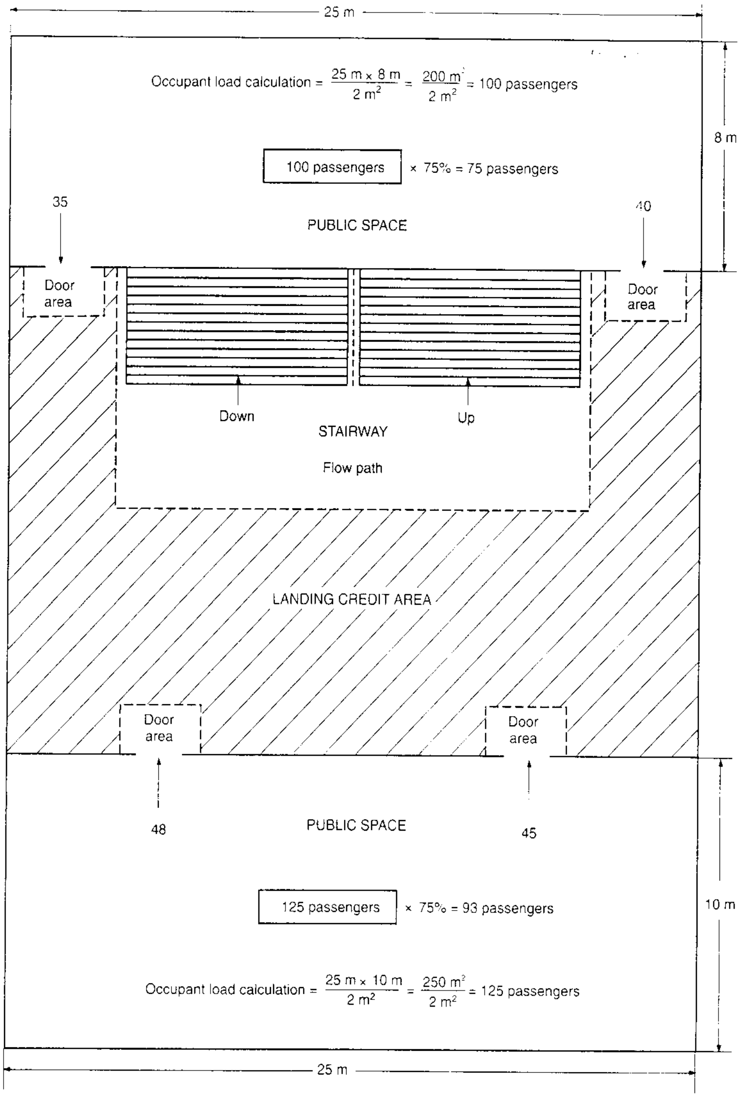
$N_1 > N_2 > N_3 > N_4$ where:

N_1 (pers) = the deck with the largest number of persons "N" entering directly the stairway

N_2 (pers) = the deck with the next largest number of persons "N" entering directly the stairway, etc.

Note 1: The doors to the muster station should have aggregate width of 10,255 mm

Figure 3 – Occupant loading calculation example



RESOLUTION A.759(18)
Adopted on 4 November 1993

MARKING OF INFLATABLE LIFERAFTS

THE ASSEMBLY,

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

RECALLING ALSO that, while regulations III/40.7.1 and 41.9.2 of the International Convention for the Safety of Life at Sea, 1974, require the ship´s name and port of registry to be marked on rigid liferafts and lifeboats, there are no such requirements therein for marking inflatable liferafts,

RECOGNIZING that properly marked inflatable liferafts may considerably facilitate the initiation or effective conduct of a search and rescue operation or the determination as to whether such an operation is necessary,

NOTING that a simple and inexpensive means of ship identification in cases mentioned above has been developed,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its sixtieth session,

INVITES Governments to require that:

(a) inflatable liferafts carry a means of identification showing the name and port of registry of the ship to which the inflatable liferaft belongs

(b) the identification can be easily updated, without opening the inflatable liferaft container; and

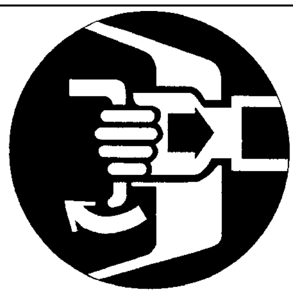
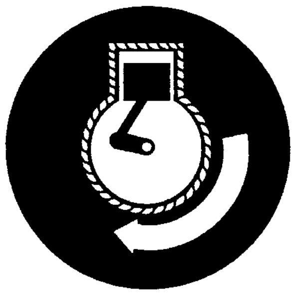
(c) To the extent practicable, existing inflatable liferafts are also marked in the same manner

RESOLUTION A.760(18)

Adopted on 4 November 1993

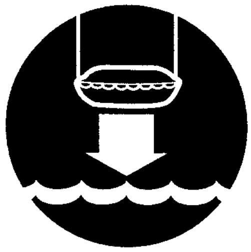
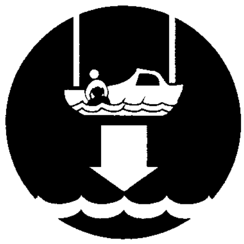
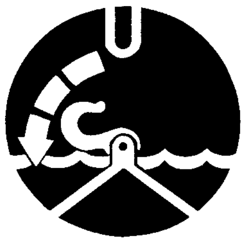
Annex 1

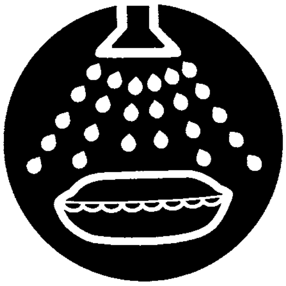
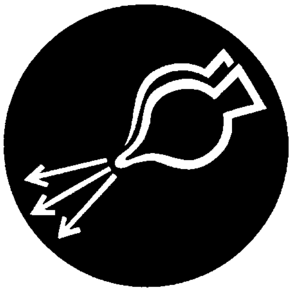
SYMBOLS FOR USE IN ACCORDANCE WITH REGULATION III/9.2.3 OF THE 1974 SOLAS CONVENTION AS AMENDED

Reference[47]	**Item**	**Symbol**[48]
1	FASTEN SEAT BELTS	
2	SECURE HATCHES	
3	START ENGINE	

[47] Numbers are used for reference purposes only and do not indicate the sequence of events as this will depend on the type of survival craft and launching appliances provided on board the ship.

[48] All symbols should be white on a blue background.

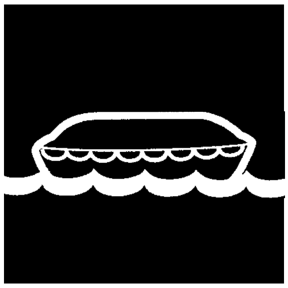
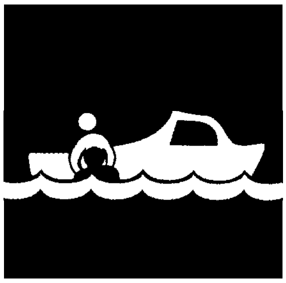
Reference	Item	Symbol
4	LOWER TO THE WATER	
4.1	THE LIFEBOAT	
4.2	THE LIFERAFT	
4.3	THE RESCUE BOAT	
5	RELEASE FALLS	

Reference	Item	Symbol
6	START WATER-SPRAY	
7	START AIR SUPPLY	
8	RELEASE GRIPES	

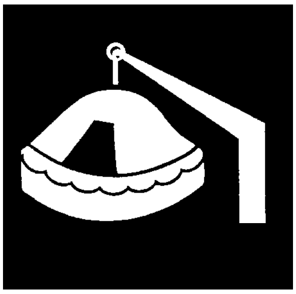
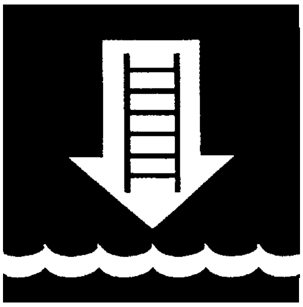
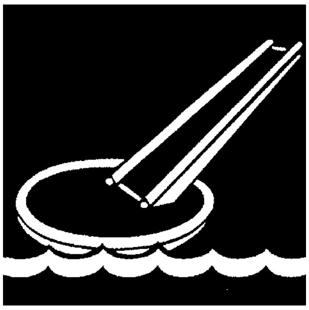
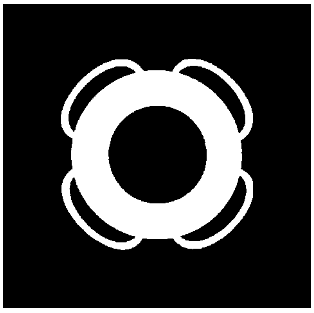
Annex 2

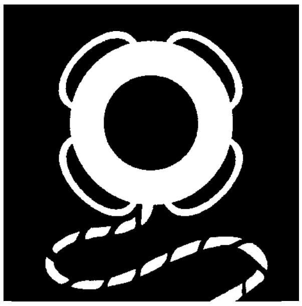
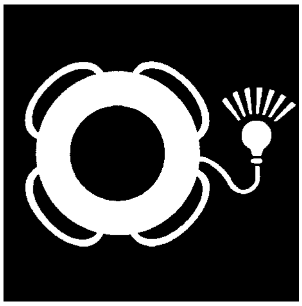
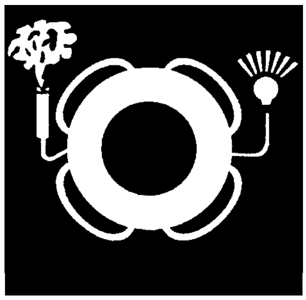
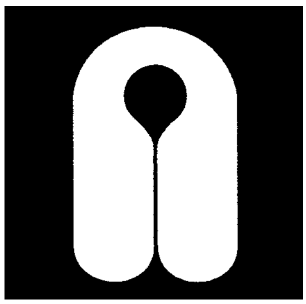
RECOMMENDED SYMBOLS INDICATING THE LOCATION OF EMERGENCY EQUIPMENT AND MUSTER AND EMBARKATION STATIONS

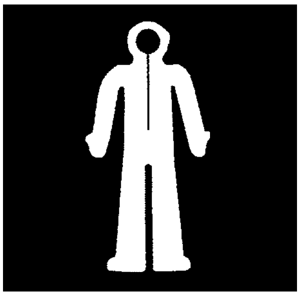
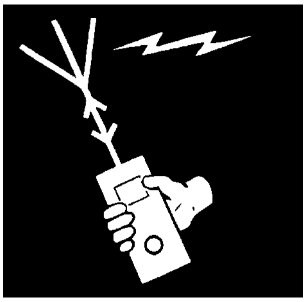
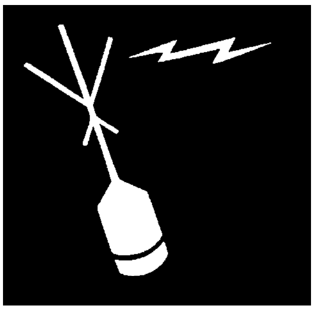
Where appropriate, a white arrow on a green background may be used in conjunction with symbols to indicate direction (see reference 22).

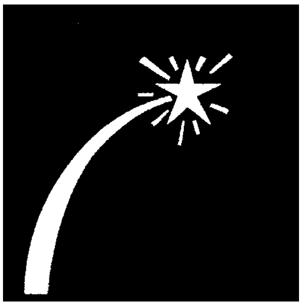
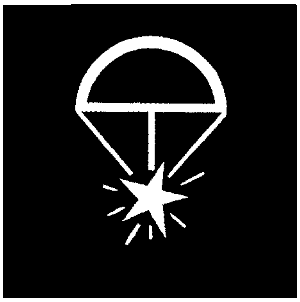
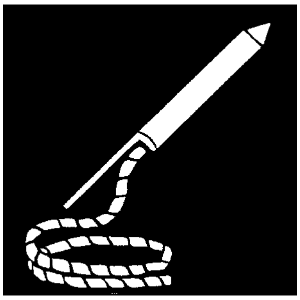
Reference	Item	Symbol[49]
1	LIFEBOAT	
2	RESCUE BOAT	
3	LIFERAFT	

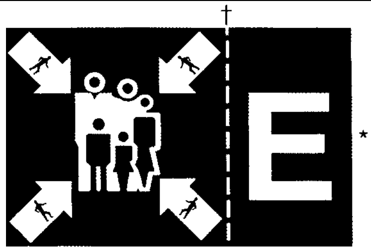
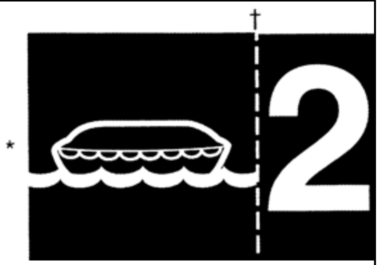
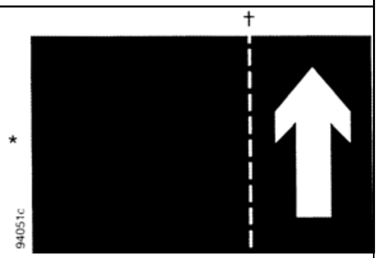
49 **All symbols should be white on a green background. The sizes of signs, letters and numbers should be to the satisfaction of the flag State Administration.**

Reference	Item	Symbol
4	DAVIT-LAUNCHED LIFERAFT	
5	EMBARKATION LADDER	
6	EVACUATION SLIDE	
7	LIFEBUOY	

Reference	Item	Symbol
8	LIFEBUOY WITH LINE	
9	LIFEBUOY WITH LIGHT	
10	LIFEBUOY WITH LIGHT AND SMOKE	
11	LIFEJACKET	

Reference	Item	Symbol
12	CHILD'S LIFEJACKET	
13	IMMERSION SUIT	
14	SURVIVAL CRAFT PORTABLE RADIO	
15	EPIRB	

Reference	Item	Symbol
16	RADAR TRANSPONDER	
17	SURVIVAL CRAFT PYROTECHNIC DISTRESS SIGNALS	
18	ROCKET PARACHUTE FLARES	
19	LINE-THROWING APPLIANCE	

Reference	Item	Symbol
20	MUSTER STATION	
* The station letter should be included on the right-hand side of the symbol		
21	EMBARKATION STATION	
* Use appropriate symbol for type of survival craft at the station. ‡ The station number should be included on the right-hand side of the symbol.		
22	DIRECTION INDICATOR (for use with any symbol)	
* Insert appropriate symbol (i.e. symbols 1 to 21) on left-hand side of the arrow. ‡ Point arrow in the direction of the equipment or station.		

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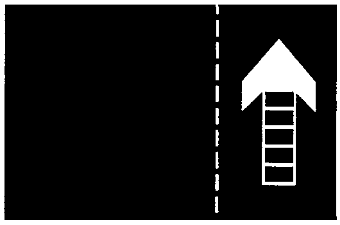
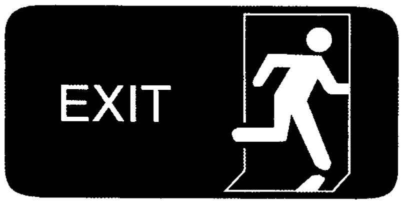
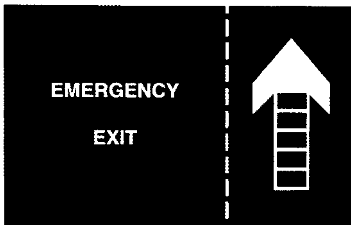
† The dashed line indicates that the whole symbol may consist of one part or of two separate parts (one for the sign and another for the number or letter). When a direction indicator (arrow) is also used it may be part of the symbol or be separate. The dashed line should not be shown.

Reference	Item	Symbol
23	EMERGENCY EXIT INDICATOR	† * 
24	EXIT	
25	EMERGENCY EXIT	† * 

* Point arrow in the direction of the equipment or station.

† The dashed line indicates that the whole symbol may consist of one part or of two separate parts (one for the sign and another for the number or letter). When a direction indicator (arrow) is also used it may be part of the symbol or be separate. The dashed line should not be shown.

RESOLUTION A.761(18)

Adopted on 4 November 1993

RECOMMENDATION ON CONDITIONS FOR THE APPROVAL OF SERVICING STATIONS FOR INFLATABLE LIFERAFTS

General

1 Administrations should ensure that the periodic survey of inflatable liferafts is performed at servicing stations that have demonstrated competence to service and repack rafts, maintain an adequate facility and use only properly trained personnel. In order to be approved, servicing stations should have demonstrated this capability for inflatable liferafts of each manufacturer whose liferafts they are competent to service and should comply with the following:

.1 servicing of inflatable liferafts should be carried out in fully enclosed spaces only. There should be ample room for the number of inflatable liferafts expected to be serviced at any one time; the ceiling should be sufficiently high to allow the largest liferafts to be serviced to be turned over when inflated, or an equally efficient means to facilitate inspection of bottom seams should be provided;

.2 the floor should be provided with a clean surface sufficiently smooth to ensure that no damage will occur to the liferaft fabric;

.3 the servicing space should be well lit, provided that direct rays of sunlight do not enter the space;

.4 the temperature and, when necessary, the relative humidity in the servicing space should be sufficiently controlled to ensure that servicing and repairs can be effectively carried out;

.5 the servicing space should be efficiently ventilated, but be free from draughts;

.6 separate areas or rooms should be provided for:

.6.1 liferafts awaiting servicing, repair or delivery;

.6.2 the repair of glass-fibre containers and the painting of compressed gas cylinders;

.6.3 materials or spare parts;

.6.4 administrative purposes;

.7 means should be provided in the liferaft storage space to ensure that liferafts in containers or valises are neither stored on top of each other in more than two tiers unless supported by shelving nor subjected to excessive loads;

.8 spare and obsolete pyrotechnics should be stored in a separate, safe and secure magazine well away from the servicing and storage spaces;

.9 sufficient tools should be available for the servicing of liferafts and release gear in accordance with the requirements of the manufacturer, including:

.9.1 suitable and accurate manometers or pressure gauges, thermometers and barometers which can be easily read;

.9.2 one or more air pumps for inflating and deflating liferafts, together with a means of cleaning and drying the air and including the necessary high-pressure hoses and adapters;

.9.3 a scale for weighing inflation gas cylinders with sufficient accuracy;

.9.4 sufficient gas for blowing through the inlet system of the liferafts;

.10 procedures should be established to ensure that each gas cylinder is properly filled and gastight before fitting to a liferaft;

.11 sufficient materials and accessories should be available for repairing liferafts, together with replacements of the emergency equipment to the satisfaction of the manufacturer;

.12 when servicing davit-launched liferafts, adequate means should be provided for overload testing of such liferafts;

.13 servicing and repair work should only be carried out by qualified persons who have been adequately trained and certificated by the liferaft manufacturer. The training procedure should ensure that servicing personnel are made aware of changes and new techniques;

.14 arrangements should be made for the manufacturer to make available to the service station:

.**14.1** changes to servicing manuals, servicing bulletins and instructions;

.14.2 proper materials and replacement parts;

.14.3 bulletins or instructions from the Administration;

.14.4 training for servicing technicians;

.15 smoking should not be allowed in the servicing and packing areas.

2 After initial approval, Administrations should arrange for the frequent inspection of servicing stations to ensure that manufacturer support is up to date and effective and that the requirements of this Recommendation are complied with.

3 Administrations should ensure that information regarding servicing facilities for inflatable liferafts is made available to mariners.

Servicing of inflatable liferafts

4 The following tests and procedures should be carried out, except where noted otherwise, at every servicing of an inflatable liferaft fitted as life-saving equipment.

5 inflatable liferaft servicing should be carried out in accordance with the appropriate manufacturer's servicing manual. Necessary procedures should include, but not be limited to, the following:

.1 inspection of the container for damage;

.2 inspection of the folded liferaft and the interior of the container for signs of dampness;

.3 a gas inflation (GI) test should be carried out at 5-year intervals, and when undertaking a gas inflation test, special attention should be paid to the effectiveness of the relief valves. The folded liferaft should be removed from its container before activating the fitted gas inflation system. After gas inflation has been initiated, sufficient time should be allowed to enable the pressure in the buoyancy tubes to become stabilized and the solid particles of CO_2 to evaporate. After this period the buoyancy tubes should, if necessary, be topped up with air, and the liferaft subjected to a pressure holding test over a period of not less than one hour, during which the pressure drop will not exceed 5% of the working pressure;

.4 each liferaft should be subjected to the necessary additional pressure (NAP) test as described in appendix 1, or any other similar test recommended by the manufacturer, at yearly intervals after the tenth year of the liferaft's life unless earlier servicing is deemed necessary as a result of visual inspection. After allowing sufficient time for the liferaft to regain fabric tension at working pressure, the liferaft should be subjected to a pressure holding test over a period of not less than one hour, during which the pressure drop will not exceed 5% of the working pressure;

.5 when a NAP or GI test is not required, a working pressure (WP) test should be carried out (see appendix 2), by inflation of the liferaft with dry compressed air, after removing it from the container shell or valise and from its retaining straps, if fitted, to at least the working pressure, or to the pressure required by the manufacturer's servicing manual if higher. The liferaft should be subjected to a pressure holding test over a period of not less than one hour, during which the pressure drop will not exceed 5% of the working pressure;

.6 while inflated, the liferaft should be subjected to a thorough inspection inside and out in accordance with the manufacturer's instructions;

.7 the floor should be inflated, checked for broken reeds and tested in accordance with the manufacturer's instructions;

.8 the seams between floor and buoyancy tube should be checked for slippage or edge lifting;

.9 with the buoyancy tube supported at a suitable height above the service floor, a person weighing not less than 75 kg should walk/crawl around the perimeter of the floor for the entire circumference and the floor seams should be checked again. Manufacturers may substitute any other seam test which will determine the integrity of the floor seam until the next inspection is due. This test should be carried out at yearly intervals after the tenth year of the liferaft's life;

.10 after deflation, arch roots should be checked in accordance with the manufacturer's instructions;
.11 all items of equipment should be checked to ensure that they are in good condition and that dated items are replaced at the time of servicing if there is less than 6 months remaining before the expiry date approved by the Administration;
.12 davit-launched liferafts should be subjected to a 10% overload suspension test at every second servicing;
.13 a check should be made to ensure that the liferaft and the atmosphere are dry when the liferaft is being repacked;
.14 the required markings should be updated and checked;
.15 a record of servicing should be maintained for at least 5 years after the date of service;
.16 statistical records should be prepared on all liferafts serviced, indicating, in particular, defects found, repairs carried out and units condemned and withdrawn from service. Such statistics should be available to the Administration.

Responsibilities of manufacturers, Administrations and shipowners

6 In order to ensure that the servicing of inflatable liferafts is effectively conducted to provide reliable survival craft in an emergency, manufacturers, Administrations and shipowners have parallel and overlapping responsibilities; these include, but are not limited to, the following:

.1 *Manufacturers* are responsible for:
.1.1 ensuring that their liferafts can be adequately serviced in accordance with this Recommendation or with any additional requirements necessary for that particular product and design and thereto accredit a sufficient number of servicing stations;
.1.2 ensuring that each servicing station accredited by them for servicing and repair of their liferafts has qualified persons whom they have adequately trained and certificated to perform such work and who are aware of any changes or new techniques;
.1.3 keeping Administrations fully informed as to the list of servicing stations accredited by them and any changes thereto;
.1.4 making available to service stations:
- changes to servicing manuals, servicing bulletins and instructions;
- proper materials and replacement parts;
- bulletins or instructions from the Administration;

.1.5 keeping Administrations fully informed of any shipping casualties known to them and involving their liferafts; and also of any failures of liferafts, other than failures during inspections which are known to them; and
.1.6 informing shipowners whenever possible of any deficiency or danger known to them and related to the use of their liferafts and taking whatever remedial measures they deem necessary;

.2 *Administrations* are responsible for conducting periodic checks of servicing stations to determine compliance with this recommendation and for checking quality assurance by spot checks or inspections that are deemed to be adequate to achieve compliance;

.3 *Shipowners* are responsible for ensuring, as a minimum requirement, that all liferafts fitted as lifesaving equipment are approved and are serviced at the appropriate intervals at an approved servicing station. Whenever practicable, a representative of the shipowner should be in attendance during service.

Appendix 1

Necessary additional pressure (NAP) test

1 Plug the pressure relief valves.

2 Gradually raise the pressure to the lesser of 2.0 times the working pressure or that sufficient to impose a tensile load on the inflatable tube fabric of at least 20% of the minimum required tensile strength.

3 After 5 minutes, there should be no seam slippage, cracking, or other defects (resolution A.521(13), part 1, paragraph 5.18.4.1), or significant pressure drop. If cracking in the buoyancy tubes is audible, the liferaft should be condemned; if no cracking is heard, the pressure in all buoyancy chambers should be reduced simultaneously by removing the plugs from the pressure relief valves.

4 Liferaft manufacturers should include tables in their servicing manuals of exact NAP test pressures corresponding to their particular tube sizes and fabric tensile strength requirements, calculated according to the equation:

$$p(\text{kg/cm}^{2)} = \frac{2\,x\,tensile\ strength\,(kg\ per\ 5\,cm)}{25\,x\,diameter\,(cm)}$$

Appendix 2

Frequency of NAP tests: working pressure (WP), gas inflation (GI) and floor seam strength (FS)

Servicing intervals	Test method
End of first year	WP test
End of second year	WP test
End of third year	WP test
End of fourth year	WP test
End of fifth year	GI test
End of sixth year	WP test
End of seventh year	WP test
End of eighth year	WP test
End of ninth year	WP test
End of tenth year	GI test + FS
Eleventh to fourteenth year	NAP test + FS
Fifteenth year	GI test + NAP + FS
Sixteenth to nineteenth year	NAP test + FS
Twentieth year	GI test + NAP + FS
Twenty-first to twenty-fourth year	NAP test + FS
Twenty-fifth year onwards	GI test + NAP + FS

NAP - Necessary additional pressure test (appendix 1)
WP - Working pressure (compressed air)
GI - Gas inflation (fitted gas)
FS - Floor seam

RESOLUTION A.771(18)
Adopted on 4 November 1993

RECOMMENDATION ON TRAINING REQUIREMENTS FOR CREWS OF FAST RESCUE BOATS

1 GENERAL

1.1 Before training is commenced, the requirements of medical fitness, particularly regarding eyesight and hearing, should be met by the candidate.

1.2 The training should be relevant to the provisions of the international Convention for the Safety of Life at Sea (SOLAS), as amended. In developing training recommendations, account should be taken of, but not limited to, knowledge of the following items:

Theory

.1 The operator should have knowledge of:
.1.1 the safety precautions during launch and recovery of a fast rescue boat;
.1.2 how to handle a fast rescue boat in prevailing and adverse weather and sea conditions;
.1.3 the navigational and safety equipment available in a fast rescue boat;
.1.4 search patterns and environmental factors affecting their execution;
.1.5 how to recover a casualty from the water and transfer of a casualty to rescue helicopter and/or mother ship; and
.1.6 the assessment of the readiness of fast rescue boats and related equipment for immediate use.

Practical

.2 Basic knowledge of the maintenance, emergency repairs, normal inflation and deflation of buoyancy compartments of inflatable fast rescue boats.
.3 Basic knowledge and skills in surface swimming in special equipment as well as handling and maintaining such equipment.
.4 The control of safe launching and recovery of the fast rescue boat.
.5 Skills in the use of communication and signalling equipment between the fast rescue boats and helicopter and/or mother ship.
.6 The handling of fast rescue boats in prevailing weather and sea conditions.
.7 The ability to right a capsized fast rescue boat.
.8 The ability to carry out search patterns, taking account of environmental factors.
.9 The ability to safely recover a casualty from the water, use the emergency equipment carried on fast rescue boats and transfer of the casualty to a place of safety.

Resolution A.472(XII) skall tillämpas på material som testats före den 1 oktober 1999. För utrustning som testas därefter skall resolution A.799(19) tillämpas.

RESOLUTION A.799(19)

Adopted on 12 December 1995

REVISED RECOMMENDATION ON TEST METHODS FOR QUALIFYING MARINE CONSTRUCTION MATERIALS AS NON-COMBUSTIBLE

1 Scope

This recommendation specifies a procedure to be used in assessing materials as meeting the requirement for non-combustible materials as specified in regulation 3 of chapter II-2 of the International Convention for the Safety of Life at Sea, 1974, as amended, and in regulation 4 of chapter I of the Torremolinos Protocol of 1993 relating to the Torremolinos International Convention for the Safety of Fishing Vessels, 1977.

2 Test procedures

Tests should be carried out in accordance with ISO Standard 1182 "Fire Tests – Building Materials – Non-combustibility Test", 3rd edition, published on 1 December 1990, with the exception of Annex A "Criteria for evaluation".

3 Criteria for qualifying marine materials as non-combustible

A material should be deemed non-combustible if all the following criteria are satisfied:

3.1 The average furnace thermocouple temperature rise as calculated in 8.1.2 of ISO 1182 does not exceed 30°C.

3.2 The average surface thermocouple temperature rise as calculated in 8.1.2 of ISO 1182 does not exceed 30°C.

3.3 The mean duration of sustained flaming as calculated in 8.2.2 of ISO 1182 does not exceed 10 seconds.

3.4 The average mass loss as calculated in 8.3 of ISO 1182 does not exceed 50%.

RESOLUTION A.800(19)

Adopted on 23 November 1995

REVISED GUIDELINES FOR APPROVAL OF SPRINKLER SYSTEMS

EQUIVALENT TO THAT REFERRED TO IN SOLAS REGULATION II-2/12

1 GENERAL

Equivalent sprinkler systems must have the same characteristics which have been identified as significant to the performance and reliability of automatic sprinkler systems approved under the requirements of SOLAS regulation II-2/12.

2 DEFINITIONS

2.1 *Antifreeze system:* A wet pipe sprinkler system employing automatic sprinklers attached to a piping system containing an antifreeze solution and connected to a water supply. The antifreeze solution is discharged, followed by water, immediately upon operation of sprinklers opened by heat from a fire.

2.2 *Deluge system:* A sprinkler system employing open sprinklers attached to a piping system connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto.

2.3 *Dry pipe system:* A sprinkler system employing automatic sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve. The water then flows into the piping system and out of the opened sprinklers.

2.4 *Preaction system:* A sprinkler system employing automatic sprinklers attached to a piping system containing air that may or may not be under pressure, with a supplemental detection system installed in the same area as the sprinklers. Actuation of the detection system opens a valve that permits water to flow into the sprinkler piping system and to be discharged from any sprinklers that may be open.

2.5 *Water-based extinguishing medium:* Fresh water or sea water with or without additives mixed to enhance fire-extinguishing capability.

2.6 *Wet pipe system:* A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire.

3 PRINCIPAL REQUIREMENTS FOR THE SYSTEM

3.1 The system should be automatic in operation, with no human action necessary to set it in operation.

3.2 The system should be capable of both detecting the fire and acting to control or suppress the fire with a water-based extinguishing medium.

3.3 The sprinkler system should be capable of continuously supplying the water-based extinguishing medium for a minimum of 30 min. A pressure tank should be provided to meet the functional requirement stipulated in SOLAS regulation II-2/12.4.1.

3.4 The system should be of the wet pipe type but small exposed sections may be of the dry pipe, preaction, deluge, antifreeze or other type to the satisfaction of the Administration where this is necessary.

3.5 The system should be capable of fire control or suppression under a wide variety of fire loading, fuel arrangement, room geometry and ventilation conditions.

3.6 The system and equipment should be suitably designed to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered in ships.

3.7 The system and its components should be designed and installed in accordance with international standards acceptable to the Organization[50], and manufactured and tested to the satisfaction of the Administration in accordance with the requirements given in appendices 1 and 2 to these guidelines.

3.8 The system should be provided with both main and emergency sources of power.

3.9 The system should be provided with a redundant means of pumping or otherwise supplying a water-based extinguishing medium to the sprinkler system.

3.10 The system should be fitted with a permanent sea inlet and be capable of continuous operation using seawater.

3.11 The piping system should be sized in accordance with an hydraulic calculation technique[51].

[50] Pending the development of international standards acceptable to the Organization, national standards as prescribed by the Administration should be applied.

[51] Where the Hazen-Williams Method is used, the following values of the friction factor "C" for different pipe types which may be considered should apply:

Pipe type	C
Black or galvanized mild steel	120
Copper and copper alloys	150
Stainless steel	150

3.12 Sprinklers should be grouped into separate sections. Any section should not serve more than two decks of one main vertical zone.

3.13 Each section of sprinklers should be capable of being isolated by one stop valve only. The stop valve in each section should be readily accessible and its location should be clearly and permanently indicated. Means should be provided for preventing the stop valves being operated by an unauthorized person.

3.14 Sprinkler piping should not be used for any other purpose.

3.15 The sprinkler system supply components should be outside category A machinery spaces.

3.16 A means for testing the automatic operation of the system for assuring the required pressure and flow should be provided.

3.17 Each sprinkler section should be provided with a means for giving a visual and audible alarm at a continuously manned central control station within one minute of flow from one or more sprinklers, a check valve, pressure gauge, and a test connection with a means of drainage.

3.18 A sprinkler control plan should be displayed at each centrally manned control station.

3.19 Installation plans and operating manuals should be supplied to the ship and be readily available on board. A list or plan should be displayed showing the spaces covered and the location of the zone in respect of each section. Instructions for testing and maintenance should also be available on board.

3.20 Sprinklers should have fast response characteristics as defined in ISO standard 6182-1.

3.21 In accommodation and service spaces the sprinklers should have a nominal temperature rating of 57°C to 79°C, except that in locations such as drying rooms, where high ambient temperatures might be expected, the nominal temperature may be increased by not more than 30°C above the maximum deckhead temperature.

3.22 Pumps and alternative supply components should be sized so as to be capable of maintaining the required flow to the hydraulically most demanding area of not less than 280 m^2. For application to a small ship with a total protected area of less than 280 m^2, the Administration may specify the appropriate area for sizing of pumps and alternative supply components.

APPENDIX I

COMPONENT MANUFACTURING STANDARDS FOR WATER MIST NOZZLES

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1 INTRODUCTION

1.1 This document is intended to address minimum fire protection performance, construction and marking requirements, excluding fire performance, for water mist nozzles.

1.2 Numbers in brackets following a section or subsection heading refer to the appropriate section or paragraph in the standard for automatic sprinkler system (part I: Requirements and methods of test for sprinklers, ISO 6182-1).

2 DEFINITIONS

2.1 *Conductivity factor (C):* a measure of the conductance between the nozzle's heat responsive element and the fitting expressed in units of $(m/s)^{0.5}$.

2.2 *Rated working pressure:* maximum service pressure at which a hydraulic device is intended to operate.

2.3 *Response time index (RTI):* a measure of nozzle sensitivity expressed as RTI = $tu^{0.5}$, where t is the time constant of the heat responsive element in units of seconds, and u is the gas velocity expressed in metres per second. RTI can be used in combination with the conductivity factor (C) to predict the response of a nozzle in fire environments defined in terms of gas temperature and velocity versus time. RTI has units of $(m \cdot s)^{0.5}$.

2.4 *Standard orientation:* in the case of nozzles with symmetrical heat responsive elements supported by frame arms, standard orientation is with the air flow perpendicular to both the axis of the nozzle's inlet and the plane of the frame arms. In the case of non-symmetrical heat responsive elements, standard orientation is with the air flow perpendicular to both the inlet axis and the plane of the frame arms which produces the shortest response time.

2.5 *Worst case orientation:* the orientation which produces the longest response time with the axis of the nozzles inlet perpendicular to the air flow.

3 PRODUCT CONSISTENCY

3.1 It should be the responsibility of the manufacturer to implement a quality control programme to ensure that production continuously meets the requirements in the same manner as the originally tested samples.

3.2 The load on the heat responsive element in automatic nozzles should be set and secured by the manufacturer in such a manner so as to prevent field adjustment or replacement.

4 WATER MIST NOZZLE REQUIREMENTS

4.1 Dimension

Nozzles should be provided with a nominal 6 mm (1/4 in.) or larger nominal inlet thread or equivalent. The dimensions of all threaded connections should conform to international standards where applied. National standards may be used if international standards are not applicable.

4.2 Nominal release temperatures [6.2][52].

4.2.1 The nominal release temperatures of automatic glass bulb nozzles should be as indicated in table 1.

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[52] Figures given in square brackets refer to ISO standard 6182-1.

4.2.2 The nominal release temperatures of fusible automatic element nozzles should be specified in advance by the manufacturer and verified in accordance with 4.3. Nominal release temperatures should be within the ranges specified in table 1.

4.2.3 The nominal release temperature that is to be marked on the nozzle should be that determined when the nozzle is tested in accordance with 5.6.1, taking into account the specifications of 4.3.

Table 1 - Nominal release temperature

GLASS BULB NOZZLES		**FUSIBLE ELEMENT NOZZLES**	
Nominal release temperature (°C)	Liquid color code	Nominal release temperature (°C)	Frame color code +
57	orange	57 to 77	uncolered
68	red	80 to 107	white
79	yellow	121 to 149	blue
93-100	green	163 to 191	red
121-141	blue	204 to 246	green
163-182	mauve	260 to 343	orange
204-343	black		

+ - Not required for decorative nozzles.

4.3 **Operating temperatures** (see 5.6.1) [6.3]

Automatic nozzles should open within a temperature range of

$$X \pm (0.035X + 0.62)°C$$

where X is the nominal release temperature.

4.4 **Water flow and distribution**

4.4.1 *Flow constant* (see 5.10) [6.4.1]

.1 The flow constant K for nozzles is given by the formula:

$$K = \frac{Q}{p^{0.5}}$$

where:

p is the pressure in bars;
Q is the flow rate in litres per minute.

.2 The value of the flow constant K published in the manufacturer's design and installation instructions should be verified using the test method of 5.10. The average flow constant K should be within ±5% of the manufacturer's value.

4.4.2 *Water distribution* (see 5.11)

Nozzles which have complied with the requirements of the first test should be used to determine the effective nozzle discharge characteristics when tested in accordance with 5.11.1. These characteristics should be published in the manufacturer's design and installation instructions.

4.4.3 *Water droplet size and velocity* (see 5.11.2)

The water droplet size distribution and droplet velocity distribution should be determined in accordance with 5.11.2 for each design nozzle at the minimum and maximum operating pressures, and minimum and maximum air flow rates, when used, as part of the identification of the discharge characteristics of the nozzles which have demonstrated compliance with the fire test. The measurements should be made at two representative locations:

.1 perpendicular to the central axis of the nozzle, exactly 1 m below the discharge orifice or discharge deflector; and

.2 radially outward from the first location at either 0.5 m or 1 m distance, depending on the distribution pattern.

4.5 Function (see 5.5) [6.5]

4.5.1 When tested in accordance with 5.5, the nozzle should open and, within 5 s after the release of the heat responsive element, should operate satisfactorily by complying with the requirements of 5.10. Any lodgement of released parts should be cleared within 60 s of release for standard response that responsive elements and within 10 s of release for fast and special response heat responsive elements for the nozzles should then comply with the requirements of 5.11.

4.5.2 The nozzle discharge components should not sustain significant damage as a result of the functional test specified in 5.5 and should have the same flow constant range and water droplet size and velocity within 5% of values as previously determined in accordance with 4.4.1 and 4.4.3.

4.6 Strength of body (see 5.3) [6.6]

The nozzle body should not show permanent elongation of more than 0.2% between the load-bearing points after being subjected to twice the average service load as determined using the method of 5.3.1.

4.7 Strength of release element [6.7]

4.7.1 *Glass bulbs* (see 5.9.1)

The lower tolerance limit for bulb strength should be greater than two times the upper tolerance limit for the bulb design load based on calculations with a degree of confidence of 0.99 for 99 % of the samples as determined in 5.9.1. Calculations will be based on the normal or gaussian distribution except where another distribution can be shown to be more applicable due to manufacturing or design factors.

4.7.2 *Fusible elements* (see 5.9.2)

Fusible heat-responsive elements in the ordinary temperature range should be designed to:

.1 sustain a load of 15 times its design load corresponding to the maximum service load measured in 5.3.1 for a period of 100 h;

.2 demonstrate the ability to sustain the design load.

4.8 Leak resistance and hydrostatic strength (see 5.4) [6.8]

4.8.1 A nozzle should not show any sign of leakage when tested by the method specified in 5.4.1.

4.8.2 A nozzle should not rupture, operate or release any parts when tested by the method specified in 5.4.2.

4.9 Heat exposure [6.9]

4.9.1 *Glass bulb nozzles* (see 5.7.1)

There should be no damage to the glass bulb element when the nozzle is tested by the method specified in 5.7.1.

4.9.2 *All uncoated nozzles* (see 5.7.2)

Nozzles should withstand exposure to increased ambient temperature without evidence of weakness or failure, when tested by the method specified in 5.7.2.

4.9.3 *Coated nozzles* (see 5.7.3)

In addition to meeting the requirements of 5.7.2 in an uncoated version, coated nozzles should withstand exposure to ambient temperatures without evidence of weakness or failure of the coating, when testing by the method specified in 5.7.3.

4.10 Thermal shock (see 5.8) [6.10]

Glass bulb nozzles should not be damaged when tested by the method specified in 5.8. Proper operation is not considered as damage.

4.11 **Corrosion** (6.11)

4.11.1 *Stress corrosion* (see 5.12.1 and 5.12.2)

When tested in accordance with 5.12.1, all brass nozzles should show no fractures which could affect their ability to function as intended and satisfy other requirements.

When tested in accordance with 5.12.2, stainless steel parts of water mist nozzles should show no fractures or breakage which could affect their ability to function as intended and satisfy other requirements.

4.11.2 *Sulphur dioxide corrosion* (see 5.12.3)

Nozzles should be sufficiently resistant to sulphur dioxide saturated with water vapour when conditioned in accordance with 5.12.3. Following exposure, five nozzles should operate when functionally tested at their minimum flowing pressure (see 4.5.1 and 4.5.2). The remaining five samples should meet the dynamic heating requirements of 4.14.2.

4.11.3 *Salt spray corrosion* (see 5.12.4)

Coated and uncoated nozzles should be resistant to salt spray when conditioned in accordance with 5.12.4. Following exposure, the samples should meet the dynamic heating requirements of 4.14.2.

4.11.4 *Moist air exposure* (see 5.12.5)

Nozzles should be sufficiently resistant to moist air exposure and should satisfy the requirements of 4.14.2 after being tested in accordance with 5.12.5.

4.12 **Integrity of nozzle coatings** [6.12]

4.12.1 *Evaporation of wax and bitumen used for atmospheric protection of nozzles (see 5.13.1)*

Waxes and bitumens used for coating nozzles should not contain volatile matters in sufficient quantities to cause shrinkage, hardening, cracking or flaking of the applied coating. The loss in mass should not exceed 5% of that of the original sample when tested by the method in 5.13.1.

4.12.2 *Resistance to low temperatures* (see 5.13.2)

All coatings used for nozzles should not crack or flake when subjected to low temperatures by the method in 5.13.2.

4.12.3 *Resistance to high temperature* (see 4.9.3)

Coated nozzles should meet the requirements of 4.9.3.

4.13 Water hammer (see 5.15) [6.13]

Nozzles should not leak when subjected to pressure surges from 4 bar to four times the rated pressure for operating pressures up to 100 bars and two times the rated pressure for pressures greater than 100 bar. They should show no signs of mechanical damage when tested in accordance with 5.15 and should operate within the parameters of 4.5.1 at the minimum design pressure.

4.14 Dynamic heating (see 5.6.2) [6.14]

4.14.1 Automatic nozzles intended for installation in other than accommodation spaces and residential areas should comply with the requirements for RTI and C limits shown in figure 1. Automatic nozzles intended for installation in accommodation spaces or residential areas should comply with fast response requirements for RTI and C limits shown in figure 1. Maximum and minimum RTI values for all data points calculated using C for the fast and standard response nozzles should fall within the appropriate category shown in figure 1. Special response nozzles should have an average RTI value, calculated using C, between 50 and 80 with no value less than 40 or more than 100. When tested at an angular offset to the worst case orientation as described in 5.6.2, the RTI should not exceed 600 $(ms)^{0.5}$ or 250% of the value of RTI in the standard orientation, whichever is the less. The angular offset should be 15° for standard response, 20° for special response and 25° for fast response.

4.14.2 After exposure to the corrosion test described in 4.11.2, 4.11.3 and 4.11.4, nozzles should be tested in the standard orientation as described in 5.6.2.1 to determine the post exposure RTI. All post exposure RTI values should not exceed the limits shown in figure 1 for the appropriate category. In addition, the average RTI value should not exceed 130% of the pre-exposure average value. All post exposure RTI values should be calculated as in 5.6.2.3 using the pre-exposure conductivity factor (C).

4.15 Resistance to heat (see 5.14) [6.15]

Open nozzles should be sufficiently resistant to high temperatures when tested in accordance with 5.14. After exposure, the nozzle should not show:

.1 visual breakage or deformation;
.2 a change in flow constant K of more than 5%; and
.3 no changes in the discharge characteristics of the water distribution test (see 4.4.2) exceeding 5%.

4.16 Resistance to vibration (see 5.16) [6.16]

Nozzles should be able to withstand the effects of vibration without deterioration of their performance characteristics when tested in accordance with 5.16. After the vibration test of 5.16, nozzles should show no visible deterioration and should meet the requirements of 4.5 and 4.8.

4.17 Impact test (see 5.17) [6.17]

Nozzles should have adequate strength to withstand impacts associated with handling, transport and installation without deterioration of their performance or reliability. Resistance to impact should be determined in accordance with 5.17.

4.18 Lateral discharge (see 5.19) [6.19]

Nozzles should not prevent the operation of adjacent automatic nozzles when tested in accordance with 5.18.

4.19 30-day leakage resistance (see 5.19) [6.20]

Nozzles should not leak, sustain distortion or other mechanical damage when subjected to twice the rated pressure for 30 days. Following exposure, the nozzles should satisfy the test requirements of 5.4.

4.20 Vacuum resistance (see 5.20) [6.21]

Nozzles should not exhibit distortion, mechanical damage or leakage after being subjected to the test specified in 5.20.

4.21 Water shield [6.22 and 6.23]

4.21.1 *General*

An automatic nozzle intended for use at intermediate levels or beneath open grating should be provided with a water shield which complies with 4.21.2 and 4.21.3.

4.21.2 *Angle of protection*

Water shields should provide an "angle of protection" of 45° or less for the heat responsive element against direct impingement of run-off water from the shield caused by discharge from nozzles at higher elevations.

4.21.3 *Rotation* (see 5.21.2)

Rotation of the water shield should not alter the nozzle service load.

4.22 Clogging (see 5.21) [6.28.3]

A water mist nozzle should show no evidence of clogging during 30 min of continuous flow at rated working pressure using water that has been contaminated in accordance with 5.21.3. Following the 30 min of flow, the water flow at rated pressure of the nozzle and strainer of filter should be within ± 10% of the value obtained prior to conducting the clogging test.

5 METHODS OF TEST [7]

5.1 General

The following tests should be conducted for each type of nozzle. Before testing, precise drawings of parts and the assembly should be submitted together with the appropriate specifications (using SI units). Tests should be carried out at an ambient temperature of 20 ± 5°C, unless other temperatures are indicated.

5.2 Visual examination [7.2]

Before testing, nozzles should be examined visually with respect to the following points:

- **.1** marking;
- **.2** conformity of the nozzles with the manufacturer's drawings and specification; and
- **.3** obvious defects.

5.3 Body strength test [7.3]

5.3.1 The design load should be measured on ten automatic nozzles by securely installing each nozzle, at room temperature, in a tensile/compression test machine and applying a force equivalent to the application of the rated working pressure.

An indicator capable of reading deflection to an accuracy of 0.01 mm should be used to measure any change in length of the nozzle between its loading bearing points. Movement of the nozzle shank thread in the threaded bushing of the test machine should be avoided or taken into account.

The hydraulic pressure and load is then released and the heat responsive element is then removed by a suitable method. When the nozzle is at room temperature, a second measurement should be made using the indicator.

An increasing mechanical load to the nozzle is then applied at a rate not exceeding 500 N/min, until the indicator reading at the load bearing point initially measured returns to the initial value achieved under hydrostatic load. The mechanical load necessary to achieve this should be recorded as the service load. Calculation of the average service load should be made.

5.3.2 The applied load should then be progressively increased at a rate not exceeding 500 N/min on each of the five specimens until twice the average service load has been applied. This load should be maintained for 15 ± 5 s.

The load should then be removed and any permanent elongation as defined in 4.6 should be recorded.

5.4 Leak resistance and hydrostatic strength tests (see 4.8) [7.4]

5.4.1 Twenty nozzles should be subjected to a water pressure of twice their rated working pressure, but not less than 34.5 bar. The pressure should be increased from 0 bar to the test pressure, maintained at twice rated working pressure for a period of 3 min and then decreased to 0 bar. After the pressure has returned to 0 bar, it should be increased to the minimum operating pressure specified by the manufacturer in not more than 5 s. This pressure should be maintained for 15 s and then increased to rated working pressure and maintained for 15 s.

5.4.2 Following the test of 5.4.1, the twenty nozzles should be subjected to an internal hydrostatic pressure of four times the rated working pressure. The pressure should be increased from 0 bar to four times the rated working pressure and held there for a period of 1 min. The nozzle under test should not rupture, operate or release any of its operating parts during the pressure increase nor while being maintained at four times the rated working pressure for 1 min.

5.5 Functional test (see 4.5) [7.5]

5.5.1 Nozzles having nominal release temperatures less than 78°C, should be heated to activation in an oven. While being heated, they should be subjected to each of the water pressure specified in 5.5.2 applied to their inlet. The temperature of the oven should be increased to 400 ± 20°C in 3 min measured in close proximity to the nozzle. Nozzles having nominal release temperatures exceeding 78°C should be heated using a suitable heat source. Heating should continue until the nozzle has activated.

5.5.2 Eight nozzles should be tested in each normal mounting position and at pressures equivalent to the minimum operating pressure, the rated working pressure and at the average operating pressure. The flowing pressure should be at least 75% of the initial operating pressure.

5.5.3 If lodgement occurs in the release mechanism at any operating pressure and mounting position, 24 more nozzles should be tested in that mounting position and at that pressure. The total number of nozzles for which lodgement occurs should not exceed 1 in the 32 tested at that pressure and mounting position.

5.5.4 Lodgement is considered to have occurred when one or more of the released parts lodge in the discharge assembly in such a way as to cause the water distribution to be altered after the period of time specified in 4.5.1.

5.5.5 In order to check the strength of the deflector/orifice assembly, three nozzles should be submitted to the functional test in each normal mounting position at 125% of the rated working pressure. The water should be allowed to flow at 125% of the rated working pressure for a period of 15 min.

5.6 Heat responsive element operating characteristics

5.6.1 *Operating temperature test* (see 4.3) [7.6]

Ten nozzles should be heated from room temperature to 20°C to 22°C below their nominal release temperature. The rate of increase of temperature should not exceed 20°C/min and the temperature should be maintained for 10 min. The temperature should then be increased at a rate between 0.4°C/min to 0.7°C/min until the nozzle operates.

The nominal operating temperature should be ascertained with equipment having an accuracy of ± 0.35% of the nominal temperature rating or ± 0.25°C, whichever is greater.

The test should be conducted in a water bath for nozzles or separate glass bulbs having nominal release temperatures less than or equal to 80°C. A suitable oil should be used for higher-rated release elements. The liquid bath should be constructed in such a way that the temperature deviation within the test zone does not exceed 0.5% or 0.5°C, whichever is greater.

5.6.2 *Dynamic heating tests* (see 4.14)

5.6.2.1 *Plunge test*

Tests should be conducted to determine the standard and worst case orientations as defined in 2.4 and 2.5. Ten additional plunge tests should be performed at both of the identified orientations. The worst case orientation should be as defined in 4.14.1. The RTI should be calculated as described in 5.6.2.3 and 5.6.2.4 for each orientation, respectively. The plunge tests should be conducted using a brass nozzle mount designed such that the mount of water temperature rise does not exceed 20°C for the duration of an individual plunge test up to a response time of 55 s. (The temperature should be measured by a thermocouple heatsinked and embedded in the mount not more than 8 mm radially outward from the root diameter of the internal thread or by a thermocouple located in the water at the centre of the nozzle inlet.) If the response time is greater than 55 s, then the mount or water temperature in degrees Celsius should not increase more than 0.036 times the response time in seconds for the duration of an individual plunge test.

The nozzle under test should have 1 to 1.5 wraps of PTFE sealant tape applied to the nozzle threads. It should be screwed into a mount to a torque of 15 ± 3 Nm. Each nozzle should be mounted on a tunnel test section cover and maintained in a conditioning chamber to allow the nozzle and cover to each ambient temperature for a period of not less than 30 min.

At least 25 ml of water, conditioned to ambient temperature, should be introduced into the nozzle inlet prior to testing. A timer accurate to ± 0.01 s with suitable measuring devices to sense the time between when the nozzle is plunged into the tunnel and the time it operates should be utilized to obtain the response time.

A tunnel should be utilized with air flow and temperature conditions[53] at the test section (nozzle location) selected from the appropriate range of conditions shown in table 2. To minimize radiation exchange between the sensing element and the boundaries confining the flow, the test section of the apparatus should be designed to limit radiation effects to within 3% of calculated RTI values[54].

The range of permissible tunnel operating conditions is shown in table 2. The selected operating condition should be maintained for the

[53] Tunnel conditions should be selected to limit maximum anticipated equipment error to 3%.

[54] A suggested method for determining radiation effects is by conducting comparative plunge tests on a blackened (high emissivity) metallic test specimen and a polished (low emissivity) metallic test specimen.

duration of the test with the tolerances as specified by footnotes 1 and 2 in table 2.

5.6.2.2 *Determination of conductivity factor (C)* [7.6.2.2]

The conductivity factor (C) should be determined using the prolonged plunge test (see 5.6.2.2.1) or the prolonged exposure ramp test (see 5.6.2.2.2).

5.6.2.2.1 *Prolonged plunge test* [7.6.2.2.1]

The prolonged plunge test is an iterative process to determine C and may require up to twenty nozzle samples. A new nozzle sample must be used for each test in this section even if the sample does not operate during the prolonged plunge test.

The nozzle under test should have 1 to 1.5 wraps of PTFE sealant tape applied to the nozzle threads. It should be screwed into a mount to a torque of 15 ± 3 Nm. Each nozzle should be mounted on a tunnel test section cover and maintained in a conditioning chamber to allow the nozzle and cover to reach ambient temperature for a period of not less than 30 min. At least 25 ml of water, conditioned to ambient temperature, should be introduced into the nozzle inlet prior to testing.

A timer accurate to ± 0.01 s with suitable measuring devices to sense the time between when the nozzle is plunged into the tunnel and the time it operates should be utilized to obtain the response time.

The mount temperature should be maintained at 20 ± 0.5°C for the duration of each test. The air velocity in the tunnel test section at the nozzle location should be maintained with ± 2% of the selected velocity. Air temperature should be selected and maintained during the test as specified in table 3.

The range of permissible tunnel operating conditions is shown in table 3. The selected operating condition should be maintained for the duration of the test with the tolerances as specified in table 3.

To determine C, the nozzle should be immersed in the test stream at various air velocities for a maximum of 15 min.[55] Velocities should be chosen such that actuation is bracketed between two successive test velocities. That is, two velocities should be established such that at the lower velocity (u_l) actuation does not occur in the 15 min test interval. At the next higher velocity (u_h), actuation should occur within the 15-minute time limit. If the nozzle does not operate at the highest velocity, an air temperature from table 3 for the next higher temperature rating should be selected.

TABLE 2 - PLUNGE OVEN TEST CONDITIONS

	Air temperature ranges[1]			**Velocity ranges[2]**		
Normal temperature°C	Standard response	Special response	Fast response	Standard response	Special response m/s	Fast response nozzle,

[55] If the value of C is determined to be less than 0.5 $(m\cdot s)^{0.5}$, a C of 0.25 $(m\cdot s)^{0.5}$ should be assumed for calculating RTI value.

	°C	°C	°C	m/s		m/s
57 to 77	191 to 203	129 to 141	129 to 141	2.4 to 2.6	2.4 to 2.6	1.65 to 1.85
79 to 107	282 to 300	191 to 203	191 to 203	2.4 to 2.6	2.4 to 2.6	1.65 to 1.85
121 to 149	382 to 432	282 to 300	282 to 300	2.4 to 2.6	2.4 to 2.6	1.65 to 1.85
163 to 191	382 to 432	382 to 432	382 to 432	3.4 to 3.6	2.4 to 2.6	1.65 to 1.85

[1] The selected air temperature should be known and maintained constant within the test section throughout the test to an accuracy of ±1°C for the air temperature range of 129°C to 141°C within the test section and within ±2°C for all other air temperatures.
[2] The selected air velocity should be known and maintained constant throughout the test to an accuracy of ±0.03 m/s for velocities of 1.65 to 1.85 and 2.4 m/s to 2.6 m/s and ±0.04 m/s for velocities of 3.4 m/s to 3.6 m/s.

TABLE 3 - PLUNGE OVEN TEST CONDITIONS FOR CONDUCTIVITY DETERMINATIONS

Nominal nozzle temperature, °C	**Oven temperature,** °C	**Maximum variation of air temperature during test,** °C
57	85 to 91	±1.0
58 to 77	124 to 130	±1.5
78 to 107	193 to 201	±3.0
121 to 149	287 to 295	±4.5
163 to 191	402 to 412	±6.0

Test velocity selection should ensure that:

$$(U_H/U_L)^{0.5} \leq 1.1$$

The test value of C is the average of the values calculated at the two velocities using the following equation:

$C = (\Delta Tg/\Delta Tea - 1)u^{0.5}$

where:

ΔTg = Actual gas (air) temperature minus the mount temperature (Tm) in °C;

ΔTea = Mean liquid bath operating temperature minus the moment temperature (Tm) in °C;

u = Actual air velocity in the test section in m/s.

The nozzle C value is determined by repeating the bracketing procedure three times and calculating the numerical average of the three C values. This nozzle C value is used to calculate all standard orientation RTI values for determining compliance with 4.14.1.

5.6.2.2.2 *Prolonged exposure ramp test* [7.6.2.2.2]

The prolonged exposure ramp test for the determination of the parameter C should be carried out in the test section of a wind tunnel and with the requirements for the temperature in the nozzle mount as described for the dynamic heating test. A preconditioning of the nozzle is not necessary.

Ten samples should be tested of each nozzle type, all nozzles positioned in standard orientation. The nozzle should be plunged into an air stream of a constant velocity of 1 m/s ± 10% and an air temperature at the nominal temperature of the nozzle at the beginning of the test.

The air temperature should then be increased at a rate of 1 ± 0.25°C/min until the nozzle operates. The air temperature, velocity and mount temperature should be controlled from the initiation of the rate of rise and should be measured and recorded at nozzle operation. The C value is determined using the same equation as in 5.6.2.2.1 as the average of the ten test values.

5.6.2.3 *RTI value calculation* [7.6.2.3]

The equation used to determine the RTI value is as follows:

$$RTI = \frac{-t_r(u)^{0,5}(1 + C/(u)^{0,5})}{In[1 - \Delta T_{ea}(1 + C/(u)^{0,5})/\Delta T_g}$$

where:

t_r = Response time of nozzles in seconds;
u = Actual air velocity in the test section of the tunnel in m/s from table 2;
ΔT_{ea} = Mean liquid bath operating temperature of the nozzle minus the ambient temperature in °C;
ΔT_g = Actual air temperature in the test section minus the ambient temperature in °C;

C = Conductivity factor as determined in 5.6.2.2.

5.6.2.4 *Determination of worst case orientation* RTI

The equation used to determine the RTI for the worst case orientation is as follows:

$$RTI_{wc} = \frac{-t_{r-wc}(u)^{0.5}[1 + C(RTI_{wc} / RTI)/(u)^{0.5}]}{In\{1 - \Delta T_{ea}[1 + C(RTI_{wc} / RTI)/(u)^{0.5}] / \Delta T_g\}}$$

where:

t_{r-wc} =Response time of the nozzles in seconds for the worst case orientation.

All variables are known as this time as per equation in 5.6.2.3 except RTI_{wc} (response time index for the worst case orientation) which can be solved iteratively as per the above equation.

In the case of fast response nozzles, if a solution for the worse case orientation RTI is unattainable, plunge testing in the worst case orientation should be repeated using the plunge test conditions under Special Response shown in table 2.

5.7 Heat exposure tests [7.7]

5.7.1 *Glass bulb nozzles* (see 4.9.1)

Glass bulb nozzles having nominal release temperatures less than or equal to 80°C should be heated in a water bath from a temperature of 20 ± 5°C to 20 ± 2°C below their nominal release temperature. The rate of increase of temperature should not exceed 20°C/min. High temperature oil, such as silence oil should be used for higher temperature rated release elements.

This temperature should then be increased at a rate of 1°C/min to the temperature at which the gas bubble dissolves, or to a temperature 5°C lower than the nominal operating temperatures, whichever is lower. The nozzle should be removed from the liquid bath and allowed to cool in air until the gas bubble has formed again. During the cooling period, the pointed end of the glass bulb (seal end) should be pointing downwards. This test should be performed four times on each of four nozzles.

5.7.2 *All uncoated nozzles* (see 4.9.2) [7.7.2]

Twelve uncoated nozzles should be exposed for a period of 90 days to a high ambient temperature that is 11°C below the nominal rating or at the temperature shown in table 4, whichever is lower, but not less than 49°C. If the service load is dependent on the service pressure, nozzles should be tested under the rated working pressure. After exposure, four of the nozzles should be subjected to the tests specified in 5.4.1, four nozzles to the test of 5.5.1, two at the minimum operating pressure and two at the rated working pressure, and four nozzles to the requirements of 4.3. If a nozzle fails the applicable requirements of a test, eight additional nozzles should be tested as described above and subjected to the test in which the failure was recorded. All eight nozzles should comply with the test requirements.

5.7.3 *Coated nozzles* (see 4.9.3) [7.7.3]

In addition to the exposure test of 5.7.2 in an uncoated version, 12 coated nozzles should be exposed to the test of 5.7.2 using the temperatures shown in table 4 for coated nozzles.

The test should be conducted for 90 days. During this period, the sample should be removed from the oven at intervals of approximately 7 days and allowed to cool for 2 h to 4 h. During this cooling period, the sample should be examined. After exposure, four of the nozzles should be subjected to the tests specified in 5.4.1, four nozzles to the test of 5.5.1; two at the minimum operating pressure and two at the rated working pressure, and four nozzles to the requirements of 4.3.

TABLE 4 - TEST TEMPERATURES FOR COATED AND UNCOATED NOZZLES

Values in °C		
Nominal release temperature	Uncoated nozzle test temperature	Coated nozzle test temperature
57-60	49	49
61-77	52	49
78-107	79	66
108-149	121	107
150-191	149	149
192-246	191	191
247-302	246	246
303-343	302	302

5.8 Thermal shock test for glass bulb nozzles (see 4.10) [7.8]

Before starting the test, at least 24 nozzles at room temperature of 20°C to 25°C for at least 30 min should be conditioned.

The nozzles should be immersed in a bath of liquid, the temperature of which should be 10 ± 2°C below the nominal release temperature of the nozzles. After 5 min, the nozzles should be removed from the bath and immersed immediately in another bath of liquid, with the bulb seal downwards, at a temperature of 10 ± 1°C. Then the nozzles should be tested in accordance with 5.5.1.

5.9 Strength tests for release elements [7.9]

5.9.1 *Glass bulbs* (see 4.7.1) [7.9.1]

At least 15 samples bulbs in the lowest temperature rating of each bulb type should be positioned individually in a test fixture using the sprinkler seating parts. Each bulb should then be subjected to a uniformly increasing force at a rate not exceeding 250 N/s in the test machine until the bulb fails.

Each test should be conducted with the bulb mounted in new seating parts. The mounting device may be reinforced externally to prevent its collapse, but in a manner which does not interfere with bulb failure.

The failure load for each bulb should be recorded. Calculation of the lower tolerance limit (TL1) for bulb strength should be made. Using the values of service load recorded in 5.3.1, the upper tolerance limit (TL2) for the bulb design load should be made. Compliance with 4.7.1 should be verified.

5.9.2 *Fusible elements* (see 4.7.2)

5.10 Water flow test (see 4.4.1) [7.10]

The nozzle and a pressure gauge should be mounted on a supply pipe. The water flow should be measured at pressures ranging from the minimum operating pressure to the rated working pressure at intervals of approximately 10% of the service pressure range on two sample nozzles. In one series of tests, the pressure should be increased from zero to each value and, in the next series, the pressure should be decreased from the rated pressure to each value. The flow constant *K* should be averaged from each series of readings, i.e., increasing pressure and decreasing pressure. During the test, pressures should be corrected for differences in height between the gauge and the outlet orifice of the nozzles.

5.11 Water distribution and droplet size tests

5.11.1 *Water distribution* (see 4.4.2)

The tests should be conducted in a test chamber of minimum dimensions 7 m x 7 m or 300% of the maximum design area being tested, whichever is greater. For standard automatic nozzles, a single open nozzle should be installed and then four open nozzles of the same type arranged in a square, at maximum spacings specified by the manufacturer, on piping prepared for this purpose. For pilot type nozzles, a single nozzle should be installed and then the maximum number of slave nozzles at their maximum spacings, specified in the manufacturer's design and installation instructions.

The distance between the ceiling and the distribution plate should be 50 mm for upright nozzles and 275 mm for pendent nozzles. For nozzles without distribution plates, the distances should be measured from the ceiling to the highest nozzle outlet.

Recessed, flush and concealed type nozzles should be mounted in a false ceiling of dimensions not less than 6 m x 6 m and arranged symmetrically in the test chamber. The nozzles should be fitted directly into the horizontal pipework by means of "T" or elbow fittings.

The water discharge distribution in the protected area below a single nozzle and between the multiple nozzles should be collected and measured by means of square measuring containers nominally 300 mm on a side. The distance between the nozzles and the upper edge of the measuring containers should be the maximum specified by the manufacturer. The measuring containers should be positioned centrally, beneath the single nozzle and beneath the multiple nozzles.

The nozzles should be discharged both at the minimum operating and rated working pressures specified by the manufacturer and the minimum and maximum installation heights specified by the manufacturer.

The water should be collected for at least 10 min to assist in characterizing nozzle performance.

5.11.2 *Water droplet size* (see 4.4.3)

The mean water droplet diameters, velocities, droplet size distribution, number density and volume flux should be determined at both the minimum and maximum flow rates specified by the manufacturer. Once the data is gathered, the method of the "Standard practice for determining data criteria and processing for liquid drop size analysis" (ASTM E799-92) will be used to determine the appropriate sample size, class size widths, characteristic drop sizes and measured dispersion of the drop size distribution. This data should be taken at various points within the spray distribution as described in 4.4.3.

5.12 Corrosion tests [7.12]

5.12.1 *Stress corrosion test for brass nozzle parts* (see 4.11.1)

Five nozzles should be subjected to the following aqueous ammonia test. The inlet of each nozzle should be sealed with a non-reactive cap, e.g. plastic.

The samples should be degreased and exposed for 10 days to a moist ammonia-air mixture in a glass container of volume 0.02 ± 0.01 m^3.

An aqueous ammonia solution, having a density of 0.94 g/cm^3, should be maintained in the bottom of the container, approximately 40 mm below the bottom of the samples. A volume of aqueous ammonia solution corresponding to 0.01 ml per cubic centimeter of the volume of the container will give approximately the following atmospheric concentrations: 35% ammonia, 5% water vapour, and 60% air. The inlet of each sample should be sealed with a non-reactive cap, e.g. plastic.

The moist ammonia-mixture should be maintained as closely as possible at atmospheric pressure, with the temperature maintained at 34 ± 2°C. Provision should be made for venting the chamber via a capillary tube to avoid the build-up of pressure. Specimens should be shielded from condensate drippage.

After exposure, the nozzles should be rinsed and dried, and a detailed examination should be conducted. If a crack, delamination or failure of any operating part is observed, the nozzle(s) should be subjected to a leak resistance test at the rated pressure for 1 min and to the functional test at the minimum flowing pressure (see 4.5.1).

Nozzles showing cracking, delamination or failure of any non-operating part should not show evidence of separation of permanently attached parts when subjected to flowing water at the rated working pressure for 30 min.

5.12.2 *Stress-Corrosion Cracking of Stainless Steel Nozzle Parts* (see 4.11.1)

5.12.2.1 Five samples are to be degreased prior to being exposed to the magnesium chloride solution.

5.12.2.2 Parts used in nozzles should be placed in a 500-millilitre flask that is fitted with a thermometer and a wet condenser approximately 760 mm long. The flask should be filled approximately one-half full with a 42% by weight magnesium chloride solution, placed on a thermostatically-controlled electrically heated mantel, and maintained at a boiling temperature of 150 ± 1°C. The parts should be unassembled, that is, not contained in a nozzle assembly. The exposure should last for 500 h.

5.12.2.3 After the exposure period, the test samples should be removed from the boiling magnesium chloride solution and rinsed in deionized water.

5.12.2.4 The test samples should then be examined using a microscope having a magnification of 25X for any cracking, delamination, or other degradation as a result of the test exposure. Test samples exhibiting degradation should be tested as described in 5.12.2.5 or 5.12.2.6, as applicable. Test samples not exhibiting degradation are considered acceptable without further test.

5.12.2.5 Operating parts exhibiting degradation should be further tested as follows. Five new sets of parts should be assembled in nozzle frames made of materials that do not alter the corrosive effects of the magnesium chloride solution on the stainless steel parts. These test samples should be degreased and subjected to the magnesium chloride solution exposure specified in 5.12.2.2. Following the exposure, the test samples should withstand, without leakage, a hydrostatic test pressure equal to the rated working pressure for 1 min and then be subjected to the functional test at the minimum operating pressure in accordance with 5.5.1.

5.12.2.6 Non-operating parts exhibiting degradation should be further tested as follows. Five new sets of parts should be assembled in nozzle frames made of materials that do not alter the corrosive effects of the magnesium chloride solution on the stainless steel parts. These test samples should be degreased and subjected to the magnesium chloride solution exposure specified in paragraph 5.12.4.1. Following the exposure, the test samples should withstand a flowing pressure equal to the rated working pressure for 30 min without separation of permanently attached parts.

5.12.3 *Sulphur dioxide corrosion test* (see 4.11.2 and 4.14.2)

Ten nozzles should be subjected to the following sulphur dioxide corrosion test. The inlet of each sample should be sealed with a non-reactive cap, e.g. plastic.

The test equipment should consist of a 5-litre vessel (instead of a 5-litre vessel, other volumes up to 15 litres may be used in which case the quantities of chemicals given below should be increased in proportion) made of heat-resistant glass, with a corrosion-resistant lid of such a shape as to prevent condensate dripping on the nozzles. The vessel should be electrically heated through the base and provided with a cooling coil around the side walls. A temperature sensor placed centrally 160 ± 20 mm above the bottom of the vessel should regulate the heating so that the temperature inside the glass vessel is 45 ± 3°C. During the test, water should flow trough the cooling coil at a sufficient rate to keep the temperature of the discharge water below 30°C. This combination of heating and cooling should encourage condensation on the surfaces of the nozzles. The sample nozzles should be shielded from condensate drippage.

The nozzles to be tested should be suspended in their normal mounting position under the lid inside the vessel and subjected to a corrosive sulphur dioxide atmosphere for 8 days. The corrosive atmosphere should be obtained by introducing a solution made up by dissolving 20 g of sodium thiosulfate ($Na_2S_2O_3H_2O$) crystals in 500 ml of water.

For at least six days of the 8-day exposure period, 20 ml of dilute sulphuric acid consisting of 156 ml of normal H_2SO_4 (0.5 mol/litre) diluted with 844 ml of water should be added at a constant rate. After 8 days, the nozzles should be removed from the container and allowed to dry for 4 to 7 days at a temperature not exceeding 35°C with a relative humidity not greater than 70%.

After the drying period, five nozzles should be subjected to a functional test at the minimum operating pressure in accordance with 5.5.1 and five nozzles should be subjected to the dynamic heating test in accordance with 4.14.2.

5.12.4 *Salt spray corrosion test* (see 4.11.3 and 4.14.2) [7.12.3]

5.12.4.1 *Nozzles intended for normal atmospheres*

Ten nozzles should be exposed to a salt spray within a fog chamber. The inlet of each sample should be sealed with a non-reactive cap, e.g. plastic.

During the corrosive exposure, the inlet thread orifice should be sealed by a plastic cap after the nozzles have been filled with deionized water. The salt solution should be a 20% by mass sodium chloride solution in distilled water. The pH should be between 6.5 and 3.2 and the density between 1.126 g/ml and 1.157 g/ml when atomized at 35°C. Suitable means of controlling the atmosphere in the chamber should be provided. The specimens should be supported in their normal operating position and exposed to the salt spray (fog) in a chamber having a volume of at least 0.43 m^3 in which the exposure zone should be maintained at a temperature of 35 ± 2°C. The temperature should be recorded at least once per day, at least 7 h apart (except weekends and holidays when the chamber normally would not be opened). Salt solution should be supplied from a recirculating reservoir through air-aspirating nozzles, at a pressure between 0.7 bar (0.07 MPa) and 1.7 bar (0.17 MPa). Salt solution runoff from exposed samples should be collected and should not return to the reservoir for recirculation. The sample nozzles should be shielded from condensate drippage.

Fog should be collected from at least two points in the exposure zone to determine the rate of application and salt concentration. The fog should be such that for each 80 cm^2 of collection area, 1 ml to 2 ml of solution should be collected per hour over a 16-hour period and the salt concentration should be 20 ± 1% by mass.

The nozzles should withstand exposure to the salt spray for a period of 10 days. After this period, the nozzles should be removed from the fog chamber and allowed to dry for 4 to 7 days at a temperature of 20°C to 25°C in an atmosphere having a relative humidity not greater than 70 %. Following the drying period, five nozzles should be submitted to the functional test at the minimum operating pressure in accordance with 5.5.1 and five nozzles should be subjected to the dynamic heating test in accordance with 4.14.2.

5.12.4.2 *Nozzles intended for corrosive atmospheres* [7.12.3.2]

Five nozzles should be subjected to the tests specified in 5.12.4.1 except that the duration of the salt spray exposure should be extended from 10 days to 30 days.

5.12.5 *Moist air exposure test* (see 4.11.4 and 4.14.2) [7.12.4]

Ten nozzles should be exposed to a high temperature-humidity atmosphere consisting of a relative humidity of 98 ± 2% and a temperature of 95 ± 4°C. The nozzles should be installed on a pipe manifold containing deionized water. The entire manifold should be placed in the high temperature-humidity enclosure for 90 days. After this period, the nozzles should be removed from the temperature-humidity enclosure and allowed to dry for 4 to 7 days at a temperature of 25 ± 5°C in an atmosphere having a relative humidity of not greater than 70%. Following the drying period, five nozzles should be functionally tested at the minimum operating pressure in accordance with 5.5.1 and five nozzles should be subjected to the dynamic heating test in accordance with 4.14.2.[56]

5.13 Nozzle coating tests [7.13]

[56] At the manufacturer´s option, additional samples may be furnished for this test to provide early evidence of failure. The additional samples may be removed from the test chamber at 30-day intervals for testing.

5.13.1 *Evaporation test* (see 4.12.1) [7.13.1]

A 50 cm^3 sample of wax or bitumen should be placed in a metal or glass cylindrical container, having a flat bottom, an internal diameter of 55 mm and an internal height of 35 mm. The container, without lid, should be placed in an automatically controlled electric, constant ambient temperature oven with air circulation. The temperature in the oven should be controlled at 16°C below the nominal release temperature of the nozzle, but at not less than 50°C. The sample should be weighed before and after a 90-day exposure to determine any loss of volatile matter. The sample should meet the requirements of 4.12.1.

5.13.2 *Low-temperature test* (see 4.12.2) [7.13.2]

Five nozzles, coated by normal production methods, whether with wax, bitumen or a metallic coating, should be subjected to a temperature of -10°C for a period of 24 h. On removal from the low-temperature cabinet, the nozzles should be exposed to normal ambient temperature for at least 30 min before examination of the coating to the requirements of 4.12.2.

5.14 **Heat resistance test** (see 4.15) [7.14]

One nozzle body should be heated in an oven at 800°C for a period of 15 min, with the nozzle in its normal installed position. The nozzle body should then be removed, holding it by the threaded inlet, and should be promptly immersed in a water bath at a temperature of approximately 15°C. It should meet the requirements of 4.15.

5.15 **Water hammer test** (see 4.13) [7.15]

Five nozzles should be connected, in their normal operating position, to the test equipment. After purging the air from the nozzles and the test equipment, 3,000 cycles of pressure varying from 4 ± 2 bar (0.4 ± 0.2 MPa) to twice the rated working pressure should be generated. The pressure should be raised from 4 bar to twice the rated pressure at a rate of 60 ± 10 bar/s. At least 30 cycles of pressure per minute should be generated. The pressure should be measured with an electrical pressure transducer.

Each nozzle should be visually examined for leakage during the test. After the test, each nozzle should meet the leakage resistance requirement of 4.8.1 and the functional requirement of 4.5.1 at the minimum operating pressure.

5.16 **Vibration test** (see 4.16) [7.16]

5.16.1 Five nozzles should be fixed vertically to a vibration table. They should be subjected at room temperature to sinusoidal vibrations. The direction of vibration should be along the axis of the connecting thread.

5.16.2 The nozzles should be vibrated continuously from 5 Hz to 40 Hz at a maximum rate of 5 min/octave and an amplitude of 1 mm (1/2 peak-to-peak value). If one or more resonant points are detected, the nozzles after coming to 40 Hz, should be vibrated at each of these resonant frequencies for 120 h/number of resonances. If no resonances are detected, the vibration from 5 Hz to 40 Hz should be continued for 120 h.

5.16.3 The nozzle should then be subjected to the leakage test in accordance with 4.8.1 and the functional test in accordance with 4.5.1 at the minimum operating pressure.

5.17 **Impact test** (see 4.17) [7.17]

Five nozzles should be tested by dropping a mass into the nozzle along the axial centreline of waterway. The kinetic energy of the dropped mass at the point of impact should be equivalent to a mass equal to that of the test nozzle dropped from a height of 1 m (see figure 2). The mass should be prevented from impacting more than once upon each sample.

Following the test, a visual examination of each nozzle should show no signs of fracture, deformation or other deficiency. If none is detected, the nozzles should be subjected to the leak resistance test, described in 5.4.1. Following the leakage test, each sample should meet the functional test requirement of 5.5.1 at a pressure equal to the minimum flowing pressure.

5.18 **Lateral discharge test** (see 4.18) [7.19]

Water should be discharged from a spray nozzle at the minimum operating and rated working pressure. A second automatic nozzle located at the minimum distance specified by the manufacturer should be mounted on a pipe parallel to the pipe discharging water.

The nozzle orifices or distribution plates (if used) should be placed 550 mm, 356 mm and 152 mm below a flat smooth ceiling for three separate tests, respectively at each test pressure. The top of a square pan measuring 305 mm square and 102 mm deep should be positioned 152 mm below the heat responsive element for each test. The pan should be filled with 0.47 l of heptane. After ignition, the automatic nozzle should operate before the heptane is consumed.

5.19 **30-day leakage test** (see 4.19) [7.20]

Five nozzles should be installed on a water filled test line maintained under a constant pressure of twice the rated working pressure for 30 days at an ambient temperature of 20 ± 5°C.

The nozzles should be inspected visually at least weekly for leakage. Following completion of this 30-day test, all samples should meet the leak resistance requirements specified in 4.8 and should exhibit no evidence of distortion or other mechanical damage.

5.20 Vacuum test (see 4.20) [7.21]

Three nozzles should be subjected to a vacuum of 460 mm of mercury applied to a nozzle inlet for 1 min at an ambient temperature of 20 ± 5°C. Following this test, each sample should be examined to verify that no distortion or mechanical damage has occurred and then should meet the leak resistance requirements specified in 5.4.1.

5.21 Clogging test (see 4.22) [7.28]

5.21.1 The water flow rate of an open water mist nozzle with its strainer or filter should be measured at its rated working pressure. The nozzle and strainer or filter should then be installed in test apparatus described in figure 3 and subjected to 30 min of continuous flow at rated working pressure using contaminated water which has been prepared in accordance with 5.21.3.

5.21.2 Immediately following the 30 min of continuous flow with the contaminated water, the flow rate of the nozzle and strainer or filter should be measured at rated working pressure. No removal, cleaning or flushing of the nozzle, filter or strainer is permitted during the test.

5.21.3 The water used during the 30 min of continuous flow at rated working pressure specified in 5.21.1 should consist of 60 l of tap water into which has been mixed 1.58 kg of contaminants which sieve as described in table 5. The solution should be continuously agitated during the test.

TABLE 5 - CONTAMINANT FOR CONTAMINATED WATER CYCLING TEST

Sieve designation[1]	Nominal sieve opening, (mm)	Grams of contaminant (±5%)[2]		
		Pipe scale	**Top soil**	**Sand**
No. 25	0.706	-	456	200
No. 50	0.297	82	82	327
No.100	0.150	84	6	89
No.200	0.074	81	-	21
No.325	0.043	153	-	3
	TOTAL	400	544	640

[1] Sieve designations correspond with those specified in the standard for wire-cloth sieves for testing purposes, ASTM E11-87, CENCO-MEINZEN sieve sizes 25 mesh, 50 mesh, 100 mesh, 200 mesh and 325 mesh, corresponding with the number designation in the table, have been found to comply with ASTM E11-87.

[2] The amount of contaminant may be reduced by 50% for nozzles limited to use with copper or stainless steel piping and by 90% for nozzles having a rated pressure of 50 bar or higher and limited to use with stainless stell piping.

6 WATER MIST NOZZLE MARKINGS

6.1 General

Each nozzle complying with the requirements of this standard should be permanently marked as follows:

.1 trademark or manufacturer's name;
.2 model identification;
.3 manufacturer's factory identification. This is only required if the manufacturer has more than one nozzle manufacturing facility;
.4 nominal year of manufacture[57] (automatic nozzles only);
.5 nominal release temperature[58] (automatic nozzles only); and
.6 K-factor. This is only required if a given model nozzle is available with more than 1 orifice size.

[57] The year of manufacture may include the last three months of the preceding year and the first six months of the following year. Only the last two digits need be indicated.

[58] Except for coated and plated nozzles, the nominal release temperature range should be colour-coded on the nozzle to identify the nominal rating. The colour code should be visible on the yoke arms holding the distribution plate for fusible element nozzles, and should be indicated by the colour of the liquid in glass bulbs. The nominal temperature rating should be stamped or cast on the fusible element of fusible element nozzles. All nozzles should be stamped, cast, engraved or colour-coded in such a way that the nominal rating is recognizable even if the nozzle has operated. This should be in accordance with table 1.

In countries where colour-coding of yoke arms of glass bulb nozzles is required, the colour code for fusible element nozzles should be used.

6.2 Nozzle housings

Recessed housings, if provided, should be marked for use with the corresponding nozzles unless the housing is a non-removable part of the nozzle.

FIGURE 1

RTI AND C LIMITS FOR STANDARD ORIENTATION

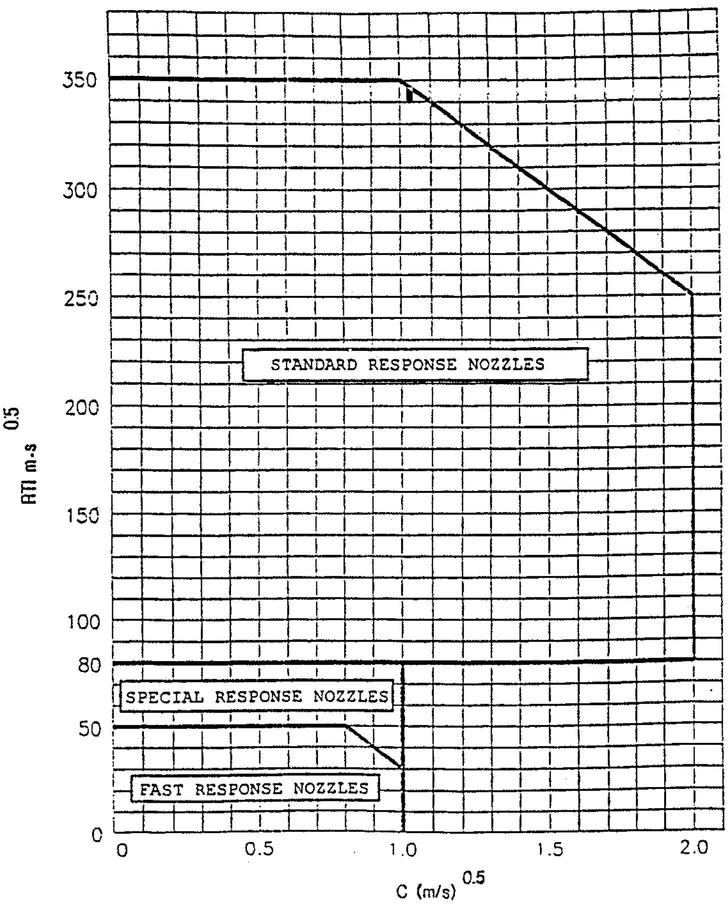


FIGURE 2

IMPACT TEST APPARATUS

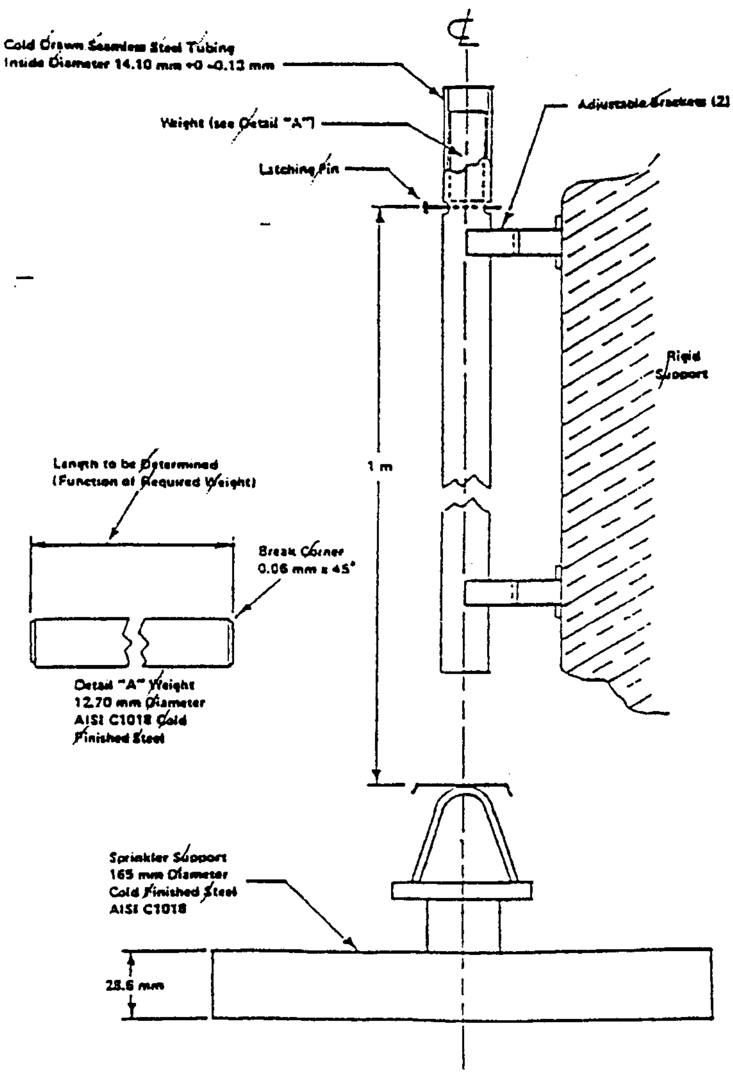
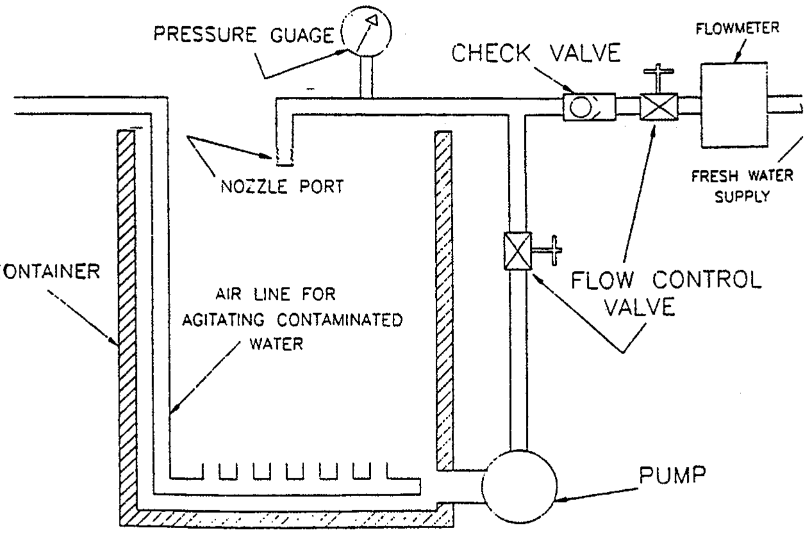


FIGURE 3

CLOGGING TEST APPARATUS



APPENDIX 2

FIRE TEST PROCEDURES FOR EQUIVALENT SPRINKLER SYSTEMS IN ACCOMMODATION, PUBLIC SPACE AND SERVICE AREAS ON PASSENGER SHIPS

1 SCOPE

1.1 These test procedures describe a fire test method for evaluating the effectiveness of sprinkler systems equivalent to systems covered by regulation II-2/12 of the SOLAS Convention [1[59]] in accommodation and service areas on board ships. It should be noted that the test method is limited to the systems' effectiveness against fire and is not intended for testing of the quality and design parameters of the individual components in the system.

1.2 In order to fulfil the requirements of 3.5 of the guidelines, the system must be capable of fire control or suppression in a wide variety of fire loading, fuel arrangement, room geometry and ventilation conditions.

1.3 Products employing materials or having forms of construction differing from the requirements contained herein may be examined and tested in accordance with the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with this document.

[59] Figures in square brackets in the text indicate the referenced publications listed later in this document.

1.4 Products complying with the text of this document will not necessarily be judged to comply, if, when examined and tested, are found to have other features which impair the level of safety contemplated by this document.

2 HAZARD AND OCCUPANCY CLASSIFICATIONS

For the purposes of identifying the different fire risk classifications, table 1 is given, which correlates the fire tests with the classification of occupancy defines in SOLAS regulation II-2/26[1]:

Table 1

Correlation between fire tests with the classification of occupancy defined in SOLAS regulation II-2/26.2.2

	Corresponding fire test				
Occupancy classification	Section 5 cabin	Section 5 corridor	Section 6 luxury cabin	Section 7 public spaces	Section 8 shopping and storage
(1) Control stations				X	
(2) Stairways		X [1]			
(3) Corridors		X [1]			
(6) Accommodation spaces of minor fire risk	X [2]		X [3]	X [4]	
(7) Accommodation spaces moderate f	X [2]		X [3]	X [4]	
(8) Accommodation spaces of greater fire risk				X	
(9) Sanitary & similar spaces	X [2]		X [3]	X [4]	
(13) Store rooms, workshops, pantries, etc.					X
(14) Other spaces in which lammable liquids are stowed					X

Note: For examples of occupancies in each category, see SOLAS regulation II-2/26 [1]
[1] For corridors and stairways wider than 1.5 m, use section 7 public space fire test instead of the corridor fire test.
[2] For spaces up to 12 m^2.
[3] For spaces from 12 m^2 up to 50 m^2.
[4] For spaces over 50 m^2.

3 DEFINITIONS

3.1 *Fire suppression*: Sharply reducing the heat release rate of a fire and preventing its regrowth by means of a direct and sufficient application of water through the fire plume to the burning fuel surface [2].

3.2 *Fire control*: Limiting the size of a fire by distribution of water so as to decrease the heat release rate and pre-wet adjacent combustibles, while controlling ceiling gas temperatures to avoid structural damage [2].

3.3 *Fire source*: Fire source is defined as the combustible material in which the fire is set and the combustible material covering walls and ceiling.

3.4 *Igniter*: The device used to ignite the fire source.

4 GENERAL REQUIREMENTS

4.1 Nozzle positioning

The testing organization should be responsible for assuring that the nozzles for each fire test are installed in accordance with the manufacturer's design and installation instructions. The tests should be performed at the maximum specified spacings, installation height and distances below the ceiling. In addition, if the testing organization finds it necessary, selected fire tests should also be conducted at minimum specified spacings, installation height and distances below the ceiling.

4.2 Water pressure and flow rates

The testing organization should be responsible for assuring that all fire tests are conducted at the operating pressure and flow rates specified by the manufacturer.

4.3 Temperature measurements

Temperatures should be measured as described in detail under each chapter. Chromelalumel not exceeding 0.5 mm diameter welded together and chromelalumel 0.8 mm should be used. The 0.8 mm thermocouple wires should be twisted three times, have the end remaining wire cut off and be heated with an oxyacetylene torch to melt and form a small ball. The temperatures should be measured continuously, at least once every two seconds, throughout the tests.

4.4 Environmental conditions

The test hall should have an ambient temperature of between 10°C to 30°C at the start of each test.

4.5 Tolerances

Unless otherwise stated, the following tolerances should apply:

.1	Length	±2% of value
.2	Volume	±5% of value
.3	Pressure	±3% of value
.4	Temperature	±5% of value

These tolerances are in accordance with ISO standard 6182-1, February 1994 edition [4].

4.6 Observations

The following observations should be made during and after each test.

.1 Time of ignition.
.2 Activation time of each nozzle.
.3 Time when water flow is shut off.
.4 Damage of the fire source.
.5 Temperature recordings.
.6 System flow rate and pressure.
.7 Total number of operating nozzles.

4.7 Fire sources

If the requirements for fire sources specified in the following sections of this test method cannot be fulfilled, it is the responsibility of the test laboratory to show that alternative materials used have burning characteristics similar to those of specified materials.

4.8 Procedure and documentation requirements

A draft copy of the design, installation and operating instruction manual should be furnished for use as a guide in the testing of the fire protection system devices.

The instructions should reference the limitations of each device and should include at least the following items:

.1 Description and operating details of each device and all necessary equipment, including identification of extinguishing system components or accessory equipment by part or model number.
.2 Nozzle design recommendation and limitations for each fire type.
.3 Type and pressure rating of pipe, tubing and fittings to be used.
.4 Equivalent length values of all fittings and all system components through which water flows.
.5 Discharge nozzle limitations, including maximum dimensional and area coverage, minimum and maximum installation height limitations, and nozzle permitted location in the protected volume.

.6 Range of filling capacities for each size storage container.
.7 Details for the proper installation of each device, including all component equipment.
.8 Reference to the specific types of detection and control panels (if applicable) to be connected to the equipment.
.9 Operating pressure ranges of the system.
.10 Method of sizing pipe or tubing.
.11 Recommended orientation of tee fittings and the splitting of flows through tees.
.**12** Maximum difference in operating (flowing) pressure between the hydraulically closest and most remote nozzle.

5 CABIN AND CORRIDOR FIRE TESTS

5.1 Test arrangement

5.1.1 The fire tests should be conducted in a 3 m by 4 m, 2.4 m high cabin connected to the centre of a 1.5 m by 12 m long corridor, 2.4 m high with both ends open.

5.1.2 The cabin should be fitted with one doorway opening, 0.8 m wide and 2.2 m high, which provides for a 0.2 m lintel above the opening.

5.1.3 The walls of the cabin should be constructed from an inner layer of nominally 12 mm thick non-combustible wall board with a nominally 45 mm thick mineral wool liner. The walls and ceiling of the corridor and ceiling of the cabin should be constructed of nominally 12 mm thick non-combustible wall boards. The cabin should be provided with a window in the wall opposite the corridor for observation purposes during the fire tests.

5.1.4 The cabin and corridor ceiling should be covered with cellulosic acoustical panels. The acoustical panels should be nominally 12 mm to 15 mm thick and should not ignite when tested in accordance with IMO resolution A.653(16).

5.1.5 Plywood panels should be placed on the cabin and corridor walls. The panels should be approximately 3 mm thick. The ignition time of the panel should not be more than 35 s and the flame spread time at 350 mm position should not be more than 100 s as measured in accordance with IMO resolution A.653(16).

5.2 Instrumentation

During each fire test, the following temperatures should be measured using thermocouples of diameter not exceeding 0.5 mm:

.1 The ceiling surface temperature above the ignition source in the cabin should be measured with a thermocouple embedded in the ceiling material from above such that the thermocouple bead is flush with the ceiling surface.

.2 The ceiling gas temperature should be measured with a thermocouple 75 ± 1 mm below the ceiling in the centre of the cabin.

.3 The ceiling surface temperature in the centre of the corridor, directly opposite the cabin doorway, should be measured with a thermocouple embedded in the ceiling material such that the thermocouple bead is flush with the ceiling (see figure 1).

5.3 Nozzle positioning

The nozzles should be installed to protect the cabin and corridor in accordance with the manufacturer's design and installation instructions subject to the following:

.1 if only one nozzle is installed in the cabin, it may be placed in the shaded areas in figure 2; and

.2 corridor nozzles should not be placed closer to the centreline of the cabin doorway than one half the maximum spacing recommended by the manufacturer. An exception is systems where nozzles are required to be placed outside each doorway.

5.4 Fire sources

5.4.1 *Cabin test fire source*

Two pullman type bunk beds having an upper and lower berth should be installed along the opposite side walls of the cabin (see figure 1). Each bunk bed should be fitted with 2.0 m by 0.8 m by 0.1 m polyether mattresses having a cotton fabric cover. Pillows measuring 0.5 m by 0.8 m by 0.1 m should be cut from the mattresses. The cut edge should be positioned towards the doorway. A third mattress should form a backrest for the lower bunk bed. The backrest should be attached in upright position in a way that prevents it from falling over (see figure 3).

The mattresses should be made of non-fire retardant polyether and they should have a density of approximately 33 kg/m^3. The cotton fabric should not be fire retardant treated and it should have an area weight of 140 g/m^2 to 180 g/m^2. When tested according to ISO 5660-1 (ASTM E-1354), the polyether foam should give results as given in the table below. The frame of the bunk beds should be of steel nominally 2 mm thick.

ISO 5660, Cone calorimeter test

Test conditions: Irradiance 35 kW/m^2. Horizontal position. Sample thickness 50 mm. No frame retainer should be used.

Test results	**Foam**
Time to ignition(s)	2-6
3 minute average HRR, q_{180} (kW/m^2)	270±50
Effective heat of combustion (MJ/kg)	28±3
Total heat release (MJ/m^2)	50±12

5.4.2 Corridor test fire source

The corridor fire tests should be conducted using eight piled polyether mattress pieces measuring 0.4 m by 0.4 m by 0.1 m, as specified in 5.4.1, without fabric covers. The pile should be placed on a stand, 0.25 m high, and in a steel test basket to prevent the pile from falling over (see figure 4).

5.5 Test method

The following series of fire tests should be performed with automatic activation of the nozzle(s) installed in the cabin and/or corridor as indicated. Each fire should be ignited with a lighted match using an igniter made of some porous material, e.g. pieces of insulating fibreboard. The igniter may be either square or cylindrical shaped, 60 mm in square or 75 mm in diameter. The length should be 75 mm. Prior to the test the igniter should be soaked in 120 ml of heptane and wrapped in a plastic bag and positioned as indicated for each cabin fire test. For the corridor fire tests, the igniter should be located in the centre at the base of the pile of the mattress pieces, and on one side of the test stand at the base of the pile of the mattress pieces.

- **.1** Lower bunk bed test. Fire arranged in one lower bunk bed and ignited with the igniter located at the front (towards door) centreline of the pillow.
- .**2** Upper bunk bed test. Fire arranged in one upper bunk bed with the igniter located at the front (towards door) centreline of the pillow.
- .**3** Arsonist test. Fire arranged by spreading 1 l of white spirits evenly over one lower bunk bed and backrest 30 s prior to ignition. The igniter should be located in the lower bunk bed at the front (towards door) centreline of the pillow.
- **.4** Disabled nozzle test. The nozzle(s) in the cabin should be disabled. Fire arranged in one lower bunk bed and ignited with the igniter located at the front (towards door) centreline of the pillow.
  If nozzle(s) in the cabin are linked with nozzle(s) in the corridor such that a malfunction would affect them all, all cabin and corridor nozzles linked should be disabled.
- **.5** Corridor test. Fire source located against the wall of the corridor under one nozzle.
- **.6** Corridor test. Fire source located against the wall of the corridor between two nozzles.

The fire tests should be conducted for 10 min after the activation of the first nozzle, and any remaining fire should be extinguished manually.

5.6 Acceptance criteria

Based on the measurements, a maximum 30 s average value should be calculated for each measuring point which forms the temperature acceptance criteria.

Acceptance criteria for the cabin and corridor tests

<table>
<tr><th colspan="2" rowspan="2"></th><th rowspan="2">Maximum 30 s. average ceiling surface temperature in the cabin (°C)</th><th rowspan="2">Maximum 30 s. average ceiling gas tempera-ture in the cabin (°C)</th><th rowspan="2">Maximum 30 s. Average ceiling surface temperature in the corridor (°C)</th><th colspan="2">Maximum acceptable damage on mattresses (%)</th><th rowspan="2">Other criteria</th></tr>
<tr><th>Lower Bunk</th><th>Upper bunk</th></tr>
<tr><td rowspan="3">Cabin tests</td><td>Lower bunk bed</td><td rowspan="2">360</td><td rowspan="2">320</td><td rowspan="2">120</td><td>40</td><td>10</td><td rowspan="2">No nozzles in corridor allowed to operate[3]</td></tr>
<tr><td>Upper bunk bed</td><td>N.A.</td><td>40</td></tr>
<tr><td>Arsonist</td><td>N.A.</td><td>N.A.</td><td>120</td><td>N.A.</td><td>N.A.</td><td>N.A.</td></tr>
<tr><td colspan="2">Corridor</td><td>N.A.</td><td>N.A.</td><td>120[1]</td><td colspan="2">N.A.</td><td>Only two independent nozzles in corridor allowed to operate[4]</td></tr>
<tr><td colspan="2">Disabled nozzle</td><td>N.A.</td><td>N.A.</td><td>400[2]</td><td colspan="2">N.A.</td><td>N.A.</td></tr>
</table>

[1] In each test, the temperature should be measured above the fire source.
[2] The fire is not allowed to propagate along the corridor beyond the nozzles closest to the door opening.
[3] Not applicable, if cabin nozzle(s) are linked to corridor nozzle(s).
[4] Not applicable, if corridor nozzle(s) are linked together.
N.A. Not applicable.

Note: After the test, the fire sources should be examined visually to determine compliance with the required maximum damage. The damages should be estimated using the following formula:

Damage to lower bunk bed = (damage to horizontal mattress (%) + 0.25 x damage to pillow (%) + damage to backrest (%))/2.25

Damage to upper bunk bed = (damage to horizontal mattress (%) + 0.25 x damage to pillow (%))/1.25

If it is not clearly obvious by visual examination whether the criteria are fulfilled or not, the test should be repeated.

6 LUXURY CABIN FIRE TESTS

6.1 Test arrangement

These fire tests should be conducted in a 2.4 m high room having equal sides and a floor area of at least 25 m^2, but not exceeding 80 m^2. The room should be fitted with two doorway openings, in cross corners opposite the fire source. Each opening should be 0.8 m wide and 2.2 m high, which provides for a 0.2 m lintel above the openings. Walls and ceilings should be made of non-combustible, nominally 12 mm thick, wall boards.

The test room ceiling should be covered 2.4 m out from the corner with cellulosic acoustical panels. The acoustical panels should be nominally 12 mm to 15 mm thick, and should not ignite when tested in accordance with IMO resolution A.653(16).

Plywood panels should be placed on two of the test room walls and extending 2.4 m out from the corner with the fire source. The panels should be approximately 3 mm thick. The ignition time of the panel should not be more than 35 s and the flame spread time at 350 mm position should not be more than 100 s as measured in accordance with IMO resolution A.653(16) (see figure 5).

6.2 Instrumentation

During the fire tests the following temperatures should be measured. Note that the instrumentation may be different, dependent on which of two types of fire sources are used.

.1 The ceiling material temperature above the ignition source should be measured using a 0.8 mm thermocouple embedded in the ceiling, 6.5 ± 0.5 mm from the surface.

.2 The ceiling gas temperature should be measured using a 0.8 mm thermocouple located 75 ± 1 mm below the ceiling within 0.2 m horizontally from the closest nozzle to the corner.

.3 The ceiling surface temperature above the ignition source should be measured using a thermocouple with diameter not exceeding 0.5 mm embedded in the ceiling material such that the thermocouple bead is flush with the ceiling surface.

.4 The ceiling gas temperature should be measured using a 0.5 mm thermocouple located 75 ± 1 mm below the ceiling within 0.2 m horizontally from the closest nozzle to the corner.

Measurements in accordance with .1 and .2 should apply when a fire source in accordance with 6.4.1 is used and .3 and .4 when a fire source in accordance with 6.4.2 is used (see figure 5).

6.3 Nozzle positioning

The distance between the outer nozzle and the walls should be one half the maximum nozzle spacing specified by the manufacturer. The distance between nozzles should be equal to the maximum spacing specified by the manufacturer.

Nozzles should be positioned with their frame arms parallel and perpendicular with the walls of the cabin, or for nozzles without frame arms, so that the lightest discharge density will be directed towards the fire area.

If non-uniform installation is selected by the manufacturer, the maximum spacing is established in the open public space scenario.

6.4 Fire source

The fire source should consist of a wood crib and a simulated furniture (i.e. UL 1626 Residential Sprinkler fuel package [7]), or, alternatively, an upholstered chair (i.e. FM 2030 Residential fuel package [8]).

6.4.1 *Wood crib/simulated furniture description*

The wood crib should weigh approximately 6 kg and should be dimensioned 0.3 m by 0.3 m by 0.3 m. The crib should consist of eight alternate layers of four trade size nominal 38 mm by 38 mm kiln-dried spruce or fir lumber 0.3 m long. The alternate layers of the lumber should be placed at right angles to the adjacent layers. The individual wood members in each layer should be evenly spaced along the length of the previous layer of wood members and stapled together.

After the wood crib is assembled, it should be conditioned at a temperature of 50 ± 3°C for not less than 16 h. Following the conditioning, the moisture content of the crib should be measured at various locations with a probe type moisture meter. The moisture content of the crib should not exceed 5% prior to the fire test. The crib should be placed on top of a 0.3 m by 0.3 m, 0.1 m high steel test tray and positioned 25 mm from each wall.

The simulated furniture should consist of two 76 mm thick uncovered polyether foam cushions having a density of 16 kg/m^3 to 20 kg/m^3, a compressive strength of 147 N to 160 N, measuring 0.9 m by 1.0 m, each attached to a wood support frame. The wood support frame should have a rectangular plywood face measuring approximately 810 mm by 760 mm on to which the foam cushions are applied. The cushions should be stretched and stapled on to plywood panels which extend perpendicular to the face towards the opposite end of the frame by approximately 180 mm. Each cushion should overlap the top of the wood frame by approximately 150 mm and the sides of the wood frame by approximately 180 mm.

This fuel package has an ultra-fast t^2 fire growth, a maximum heat release in excess of 2.5 MW and a growth time (time to reach 1 MW) of 80 ± 10 s (see figure 5).

6.4.2 *Upholstered chair description*

The fuel package consists of the following items (see figure 6).

Item	Code	No. of units	Dimensions and description
Simulated sofa end	S	1	19 mm plywood structure, open top and bottom, 610 mm by 914 mm, 610 mm high
Chair (recliner)[1]	C	1	Custom-made reclining chair approximately 760 mm by 914 mm, 990 mm high. All new materials consisting of vinyl covering with cotton backing (4.54 kg); polyurethane foam (seat 2.27 kg, 127 mm thick); polyurethane (arms, 1.36 kg, 25 mm thick); pine structure; total weight 23.8 kg, built by Old Brussels of Sturbridge, Massachusetts
End table	E	1	Table top; 19 mm particle board, 660 mm by 495 mm; table legs are softwood, i.e. pine, fir, etc; 38 mm by 38 mm, 514 mm high
Curtains	CW	4	2 panels, rod pocket panels (1,016 mm by 1,829 mm), fabric blend: 50% polyester, 50% cotton 2 panels sheer rod pocket panels (1,016 mm by 1,829 mm), (100% polyester batiste)

[1] An equivalent chair may be specified as a fire source with maximum heat release rate of 1.5 MW, a Required Delivered Density of 5 mm/min, and a growth time of (time to reach 1 MW assuming second power growth in time) of 75s - 125 s.

6.5 Test method

The fire tests should be conducted for 10 min after the activation of the first nozzle, and any remaining fire should be extinguished manually.

6.5.1 *Wood crib/simulated furniture*

0.21 of heptane should be placed on a 5 mm water base in the test tray positioned directly below the wood crib. Approximately 120 g total of excelsior (wood wool) should be pulled apart and loosely positioned on the floor with approximately 60 g adjacent to each section of the simulated furniture.

The heptane should be ignited and 40 s later the excelsior should also be ignited.

6.5.2 *Upholstered chair*

Ignition should take place using a lighted match at the centre of two horizontal axially parallel and adjacent 0.3 m long cotton wicks, each 9.3 mm in diameter, saturated with 25 cl of ethyl alcohol. The wick should be positioned at the base of the chair as described in figure 6, within 2 min prior to ignition.

6.6 Acceptance criteria

Based on the measurements, a maximum of 30 s average value should be calculated for each measuring point which forms the temperature acceptance criteria.

	Max. 30 s average ceiling material/surface temperature (°C)	**Max. 30 s average ceiling gas temperature (°C)**
Fire source		
As per 6.4.1	260	320
As per 6.4.2	260	320

7 PUBLIC SPACE FIRE TESTS

7.1 Test arrangements

The fire tests should be conducted in a well-vented building under a ceiling of at least 80 m^2 m in area with no dimension less than 8 m. There should be at least 1 m space between the perimeters of the ceiling and any wall of the test building. The ceiling height should be set at 2.5 m and 5.0 m respectively.

Two different tests should be conducted as per 7.1.1 and 7.1.2.

7.1.1 *Open public space test*

The fire source should be positioned under the centre of the open ceiling so that there is an unobstructed flow of gases across the ceiling. The ceiling should be constructed from a non-combustible material.

7.1.2 *Corner public space test*

The test should be conducted in a corner constructed by two at least 3.6 m wide, nominally 12 mm thick, non-combustible wall boards.

Plywood panels should be placed on the walls. The panels should be approximately 3 mm thick. The ignition time of the panel should not be more than 35 s and the flame spread time at 350 mm position should not be more than 100 s measured in accordance with IMO resolution A.653(16).

The ceiling should be covered, 3.6 m out from the corner, with cellulosic acoustical panels. The acoustical panels should be nominally 12-15 mm thick, and should not ignite when tested in accordance with IMO resolution A.653(16).

7.2 Instrumentation

During each fire test, the following temperatures should be measured using thermocouples with diameter not exceeding 0.5 mm.

7.2.1 *Open public space test*

.1 The ceiling surface temperature above the ignition source should be measured using a thermocouple embedded in the ceiling material such that the thermocouple bead is flush with the ceiling surface.

.2 The ceiling gas temperature should be measured using a thermocouple located 75 ± 1 mm below the ceiling 1.8 m from ignition.

7.2.2 *Corner public space test*

.1 The ceiling surface temperature above the ignition source should be measured using a thermocouple embedded in the ceiling material such that the thermocouple bead is flush with the ceiling surface.

.2 The ceiling gas temperature should be measured using a thermocouple located 75 ± 1 mm below the ceiling within 0.2 m horizontally from the closest nozzle to the corner.

7.3 Nozzle positioning

For nozzles with frame arms, tests should be conducted with the frame arms positioned both perpendicular and parallel with the edges of the ceiling or corner walls. For nozzles without framed arms, the nozzles should be orientated so that the lightest discharge density will be directed towards the fire area.

7.4 Fire sources

7.4.1 *Open public space*

The fire source should consist of four sofas made of mattresses as specified in 5.4.1 installed in steel frame sofas. The sofas should be positioned as shown in figure 7 spaced 25 mm apart.

One of the middle sofas should be ignited, centric and at the bottom of the backrest, with an igniter as described in 5.5.

7.4.2 *Corner public space test*

The fire source should consist of a sofa, as specified in 7.4.1, placed with the backrest 25 mm from the right hand wall and close up to the left hand wall. A target sofa should be placed along the right hand wall with the seat cushion 1.0 m from the first sofa and another target sofa should be placed 0.5 m from it on the left hand side. The sofa should be ignited using an igniter, as described in 5.5, that should be placed at the far left of the corner sofa, at the base of the backrest, near the left hand wall (see figure 8).

7.5 Test method

The fire tests should be conducted for 10 min after the activation of the first nozzle, and any remaining fire should be extinguished manually.

7.5.1 *Open public space tests*

Fire tests should be conducted with the ignition centred under one, between two and below four nozzles.

7.5.2 *Corner public space test*

Two fire tests should be conducted with at least four nozzles arranged in a 2 x 2 matrix. For the second fire test, the nozzle closest to the corner should be disabled.

7.6 Acceptance criteria

Based on the measurements, a maximum 30 s average value should be calculated for each measuring point which forms the temperature acceptance criteria.

7.6.1 *Acceptance criteria for the public space tests*

		Maximum 30 s. Average ceiling surface temperature (°C)	Maximum 30 s. average ceiling gas temperature (°C)	Maximum acceptable damage on mattresses (%)
Open space		360	220[2]	50/35[1]
Corner	normal	360	220	50/35[1] (ignition sofa) No charring of target sofas
	Disabled nozzle	N.A.	N.A.	50 (target sofas)

[1] 50% is the upper limit for any single test. 35% is the upper limit for the average of the public space tests required in 7 and 9 at each ceiling height (excluding the disabled sprinkler test).
[2] The gas temperature should be measured at four different positions and the evaluation of the results is based on the highest reading.
N.A. Not applicable.

8 SHOPPING AND STORAGE AREA FIRE TESTS

8.1 Test arrangements

As per 7.1 but with 2.5 m ceiling height only.

8.2 Instrumentation

No temperature measurement are required.

8.3 Nozzle positioning

As per 7.3.

8.4 Fire source

The fire source should consist of two central, 1.5 m high, solid piled stacks of cardboard boxes packed with polystyrene unexpanded plastic cups with a 0.3 m flue space. Each stack should be approximately 1.6 m long and 1.1 m to 1.2 m wide.

A suitable plastic commodity is the FMRC standard plastic commodity [9]. Similar commodities might be used if they are designed in a similar way and are proven to have the same burning characteristics and suppressability.

The fire source should be surrounded by six 1.5 m high solid piled stacks of empty cardboard boxes forming a target array to determine if the wire will jump the aisle. The boxes should be attached to each other, for example by staples, to prevent them from falling over (see figure 9).

8.5 Test method

Fire tests should be conducted with the ignition centred under one, between two and below four nozzles.

Each fire should be ignited with a lighted match using two igniters as described in 5.5. The igniters should be located placed on the floor, each against the base of one of the two central stacks and ignited simultaneously.

The fire tests should be conducted for 10 min after the activation of the first nozzle, and any remaining fire should be extinguished manually.

8.6 Acceptance criteria

.1 No ignition or charring of the target cartons is allowed.

.2 No more than 50% of the cartons filled with plastic cups should be consumed.

9 VENTILATION TEST

One corner public space test of 7 and the corridor space test which has given the worst result among those in 5.4.2 should be repeated with the ambient air having a minimum velocity of 0.03 m/s.

The ambient air velocity in the public space tests should be measured 1 m above the floor and 1 m below the ceiling at a location 5 m out from the corner, midway between the enclosure walls. Air velocity in the corridor should be measured at the mid-height.

9.1 Acceptance criteria

The fire should not progress to the edge of the combustible wall or ceiling.

10 REFERENCED PUBLICATIONS

[1] *The International Convention for Safety of Life at Sea (SOLAS),* International Maritime Organization, London.

[2] Solomon, Robert E, *Automatic Sprinkler Systems Handbook,* National Fire Protection Association, Batterymarch Park, Quincy, MA, USA, 5th edition, 1991

[3] ANSI/UL 723, *Surface Burning Characteristics of Building Materials*

[4] ISO 6182/1 February 1994 edition

[5] ISO 5660-1, *Fire Tests - Reaction of fire - Rate of heat release from building products (Cone calorimeter method),* 1st edition, 1993

[6] Babrauskas, V, and Wetterlund, I, *Instructions for Cone calorimeter testing of furniture samples,* CBUF Consortium, SP-AR 1993:65, Borås, Sweden, 1993

[7] *Standard for Residential Sprinklers for Fire-Protection Service,* UL 1626, Underwriters Laboratories Inc., Northbrook, IL, USA, December 28, 1990 revision

[8] *Approval Standard for Residential and Limited Water Supply Automatic Sprinklers,* Class 2030, Factory Mutual Research Corporation, Norwood, MA, USA, January 27, 1993

[9] Chicarello, Peter, J., Troup, Joan, M.A., *Fire Products Collector Test Procedure for Determining the Commodity Classification of Ordinary Combustible Products,* Factory Mutual Research Corporation, Norwood, MA, USA, August, 1990

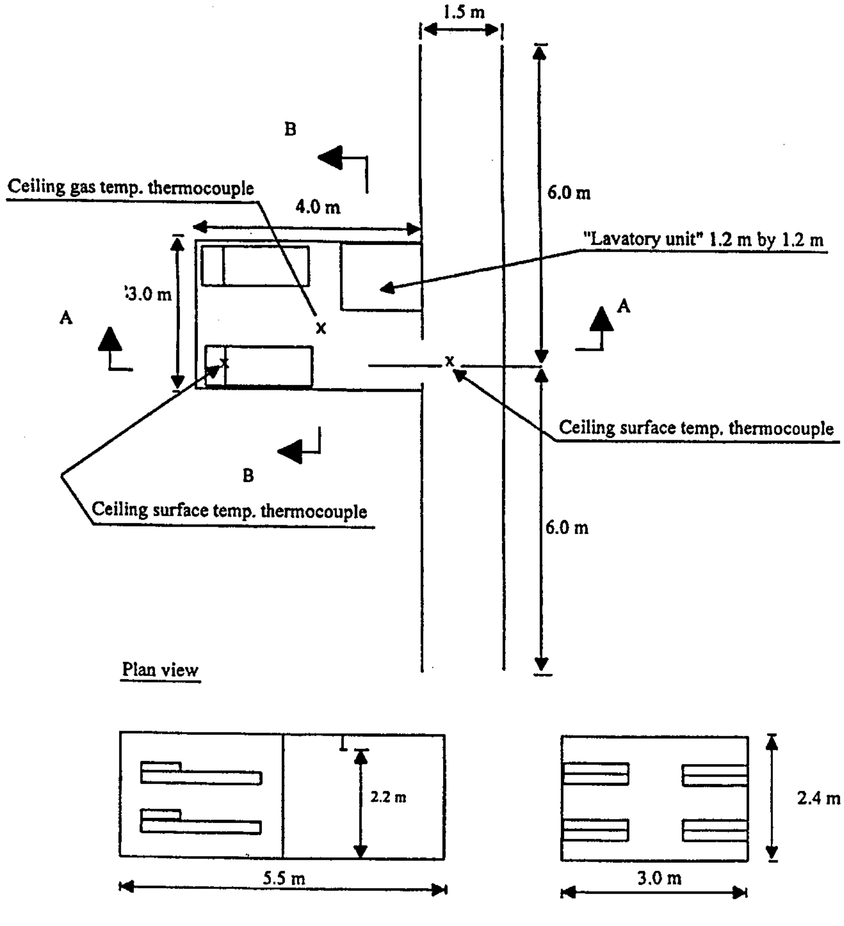


Figure 1

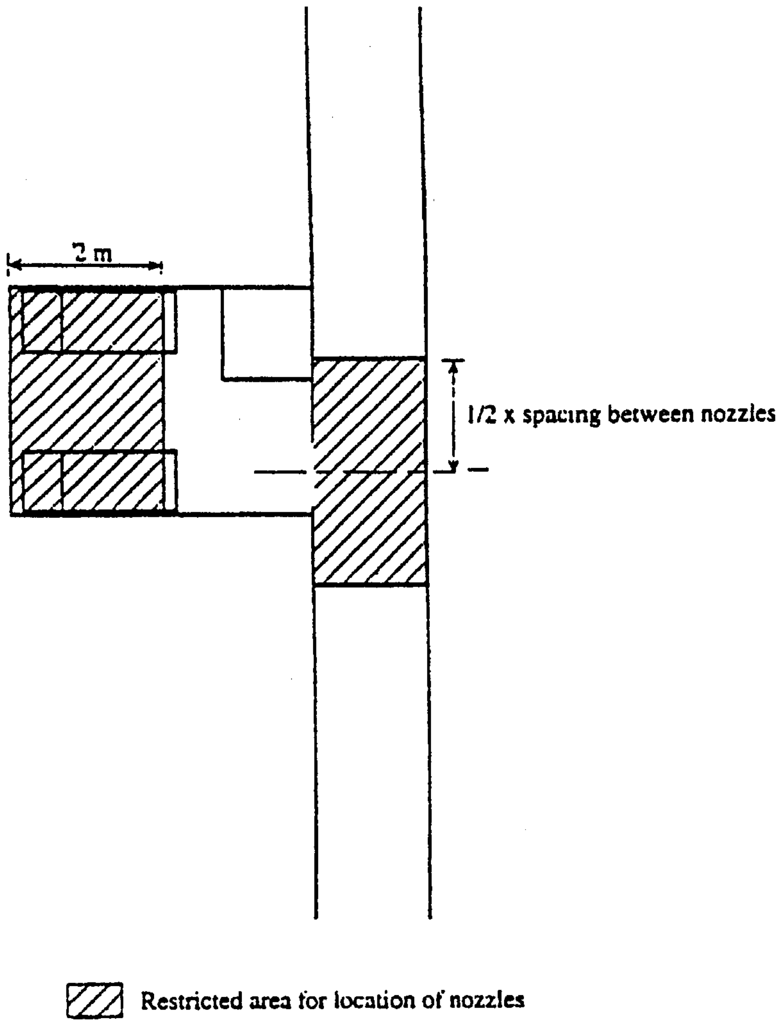

2 m
1/2 x spacing between nozzles
Restricted area for location of nozzles

Figure 2

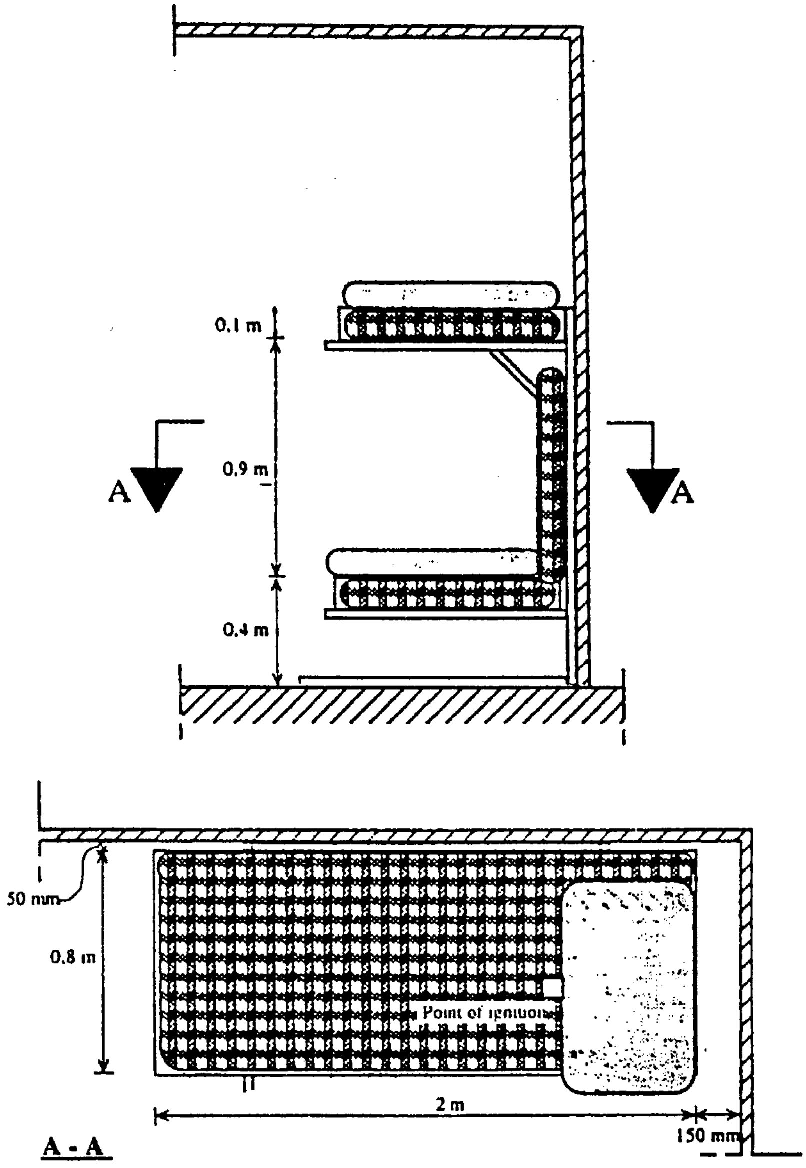


Figure 3

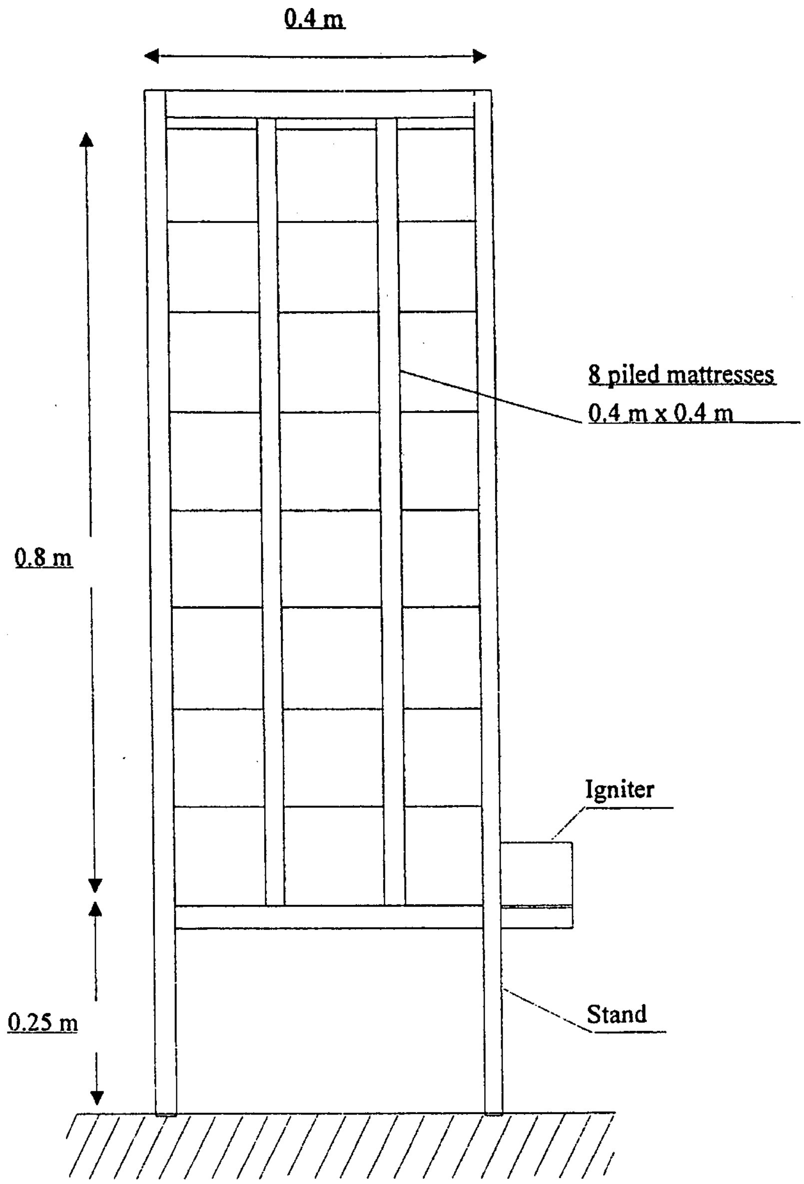


Figure 4

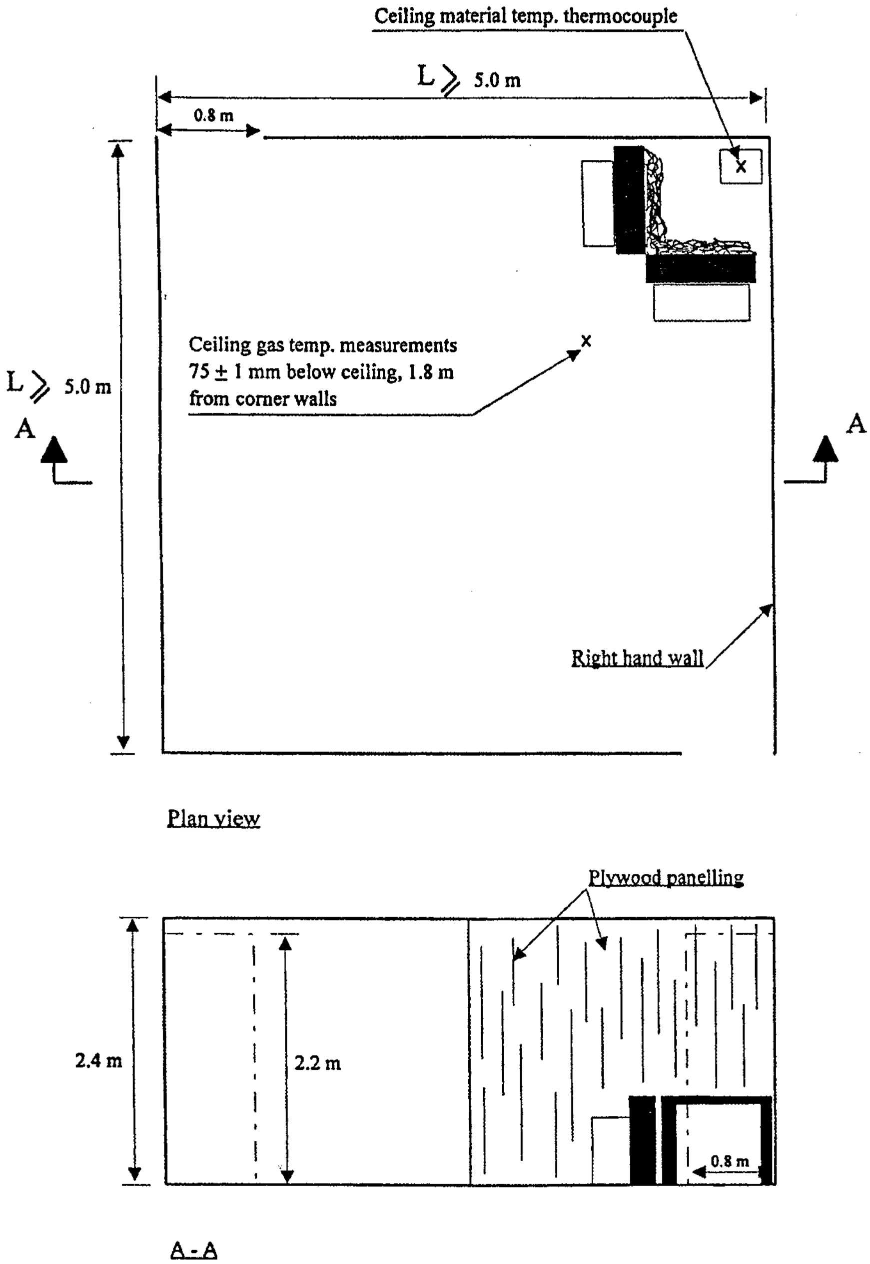


Figure 5
(shown with wood crib/simulated furniture)

Upholstered chair fuel package
(dimensions in metres)

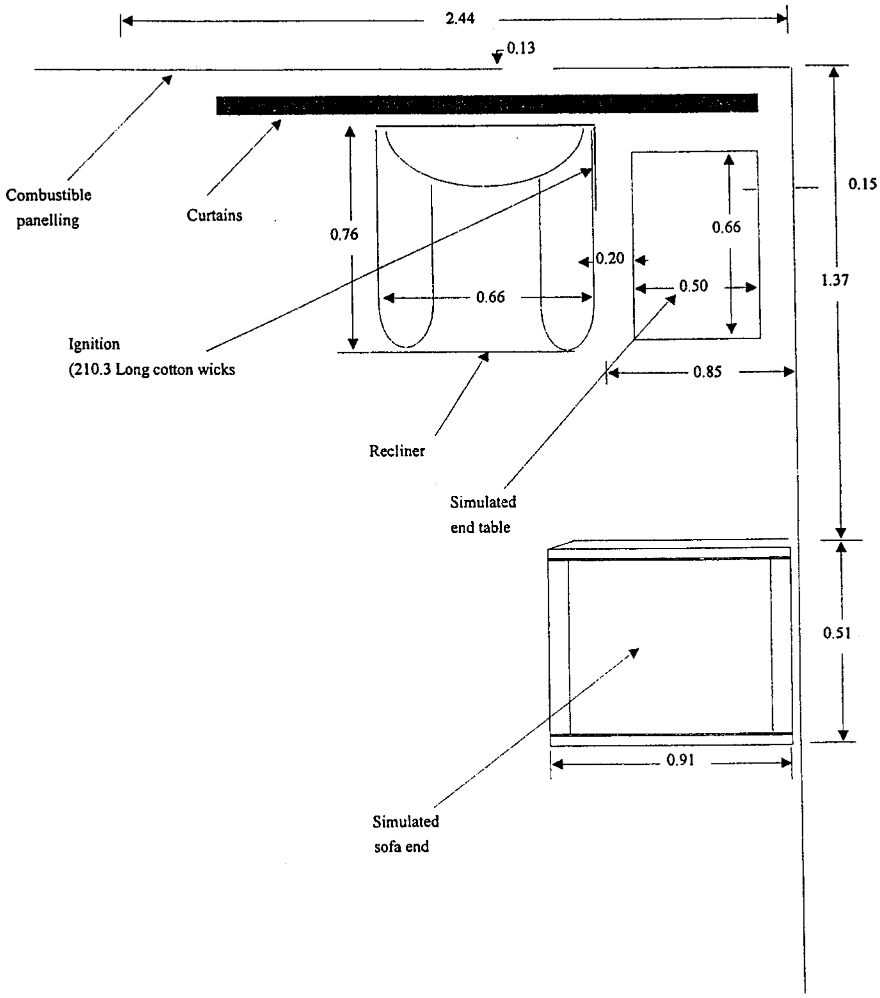


Figure 6

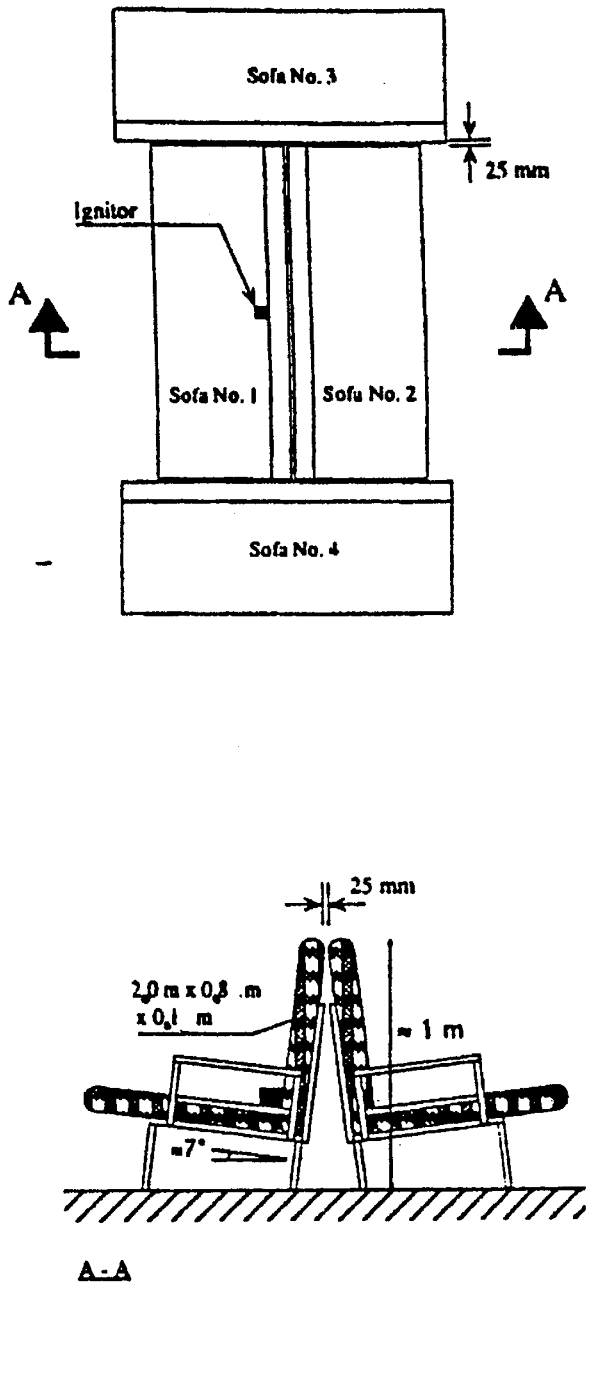
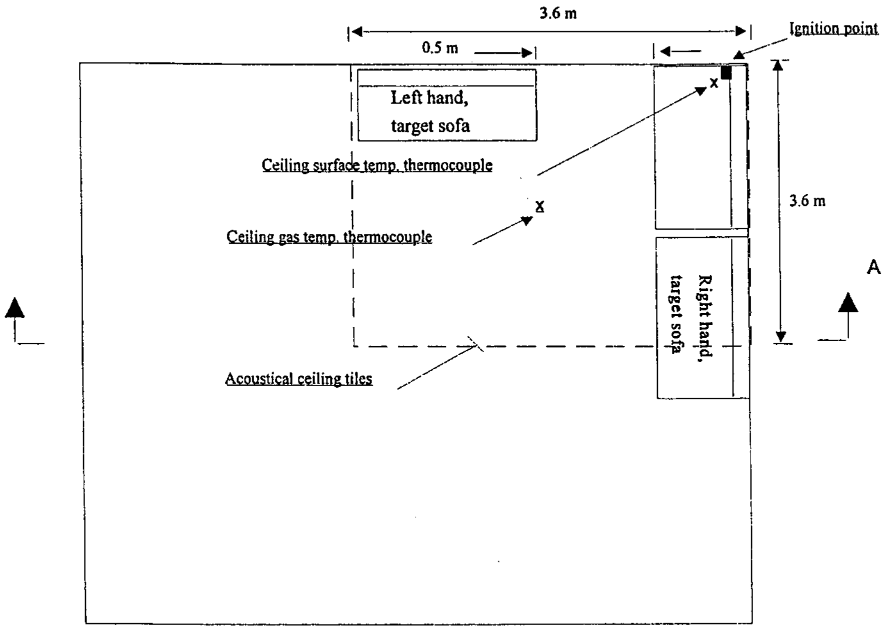
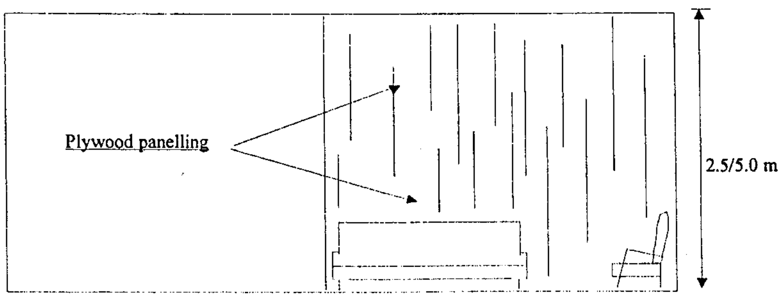

Sofa No. 3
25 mm
Ignitor
A
A
Sofa No. 1
Sofa No. 2
Sofa No. 4
25 mm
2,0 m x 0,8 m
x 0,1 m
≈ 1 m
≈7°
A-A

Figure 7



Plan view



A - A

Figure 8

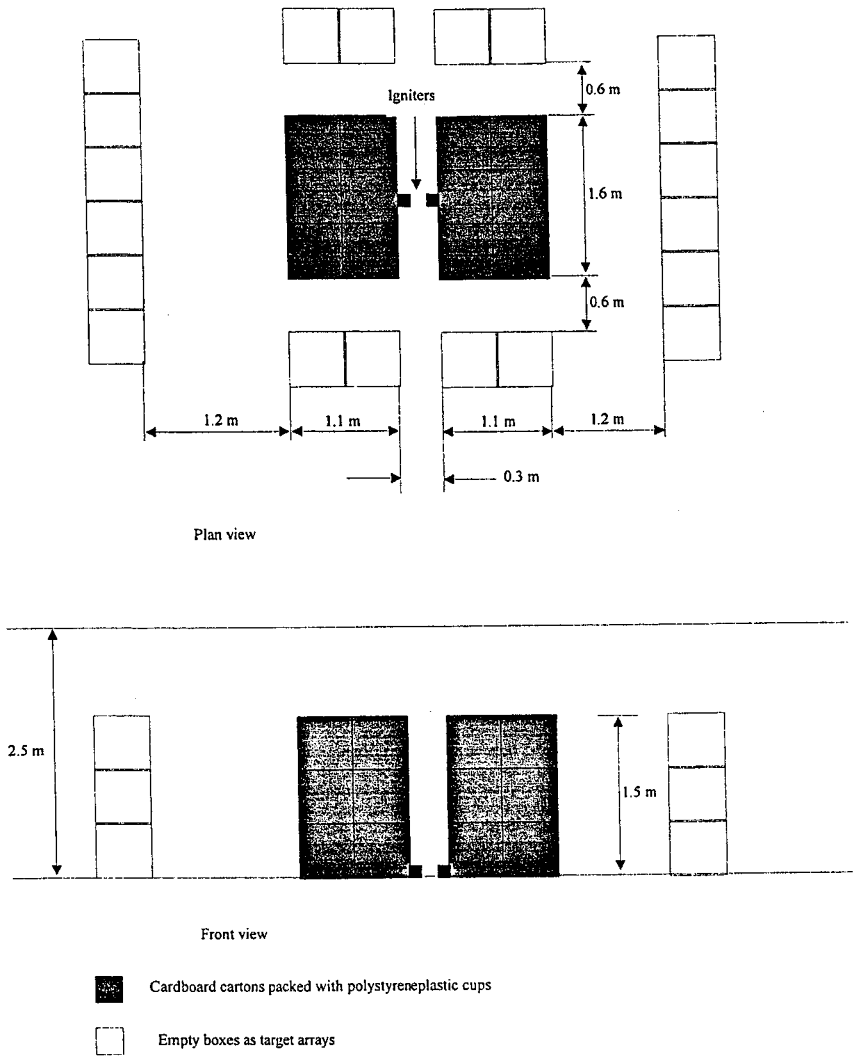

Igniters
0.6 m
1.6 m
0.6 m
1.2 m
1.1 m
1.1 m
1.2 m
0.3 m
Plan view
2.5 m
1.5 m
Front view
Cardboard cartons packed with polystyreneplastic cups
Empty boxes as target arrays

Figure 9

MSC/CIRC.574
Adopted on 3 June 1991

THE ATTAINED SUBDIVISION INDEX 'A' FOREXISTING RO-RO PASSENGER SHIPS

The calculation procedure to assess the survivability characteristics of existing ro-ro passenger ships when using a simplified method based upon resolution A.265(VIII)

1 General comments

1.1 At the thirty-fifth session of the SLF Sub-Committee, following a proposal by the United States (SLF 35/4/23), it was agreed that a simplified version of resolution A.265(VIII) should be used to assess the survivability characteristics of existing ro-ro passenger ferries (SLF 35/20, paragraphs 4.21, 4.27 to 4.32 and annex 5 refers).

1.2 The method proposed involves a calculation procedure which contains all the essential probabilistic elements of the full resolution A.265(VIII) method given in the "Regulations on subdivision and stability of passenger ships as an equivalent to Part B of chapter II of the International Convention for the Safety of Life at Sea, 1960".

1.3 The principal probabilistic elements mentioned in 1.2 are the factors 'a', 'p', 'r' and 's'.

- 'a' is a factor which estimates the probability of damage occurring at a particular position in the ship's length;
- 'p' is a factor which estimates the probability of the longitudinal extent of damage;
- 'r' is a factor which estimates the probability of the degree of penetration in from the ship side (this factor is only relevant where longitudinal subdivision is taken into account); and
- 's' is a factor which is a measure of survival probability. When s = 0, this means that there is no contribution to the index W for the damage case being considered. When s = 1, this means that all the conditions for survival given by the specified residual stability criteria are fully met.

1.4 The factors 'a' and 'p', which refer to the centre of damage and longitudinal extent of damage, are to be taken directly from formulae (III) and (IV) of regulations 6(b) and 6(c) respectively.

1.5 Where longitudinal subdivision is provided, allowance can be given for this - and it should be noted at this point that such subdivision may be inboard or outboard of the B/5 line. In such cases, the 'r' factor given at formula (X) of regulation 7(b)(ii) is to be used. However, the deterministic requirement of a minimum double bottom height of B/10 of regulation 7(a)(i) is not to be applied.

1.6 In the case of the 's' factor, however, the formula for 's' is to be that which was first proposed by the USSR in SLF 35/4/9, and is reproduced in page 3, annex 5, of SLY 35/20. The use of this formula ensures that in all cases where all the SOLAS 90 criteria are met, the 's' factor is equal to 1.

1.7 Further simplification has been introduced by specifying that the calculation of 's' is to be confined to the deepest subdivision draught, rather than the three draughts d_1, d_2 and d_3 and corresponding s_l, s_2 and s_3 values given in regulation 6(d)(ii) of the full resolution A.265(VIII) method.

1.8 Finally, to limit as far as possible the number of damage stability calculations which need to be carried out and also to standardize the calculation procedure, regulation 6(a)(ii), should be applied only as far as the words "… the summation is also taken for all possible pairs of adjacent compartments." The remaining wording of regulation 6(b)(ii) should be ignored for the purposes of this simplified method.

2 The calculation procedure

2.1 Establish the following principal parameters:
- **.1** the subdivision length, L_s Regulation 1(b)
- **.2** the subdivision breadth, B_1 Regulation 1(d)(i)
- **.3** the subdivision breadth, B_2 Regulation 1(d)(ii)
- **.4** the deepest subdivision draught, d_s Regulation 1(a)(ii)
- **.5** the number of main compartments
- **.6** the ship's maximum operational KG at the deepest subdivision draught.

2.2 For each of the main compartments establish the following:
- **.1** the values X_1, X_2 Regulation 6(b)
- **.2** the corresponding ζ_1, ζ_2 and ζ_{12} values Regulation 6(b)
- **.3** using the values obtained from .1 and .2, calculate:
  'a' - see regulation 6(b), formula (III)
  'p' - see regulation 6(c), formula (IV)
  'r' - see regulation 7(b)(ii), formula (X)
  (where longitudinal subdivision is concerned).

2.3 The calculation of the 's' factor is by the use of the formula given in page 3, annex 5, of SLF 35/20. The formula is:

$$s = c*2.58*4\sqrt{GZ_{\max}*Range*Area}$$

When the criteria for compliance with the requirements of regulation II-1 of the 1974 SOLAS Convention, as amended, are fully met, then s = 1 is to be assumed. The 's' factor is only to be calculated for the deepest subdivision draught (d_s), rather than for the three draughts specified for the full resolution A.265(VIII) method. The deepest subdivision draught in this instance is the subdivision draught appropriate to the vessel.

2.4 The damage stability results which are used to obtain the residual stability characteristics, that is, GZ_{max}, range and area under the curve, are to be based on the ship's maximum operational KG at the deepest subdivision draught. Level trim is to be assumed.

2.5 A tabular summary of 'a', 'p', 'r', 's' should now be made for all the main compartments. The product a*(pr)*s is to be calculated for each damage case to obtain the contribution to the index 'A' (say, $\zeta A > 0$). A summation of the 'ζA' values is then made to obtain the contribution to the 'A' value from the single compartments alone.

2.6 The procedure outlined above is now performed for all cases involving the assumed flooding of two adjacent compartments.

2.7 If the vessel is not fully compliant with the required residual stability standard, then at least one of the damage cases appropriate to the subdivision standard will have an 's' value which is less than 1, i.e:

.1 for a two-compartment vessel, at least one two-compartment damage case will have s < 1;

.2 for a one-compartment vessel, at least one one-compartment damage case will have s < 1.

2.8 After this the KG described in 2.4 above is to be modified such that the results of the worst damage case just meet the required residual stability standard, i.e. s = l for the worst case.

2.9 A subdivision index A_{max} is then calculated at the same draught and trim used in 2.4 above but using the modified KG value described in 2.8 above. All single and two-compartment groups contributing to the index are to be included. For a vessel having a two-compartment standard, this means that all 's' values will be equal to1. For a vessel having a one-compartment standard, all one-compartment damages will have 's' values equal to 1.

The use of the probabilistic concept in assessing the residual stability standards of existing ro-ro passenger ships

(The text below contains only the probabilistic parts of IMO resolution A.265(VIII) which are to be applied for this assessment only)

The primary objective is to calculate the attained subdivision index 'A', by modifying the normal calculation procedure as indicated below, for a substantial sample of existing ro-ro passenger ships.

Therefore, it is only necessary to consider those parts of regulations 1 to 8 inclusive which should apply for the sake of this exercise.

Of these eight regulations, all those which are deterministic in nature are either ignored or adapted to conform to probabilistic principles.

Regulation 2 - Subdivision index

For the purposes of this exercise this regulation is to be ignored.

Regulation 4 - Permeabilities

4(a) Applies.
4(b) Replace the permeability value for cargo spaces by a constant value of 0.90 for freight/vehicle spaces.

Regulation 5 - Subdivision and damaged stability

5(b)(iii) Applies.
5(c)(i)(1) The requirements for the GM values (in the final stage of flooding) are to be replaced by the requirements given in USSR paper SLF 35/4/9 - See later for a full description of these requirements.
5(c)(i)(2) The maximum permitted equilibrium angle after flooding is included in the requirements of regulation 5(c)(i)(1).
5(c)(i)(3) This is to be interpreted as non-immersion of the bulkhead deck - note that this is not the margin line - in the final stage of flooding
5(c)(ii) Applies.
5(c)(iii) Applies.
In respect of the time for equalisation of cross-connected spaces, the provisions of resolution A.266(VIII) should be applied.
5(c)(iv) Applies.
A standard of residual stability during the intermediate stages of flooding, for the purposes of this exercise only, is to be governed by the heel angle given in this regulation, i.e. 20°.
5(d) Applies, except that in place of the final sentence - "For each initial trim ... flooded condition" put "The ship shall be at its design trim (i.e. zero trim in most cases) at the deepest subdivision loadline".

Regulation 6 - Attained subdivision index

6(a)(i) Applies, except that the words "In addition to complying with regulation 5" should be ignored.
6(a)(ii) Applies, except that a full stop should be placed after "... for all possible pairs of adjacent compartments" and the rest of the subparagraph should be ignored.
6(a)(iii) Applies, except that the words "according to Regulation 5" should be ignored.
6(b) Applies, except that when the end bulkheads of a compartment contains a step, or steps, then the length of such a compartment is to be based upon the position of those end bulkheads at the ship side.
6(c)(i) Applies.
6(c)(ii) Applies.

6(c)(iii)	Applies.
6(d)(i)	Replace the formula (VIII) by the formula for 's_i' from the paper SLF 35/4/9 - see below for full details. In respect of GM_R, this should be taken as the GM corresponding to the intact condition at the deepest subdivision loadline.
6(d)(ii)	In place of the weighted 's' value i.e. $s = 0.45\ s_1 + 0.33s_2 + 0.22s_3$, 's' for the deepest subdivision loadline should be used.
6(d)(iii)	Applies.

Regulation 7 - Combined longitudinal and transverse subdivision

7(a)(iii)	Applies.
7(b)	Applies.
7(c)	Applies.

The 's' factor to be used for this exercise only

$$s = c*2.58*4\sqrt{GZ_{\max} * Range * Area}$$

where:

GZ_{max}	is the maximum positive residual righting lever (m) within the range of 15° beyond the angle of equilibrium, but not more than 0.1 m;
Range	is the range of positive righting levers beyond the angle of equilibrium, in degrees, but not more than 15°;
Area	is the area under the righting lever curve (m.rad), measured from the angle of equilibrium to the lesser of the angles at which progressive flooding occurs, or 22° (measured from the upright) in the case of a one-compartment flooding, or 27° (measured from the upright) for the flooding of two or more adjacent compartments, but not more than 0.015 m.rad. In respect of the 'Area', please note that the allowable area is up to a heel angle, measured from the upright 22°/27°, depending on whether flooding of a single compartment or two adjacent compartments is concerned.

and c is determined according to the following:

c = 1 where the final angle of equilibrium θ_c is not more than 7°,
c = 0 where the final angle of equilibrium θ_c is more than 20°,
else $c = \sqrt{\dfrac{20° - \theta}{20° - 7°}}$ c

Tabular statement concerning the survival capability of an existing ro-ro passenger ship

Application of MSC/Circ.574

Ship designation for identification purposes

1.	Principal particulars (in metres)	

Subdivision length Ls	Breadth Bl	Depth	
		To bulkhead dk.	To dk. limiting the allowed buoyancy

2.	Give the number of compartments – below the bulkhead dk. – bounded by the main transverse bulkheads	
3.	Of the compartments mentioned at 2., how many rely on longitudinal subdivision (inside B/5) to meet the deterministic requirements? Give in terms of % Ls.	______ @ % Ls
4.	Year of build.	
5.	Year of issue of the initial Passenger Certificate.	
6.	Lifeboat capacity.	
7.	The total number of persons permitted to be on board (passengers and crew)	
8.	Deepest subdivision loadline, d_s.	
9.	The SOLAS regulations which apply.	
10.	According to 9., what compartment standard?	
11.	Give the actual ship KG (in metres) for the loading condition (at draught d_s) used in the damage stability calculations. If the KG used is not the actual KG, give further details at 17.	
12.	Is the freight/vehicle cargo carried below the bulkhead deck? carried above the bulkhead deck?	
13.	Attained subdivision index A	
14.	Give the notional ship KG such that the s-values appropriate to the compartmental standard at 10, are equal to 1.	
15.	Maximum subdivision index A_{max}	
16	Ratio A/A_{max} in %	
17	**Additional relevant information**	

MSC/CIRC.809

Adopted on 30 June 1997

RECOMMENDATION FOR CANOPIED REVERSIBLE LIFE-RAFTS, AUTOMATICALLY SELF-RIGHTING LIFERAFTS AND FAST RESCUE BOATS

INCLUDING TESTING, ON RO-RO PASSENGER SHIPS

ANNEX

1 APPLICATION

This recommendation should apply to canopied reversible liferafts, automatically self-righting liferafts and fast rescue boats required by SOLAS regulation III/26.

2 CANOPIED REVERSIBLE LIFERAFTS

2.1 Except as provided in this section, all canopied reversible liferafts should comply with the requirements of paragraph 4.1, and if an inflatable liferaft, paragraph 4.2, or if a rigid liferaft, with the requirements of paragraph 4.3.

Unless indicated otherwise, paragraphs referred to in this recommendation are those of the International Life-Saving Appliance (LSA) Code (resolution MSC.48(66)).

2.2 The requirements of paragraphs 4.2.5.2 and 4.2.6.2 do not apply to inflatable canopied reversible liferafts and the requirements of paragraph 4.3.5.1 do not apply to rigid canopied reversible liferafts.

2.3 The floating canopied reversible liferaft should be fitted with self-draining arrangements. The liferafts should be capable of being safely used at all times by untrained persons.

2.4 The canopied reversible liferaft should be capable of operating safely whichever way up it is floating. The liferaft should have a canopy on both sides of the main body, if applicable, of the liferaft, which should be set in place when the liferaft is launched and waterborne. Both canopies should meet the requirements of paragraphs 4.1.1.5, 4.1.3.3 and 4.1.3.4.

2.5 The equipment required under paragraph 4.1.5 should be readily accessible whichever way up the canopied reversible liferaft is floating, either by use of an equipment container which is accessible from either side, or by duplication of equipment on each side of the liferaft.

2.6 The fully equipped canopied reversible liferaft should float in a stable upright position in a seaway at all times, regardless of the conditions of loading.

2.7 The canopied reversible liferafts do not need to be arranged for easy side-to-side transfer and are therefore not subject to the 185 kg mass limitation of paragraph 4.1.2.2.

2.8 On ro-ro passenger ships operating on fixed routes in shallow water, the requirements that liferafts be arranged so as to ensure that the liferafts are not dragged under the sinking ship, can be achieved by using a liferaft painter with a length of at least the maximum depth of the water plus an additional 20 %.

3 AUTOMATICALLY SELF-RIGHTING LIFERAFTS

3.1 Except as provided in this section, all automatically self-righting liferafts should comply with the requirements of paragraph 4.1 and, if an inflatable liferaft, with the requirements of paragraph 4.2 or, if a rigid liferaft, with the requirements of paragraph 4.3.

3.2 The requirements of paragraphs 4.2.5.2 and 4.2.6.2 do not apply to inflatable automatically self-righting liferafts. The requirements of 4.3.5.1 do not apply to rigid automatically self-righting liferafts.

3.3 The fully equipped liferaft should automatically turn from a capsized position to an upright position on the surface of the water, regardless of whether it inflates in the inverted position underwater or on the surface of the water or capsizes for any reason following inflation.

3.4 The floating automatically self-righting liferaft should be fitted with self-draining arrangements. The liferaft should be capable of being safely used at all times by untrained persons.

3.5 The automatically self-righting liferafts do not need to be arranged for easy side-to-side transfer and are therefore not subject to the 185 kg mass limitation of paragraph 4.1.2.2.

3.6 On ro-ro passenger ships operating on fixed routes in shallow water, the requirement that liferafts be arranged so as to ensure that the liferafts are not dragged under the sinking ship, can be achieved by using a liferaft painter with a length of at least the maximum depth of the water plus an additional 20 %.

4 FAST RESCUE BOATS

The provisions of this section should apply to fast rescue boats in lieu of provisions of the Guidelines on fast rescue boats (resolution A.656(16)).

4.1 Requirements for fast rescue boats.

4.1.1 The fast rescue boat and its launching appliances should be such as to enable it to be safely launched and retrieved under adverse weather and sea conditions.

4.1.2 Except as provided in this section, all fast rescue boats should comply with the requirements of section 5.1, except for paragraphs 4.4.1.5.3, 4.4.1.6, 4.4.6.8, 4.4.7.2, 5.1.1.6 and 5.1.1.10.

4.1.3 Notwithstanding paragraph 5.1.1.3.1, fast rescue boats should have a hull length of not less than 6 m and not more than 8.5 m, including inflated structures.

4.1.4 Fully equipped fast rescue boats should be capable of manoeuvring for at least 4 h at a speed of at least 20 knots in calm water with a crew of 3 persons and at least 8 knots with a full complement of persons and equipment.

4.1.5 Fast rescue boats should be self-righting or capable of being readily righted by not more than two of their crew.

4.1.6 Fast rescue boats should be self-bailing or be capable of being rapidly cleared of water.

4.1.7 Fast rescue boats should be steered by a wheel at a helmsman's position remote from the tiller. An emergency steering system providing direct control of the rudder, water jet or outboard motor should also be provided.

4.1.8 Engines in fast rescue boats should stop automatically or be stopped by the helmsman's emergency release switch should the rescue boat capsize. When the rescue boat has righted, each engine or motor should be capable of being restarted, provided the helmsman's emergency release, if fitted, has been reset. The design of the fuel and lubricating systems should prevent the loss of more than 250 ml of fuel or lubricating oil from the propulsion system should the rescue boat capsize.

4.1.9 Fast rescue boats should, if possible, be equipped with an easily and safely operated fixed single-point suspension arrangement or equivalent.

4.1.10 A rigid fast rescue boat should be constructed in such a way that, when suspended by its lifting point it is of sufficient strength to withstand a load without residual deflection on removal of load of 4 times the mass of its full complement of persons and equipment.

4.1.11 The normal equipment of the fast rescue boat should include a hands free and watertight VHF radiocommunication set.

4.1.12 The crew of the fast rescue boat should consist of at least the helmsman and two crew members trained and drilled regularly having regard to the Seafarers[*] Training, Certification and Watchkeeping (STCW) Code and recommendations adopted by the Organization.

4.2 Fast rescue boat launching appliances.

4.2.1 Every fast rescue boat launching appliance should comply with the requirements of paragraphs 6.1.1 and 6.1.2 except 6.1.2.10.

4.2.2 The launching appliance should be fitted with a device to dampen the forces due to interaction with the waves when the fast rescue boat is launched or recovered. The device should include a flexible element to soften shock forces and a damping element to minimize oscillations.

4.2.3 The winch should be fitted with an automatic high-speed tensioning device which prevents the wire from going slack in all sea state conditions in which the fast rescue boat is intended to operate.

4.2.4 The winch brake should have a gradual action. When the fast rescue boat is lowered at full speed and the brakes are applied sharply, the additional dynamical force induced in the wire due to retardation should not exceed 0.5 times the working load of the launching appliance.

4.2.5 The lowering speed for a fully equipped fast rescue boat with its full complement of persons on board should not exceed 1 m/s. Notwithstanding the requirements of paragraph 6.1.1.9, launching appliances should be capable of hoisting the fully equipped rescue boat loaded with 6 persons at a speed of not less than 0.8 m/s. The appliance should also be capable of lifting the rescue boat with the maximum number of persons that can be accommodated in the rescue boat as calculated under paragraph 4.4.2.

4.2.6 At least three turns of wire should remain on the winch after the fast rescue boat is lowered to the sea with the ship at its lightest seagoing condition, a trim of up to 10 degrees and a list of up to 20 degrees, either way.

5 TESTING OF CANOPIED REVERSIBLE LIFERAFTS, AUTOMATICALLY SELF-RIGHTING LIFERAFTS AND FAST RESCUE BOATS

The testing of canopied reversible liferafts, automatically self- righting liferafts and fast rescue boats should be carried out in accordance with the provisions of the Recommendation on testing of canopied reversible liferafts, automatically self-righting liferafts and fast rescue boats, set out in the appendix.

[*] Refer to the Recommendations on training requirements for crews of fast rescue boats, adopted by the Organization by resolution A.771(18) and section A-VI/2, table A-VI/2-2 "Specification of the minimum standard of competence in fast rescue boats" of the Seafarers' Training, Certification and Watchkeeping (STCW)

APPENDIX

RECOMMENDATION ON TESTING OF CANOPIED REVERSIBLE LIFERAFTS, AUTOMATICALLY SELF-RIGHTING LIFERAFTS AND FAST RESCUE BOATS ON RO-RO PASSENGER SHIPS

The canopied reversible liferafts, automatically self-righting liferafts and fast rescue boats on ro-ro passenger ships should be tested in accordance with the provisions of the Recommendation on Testing of Life-Saving Appliances (resolution A.689(17)) modified as indicated below.

NOTE: The amended text is contained in the respective documents. The amendments impede the following paragraphs: 5.17.2, 5.17.2.2, 5.17.13, 5.17.9, 5.18, 5.19, 5.20, 5.21, 7.4, 7.5, 7.6, 8.1.4, 8.1.5 and 8.1.8.

MSC/CIRC.849

Adopted on 8 June 1998

ANNEX

GUIDELINES FOR THE PERFORMANCE, LOCATION, USE AND CARE OF EMERGENCY ESCAPE BREATHING DEVICES (EEBDs)

1 SCOPE

1.1 These Guidelines provide information and guidance on the location, use, and care of emergency escape breathing devices (EEBDs), to provide personnel breathing protection against a hazardous atmosphere while escaping to an area of safety.

2 GENERAL

2.1 An EEBD is a supplied-air or oxygen device only used for escape from a compartment that has a hazardous atmosphere and should be of approved type.

2.2 EEBDs are not to be used for fighting fires, entering oxygen deficient voids or tanks, or worn by fire-fighters. In these events, a self-contained breathing apparatus, which is specifically suited for such situations, should be used.

3 DEFINITIONS

3.1 "Face piece" means a face covering that is designed to form a complete seal around the eyes, nose and mouth which is secured in position by a suitable means.

3.2 "Hood" means a head covering which completely covers the head, neck, and may cover portions of the shoulders.

3.3 "Hazardous atmosphere" means any atmosphere that is immediately dangerous to life or health.

4 PARTICULARS

4.1 The EEBD should have at least a duration of service of 10 min.

4.2 The EEBD should include a hood or full face piece, as appropriate, to protect the eyes, nose and mouth during escape. Hoods and face pieces should be constructed of flame resistant materials, and include a clear window for viewing.

4.3 An unactivated EEBD should be capable of being carried hands-free.

4.4 The EEBDs, when stored, should be suitably protected from the environment.

4.5 Brief instructions or diagrams clearly illustrating the use should be clearly printed on the EEBD. The donning procedures should be quick and easy to allow for situations where there is little time to seek safety from a hazardous atmosphere.

4.6 Unless personnel are individually carrying EEBDs, consideration should be given for placing such devices along the escape routes within the machinery spaces or at the foot of each escape ladder within the space. In addition, control spaces and workshops located within the machinery spaces should also be considered for the possible location of such devices.

5 CARE

5.1 The EEBD should be maintained in accordance with the manufacturer's instructions.

5.2 Spare EEBDs should be kept on board.

5.3 Maintenance requirements, manufacturer's trademark and serial number, shelf life with accompanying manufacture date and name of approving authority should be printed on each EEBD.

6 TRAINING

6.1 Training in the use of the EEBD should be considered as a part of basic safety training.

6.2 All EEBD training units should be clearly marked.

6.3 Personnel should be trained to immediately don an EEBD prior to exiting a space when the atmosphere becomes life threatening. This is necessary due to the possibility of encountering smoke during escape.
Such training should be accomplished by scheduling routine escape drills for crew members working in the engineering or machinery spaces.

6.4 An EEBD may also be used to escape from a machinery space due to an accidental release of a fixed CO_2 system and can be carried by fire-fighters for the sole purpose of providing the device to personnel in need of emergency assistance.

MSC.CIRC./914

Adopted on 4 June 1999

GUIDELINES FOR THE APPROVAL OF ALTERNATIVE FIXED WATER-BASED FIRE-FIGHTING SYSTEMS FOR SPECIAL CATEGORY SPACES

1. The Maritime Safety Committee, at its seventy-first session (19 to 28 May, 1999), approved Guidelines for the approval of alternative fixed water-based fire-fighting systems for special category spaces prepared by the Sub-Committee on fire protection, at its forty-third session, as set out in the annex.

2 Member Governments are invited to apply the annexed Guidelines when approving alternative fixed water-based fire-fighting systems for use in special category spaces and inform the Organization of any technical problems identified in their implementation.

ANNEX

GUIDELINES FOR THE APPROVAL OF ALTERNATIVE FIXED WATER-BASED FIRE-FIGHTING SYSTEMS FOR SPECIAL CATEGORY SPACES

1 General
These guidelines have been developed in recognition of the need for alternative fixed water-based fire-fighting systems in addition to the recommendation on fixed fire-extinguishing systems for special category spaces, as contained in resolution A.123(V).

2 Definitions

2.1 ”Antifreeze system”: A wet pipe system employing automatic nozzles or sprinklers attached to a piping system containing an antifreeze solution and connected to a water supply. The antifreeze solution is discharged, followed by water, immediately upon operation of nozzles or sprinklers opened by heat from a fire.

2.2 "Deluge system": A system employing open nozzles or sprinklers attached to a piping system connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the nozzles or sprinklers. When this valve opens, water flows into the piping system and discharges from all nozzles or sprinklers attached thereto.

2.3 "Dry pipe system": A system employing automatic nozzles or sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a nozzle or sprinkler) permits the water pressure to open a valve known as a dry pipe valve. The water then flows into the piping system and out of the opened sprinklers.

2.4 "Fire suppression": A reduction in heat output from the fire and control of the fire to restrict its spread from its seat and reduce the flame area.

2.5 "Fire control": The limitation of the growth of the fire by prewetting adjacent combustibles and controlling ceiling gas temperatures to prevent structural damage.

2.6 "Preaction system": A system employing automatic nozzles or sprinklers attached to a piping system containing air that may or may not be under pressure, with a supplemental detection system installed in the same area as the nozzles or sprinklers. Actuation of the detection system opens a valve that permits water to flow into the piping system and to be discharged from any nozzles or sprinklers that have operated.

2.7 "Water-based extinguishing medium": Fresh water or seawater with or without additives mixed to enhance fire-extinguishing capability.

2.8 "Wet pipe system": A system employing automatic nozzles or sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire.

3 Principle requirements

3.1 The system may be automatically activated, manually activated or automatically activated with manual release capabilities.

3.2 Automatically activated systems may be of the wet pipe, dry pipe, preaction or deluge type. Manually activated systems may be of the deluge type. Automatically activated systems with manual release capabilities should be of the deluge type.

3.3 The system should be capable of fire suppression and control with confirmation testing in accordance with the appendix to these guidelines.

3.4 For wet pipe, dry pipe and preaction systems, the capacity of the water supply to the system should be based on a total simultaneous coverage of the most hydraulically demanding 280 m^2 area or four times the Area of Operation determined by the test described in the appendix to these guidelines, whichever is greatest. For deluge systems, the water supply should be based on a total simultaneous coverage of the two most hydraulically demanding adjacent sections sized in accordance with paragraph 3.5.

3.5 The system should be divided into sections which normally cover the full breadth of the vehicle deck space(s), except that in ships where the vehicle deck is subdivided with longitudinal "A" class divisions forming boundaries of staircases, etc., the breadth of the sections can be reduced accordingly. Each section should be a minimum of 20 m and a maximum of 24 m in length.

3.6 It should be possible to manually shut the section control valves from outside the protected space. Each section should be capable of being isolated by one section control valve. The section control valves should be located outside the protected space, be readily accessible and their locations should be clearly and permanently indicated. Means should be provided to prevent the operation of the section control valves by an unauthorised person.

3.7 The electrical components of the pressure source for the system should have a minimum rating of IP 54. The power supply should be provided from outside the protected space.

3.8 The system should be provided with a redundant means of pumping or otherwise supplying the water to the system. If the ship's fire main water supply has sufficient capacity (delivery rate and pressure) for use as the redundant water supply, the system may be connected to the ship's fire main by a control valve and, in addition, a non-return valve to prevent a backflow from the system.

3.9 The system should be fitted with a permanent sea inlet and be capable of continuous operation using sea water.

3.10 The system supply equipment should be located outside the protected spaces.

3.11 The system and its components should be designed to withstand ambient temperatures, vibration, humidity, shock, impact, clogging and corrosion normally encountered.

3.12 The system and its components should be designed and installed based on international standards acceptable to the Organization. The system components should be manufactured and tested based on the relevant sections of appendix A of MSC/Circ.668, as amended by MSC/Circ.728.

3.13 The nozzle location, type of nozzle and nozzle characteristics should be within the limits tested to provide fire suppression and control as referred to in paragraph 3.3. In addition, nozzles should be located to protect spaces above and below hoistable decks and ramps.

3.14 System designs should be limited to the use of the maximum and minimum temperature ratings of the thermally sensitive fire detection devices tested to provide fire suppression and control as referred to in paragraph 3.3.

3.15 Activation of the system should give a visual and audible alarm in the protected space and at a continuously manned station. The visual and audible alarms should be activated when one or more nozzles operate. An alarm in a continuously manned station should indicate the specific section of the system that is activated. The system alarm requirements described within this paragraph are in addition to, and not a substitute for, the detection and fire alarm system required by SOLAS regulation II-2/37.

3.16 A means for testing the automatic operation of the system and, in addition, assuring the required pressure and flow should be provided.

3.17 If the system is pre-primed with water containing a fire suppression enhancing additive and/or an antifreeze agent, periodic inspection and testing, as specified by the manufacturer, should be undertaken to assure that their effectiveness is being maintained.

3.18 Operating instructions for the system should be displayed at each operating position.

3.19 Installation plans and operating manuals should be supplied to the ship and be readily available on board. A list or plan should be displayed showing spaces covered and the location of the zone in respect of each section. Instructions for testing and maintenance should be available on board.

3.20 Spare parts and operating and maintenance instructions should be provided as recommended by the manufacturer.

3.21 Where automatically operated fire-fighting systems are installed, a warning notice should be displayed outside each entry point stating the type of medium used and the possibility of automatic release.

APPENDIX

FIRE TEST METHOD FOR ALTERNATIVE FIXED WATER-BASED FIRE-FIGHTING SYSTEMS FOR SPECIAL-CATEGORY SPACES

1 Scope

1.1 This test method is intended for evaluating the effectiveness of alternative fixed water-based fire-fighting systems as compared to resolution A.123(V).

1.2 The test programme has two objectives:

1 establishing nozzle location, nozzle characteristics, minimum water delivery rate and minimum water pressure for systems which will provide the required level of system response time, and, fire detection, suppression and control; and

.2 establishing the minimum Area of Operation of the system for the purpose of determining hydraulic design requirements for wet pipe, dry pipe and preaction systems.

2 Field of application

These tests are applicable to systems installed in special category spaces with deck heights equal to, or greater than, 2.4 m.

3 General requirements

3.1 Sampling

The nozzles and other components to be tested should be supplied by the manufacturer together with design and installation criteria, operational instructions, drawings and technical data sufficient for the identification of the components.

3.2 Tolerances

Unless otherwise stated, the following tolerances should apply:

.1	Length	+/- 2 % of value
.2	Volume	+/- 5 % of value
.3	Pressure	+/- 3 % of value
.4	Temperature	+/- 2 % of value

3.3 Observations

The following observations should be made during and after each test:

.1 Time of ignition.
.2 Activation time of first nozzle.
.3 Time when water flows out through first nozzle.
.4 Time when water flow is shut off.
.5 Time when the test is terminated.
.6 Total number of activated nozzles.

3.4 Test hall and environmental conditions

The test hall where the tests are conducted should have a minimum floor area of 300 m^2 and a ceiling height in excess of 8 m. The test hall may be equipped with a forced ventilation system, or be natural ventilated, in order to ensure that there is no restriction in air supply to the test fires. The test hall should have an ambient temperature of between 10 degrees C and 30 degrees C at the start of each test.

3.5 Measurement equipment

Temperatures should be measured using a Plate Thermometer similar to that described in the references below.* The instrument consists of a 0.7 mm thick Inconel 600 steel plate, 100 mm by 100 mm square. It is insulated on the back by a 10 mm thick ceramic fibre pad. Other types of measurement equipment are allowed, if it is proven that they provide similar temperature versus time results.

System water pressure and total water flow rate should be measured by using suitable equipment.

*References

[1] Wickström, Ulf, "The plate thermometer - A simple instrument for reaching harmonized fire resistance tests", SP-REPORT 1989:03, Swedish National Testing and Research Institute, Borås, 1989

[2] Wickström, Ulf, "The plate thermometer - A simple instrument for reaching harmonized fire resistance tests", Fire Technology, Volume 30, No. 2, 1994

3.6 The tests should simulate the conditions of an actual installed system regarding objectives such as time delays between the activation of the system and minimum system water pressure or water delivery. In addition, the use of a pre-primed fire suppression enhancing and/or antifreeze agent, if applicable, should be taken into account.

4 Determination of fire suppression and control capabilities

4.1 Principle

This test procedure tests the effectiveness of a water-based fire-fighting system against a combination of a pool fire and a cargo fire in two simulated freight trucks. At least two tests should be conducted at the minimum and the maximum ceiling to nozzle distance limitations, specified by the manufacturer.

4.2 Fire sources

The primary fire sources consist of:

.1 a flammable liquid pool fire;
.2 plastic commodity cardboard cartons; and
.3 a non-fire retardant tarpaulin.

4.2.1 N-Heptane should be used as the flammable liquid.

4.2.2 A cartoned plastic commodity should be used for the cargo of the simulated freight trucks. An acceptable commodity is either the EUR Std Plastic or the FMRC Std Plastic. These commodities consist of empty polystyrene cups without lids, placed upside down, in compartmented cartons. Details of the commodities are given in table 4.2.2.

Table 4.2.2
Details of specified plastic commodities

Designation	Nominal size of individual carton (L x W x H) (mm)	Number of cups
EUR Std Plastic	600 x 400 x 500	120
FMRC Std Plastic	530 x 530 x 500	125

The corrugated cartons, partitions and pads for packaging the cups should be non-fire retardant, have a "C" flute configuration and be plain printed.

4.2.3 The tarpaulin used to cover the simulated freight trucks should be made from non-fire retardant Polyester having a nominal area weight of 600 +/-50 g/m**2.

4.3 Apparatus

4.3.1 Test area

The tests should be conducted in a test hall as specified in paragraph 3.4 under a flat, smooth, non-combustible ceiling of at least 100 m**2.

4.3.2 Simulated freight trucks

Two simulated freight trucks should be constructed using steel racks (see figures 4.3.2-1 through 3). The racks should have an overall length of 5.8 m, an overall width of 2.4 m and be placed side by side, 0.6 +/-0.05 m apart. The overall height of the simulated freight trucks should be 4.5 +/-0.05 m. At 1.2 +/-0.05 m above the floor, a bottom should be built in each of the racks. The bottom should be built of nominally 2 mm thick steel plates.

Horizontal steel beams on the sides facing the flue space of the racks should be used to prevent the cartons from falling over. The beams should be 0.08 +/-0.02 m in height and be spaced approximately 0.5 m vertically apart. The top beam should be positioned at the level of the top of the stacks of cartons described in 4.3.3.

Around the bottom of the perimeter of the racks, tailgates should be built. The tailgates should be 0.6 m high and be constructed from nominally 12 mm thick non-combustible fibre boards.

Nominally 50 mm by 50 mm crossbeams should be installed perpendicular to the long side, at the top of each of the two racks. The crossbeams should be made from wood and spaced approximately 0.6 m apart.

The sides and the top of the two racks should be fully covered with a tarpaulin as specified in paragraph 4.2.3. The tarpaulin should be stapled to the tailgates all around the simulated freight trucks and to both ends of each of the nine wooden crossbeams.

4.3.3 The cargo of the simulated freight trucks

Three stacks of cardboard cartons should be located on each of the simulated freight trucks. The central stack should consist of plastic commodity cardboard cartons, the outer two stacks should consist of cardboard cartons without plastic cups (with internal divisions only). All stacks should be placed on conventional wood pallets. Spacers made of a suitable non-combustible material should be used under the pallets to provide for a vertical distance between the top of the stacks and the top of the simulated freight trucks of 0.5 +/- 0.05 m.

If the EUR Std Plastic commodity cartons are used, each of the carton stacks should consist of 60 cartons, and have an overall dimension of 1.6 m by 1.8 m by 2.5 m (height).

If the FMRC Std Plastic commodity cartons are used, each of the carton stacks should consist of 45 cartons, and have an overall dimension of 1.6 m by 1.6 m by 2.5 m (height).

All outer columns of cartons should be stapled together at all rows to prevent the stacks from falling over.

The distance between the carton stacks and the flue space, as well as between the individual carton stacks should be 0.3 +/- 0.05 m.

4.3.4 Target arrays

Two target arrays, with an overall length of 8.0 m, made from the tarpaulin as specified in paragraph 4.2.3, should be installed at the same overall height of the simulated freight trucks. The tarpaulin should be attached, using staples, to a wood framework so that a 1 m wide horizontal and a 3.3 m high vertical area is formed. Behind each of the target tarpaulins should be a single row of empty cardboard cartons as defined in paragraph 4.2.2, which are located continuously along the target array. The cardboard cartons should be supported along their bottom as well as along their outside surfaces to prevent them from falling over during the fire test. See figures 4.3.2-2, 4.3.2-3 and 4.3.4.

4.3.5 Pool fire tray

A nominally 2 m long by 1.5 m wide by 2 mm thick steel tray should be positioned centrically under the simulated freight trucks as shown in figure 4.3.2-3. The tray should have a 100 mm rim height. Means should be provided to prevent overflowing of the tray.

4.4 Nozzle positioning

Nozzles should be installed in an array above the simulated freight trucks in accordance with the manufacturer's design and installation criteria. However, nozzles along the centreline between the simulated freight trucks are not permitted to be installed closer to the centre point of the pool fire tray than half the nozzle spacing.

4.5 Instrumentation

Instrumentation for the continuous measuring and recording of test conditions should be employed. The following measurements should be made:

.1 The temperature flush with the ceiling at three positions. See figure 4.5.
.2 The temperature at 0.08 +/- 0.02 m underneath the bottom of the simulated freight trucks, at two positions. See figure 4.5.
.3 System water pressure near the centre of the piping array.
.4 The total water flow rate of the system.

Note: Additional ceiling temperature measurement positions should be used if it is suspected that other positions are being exposed to higher temperatures.

4.6 Test programme and test procedure

4.6.1 Test programme

Tests should be conducted at the minimum system water pressure, minimum and maximum ceiling heights as well as at the minimum and maximum distance between the lowest part of the nozzles and the ceiling, as specified by the manufacturer. The minimum ceiling height should not to be less than 4.8 m.

4.6.2 Test procedure

The test procedure should be applied as follows:

.1 The water pressure used at the start of the test should be set at the minimum value for the system specified by the manufacturer, flowing six open nozzles. If more than six nozzles operate during the test, the water supply pressure should be adjusted accordingly, to keep the required minimum system water pressure.

.2 The tray should be filled with 10 mm (30 L) of n-Heptane on a 10 mm water base.
.3 The measurements are started.
.4 The flammable liquid pool fire should be lit by means of a torch or a match.
.5 The fire should be allowed to burn for a period of 10 minutes or until is it clear that any of the acceptance criteria has failed.
.6 Any remaining fire should be manually extinguished.
.7 The test is terminated.

4.7 Acceptance criteria

The following three criteria should be met:

.1 The temperature measured underneath the simulated freight trucks at either measurement position should be reduced to below 500 degrees C no later than three minutes after ignition and to below 300 degrees C no later than four minutes after ignition.

.2 The cardboard cartons in the target arrays should not ignite.

.3 The maximum five minute average ceiling surface temperature at any measurement position should not exceed 600 degrees C.

5 Determination of area of operation

5.1 Principle

The test procedure described in this section is intended to establish the Area of Operation of wet pipe, dry pipe and preaction systems.

5.2 Apparatus

5.2.1 Test area
The tests should be conducted in a test hall as specified in paragraph 3.4 under a flat, smooth, non-combustible ceiling. The ceiling area should be large enough to allow installation of enough nozzles to fulfil the requirements of paragraph 5.6.

5.2.2 Pool fire trays
The fire source should consist of a large open pool fire with n-Heptane. Four nominally 1.25 m long by 1.25 m wide by 2 mm thick steel trays should be positioned abutting each other and forming a square pool area totalling 6.25 m**2. The trays should have a 100 mm rim height. The centre point of the pool should be centrally positioned below four nozzles. The intention is to not use any other fire source.

5.3 Nozzle positioning

The type of nozzle, installed at the spacing and the orientation proven to meet the requirements of paragraph 4.7 should be installed. Enough nozzles should be installed to fulfil the requirements of paragraph 5.6.

5.4 Instrumentation

Instrumentation for the continuous measurement and recording of test conditions should be employed. The following measurements should be made:

.1 System water pressure near the centre of the piping array.

.2 The total water flow rate of the system.

5.5 Test programme and test procedure

5.5.1 Test programme

Tests should be conducted at the minimum system water pressure, minimum and maximum ceiling heights as well as at the minimum and maximum distance between the lowest part of the nozzles and the ceiling, as specified by the manufacturer. The minimum ceiling height should not be less than 4.8 m.

5.5.2 Test procedure

The test procedure should be applied as follows:

.1 The water pressure used at the start of the test should be set at the minimum value for the system specified by the manufacturer, flowing six open nozzles. If more than six nozzles operate during the test, the water supply pressure should be adjusted accordingly, to keep the required minimum system water pressure.
.2 Each of the trays should be filled with 5 mm (8 L) of n-Heptane on a 10 mm (16 L) water base.
.3 The measurements are started.
.4 The flammable liquid pool fire should be lit by means of a torch or a match.
.5 The fire should be allowed to burn until all flammable liquid is consumed.
.6 The test is terminated.

5.6 Acceptance criteria

The following two criteria should be met:

.1 The outermost nozzles in any direction from the centre point of the pool fire trays should not be allowed to operate.

.2 No nozzle should operate further away than on a 10 m radius from the centre point of the pool fire trays.

5.7 Determination of area of operation. The area of operation should be determined by multiplying the maximum number of nozzles that operated in the tests as specified in paragraph 5.5.1 by the coverage area of the individual nozzles.

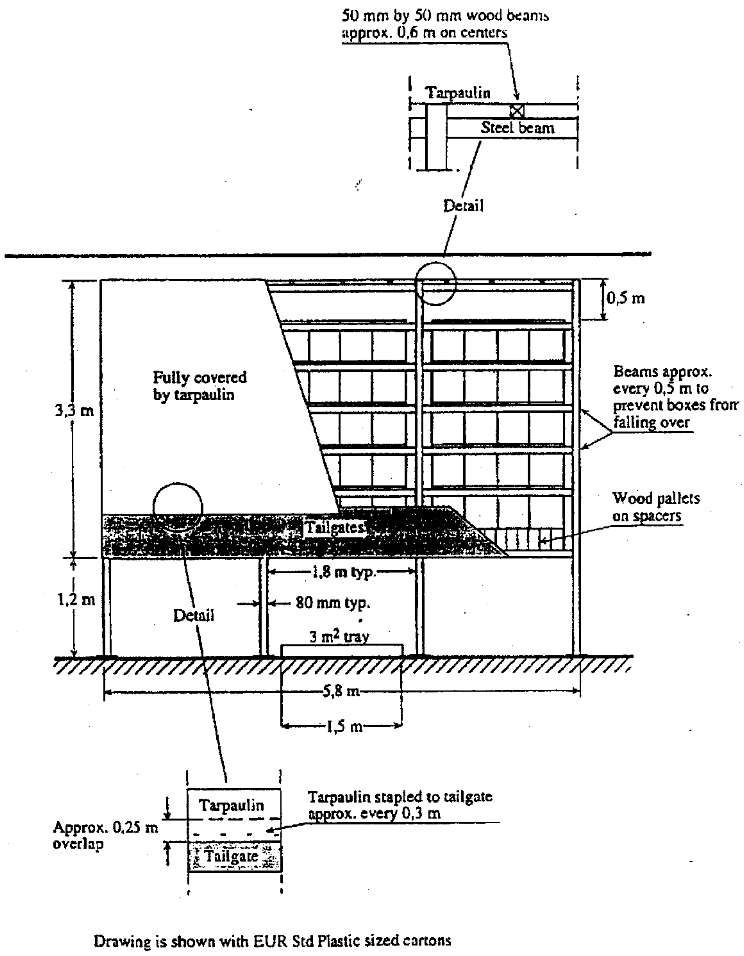
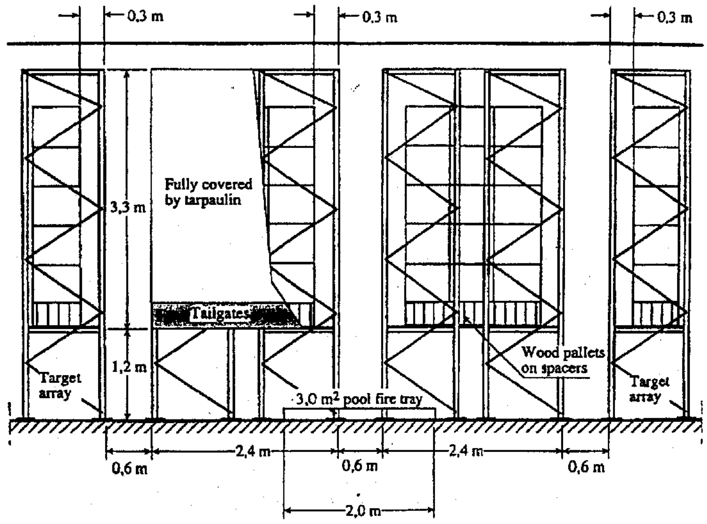
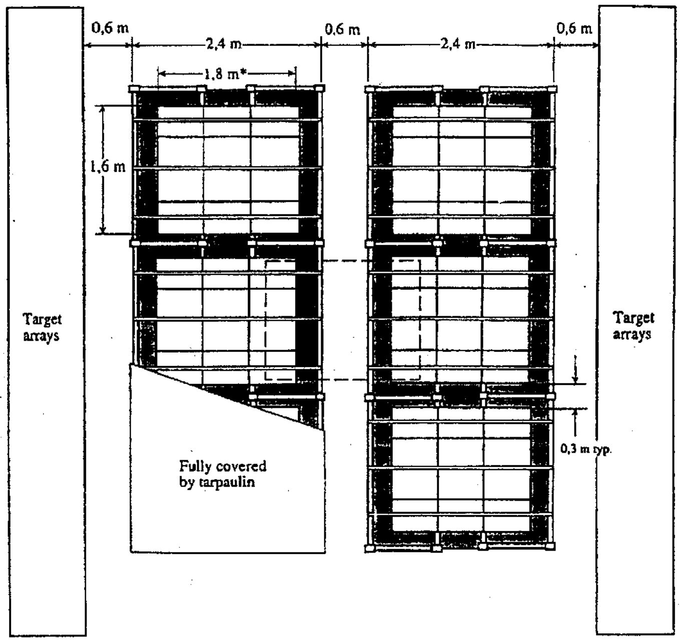


Figure 4.3.2-1



Drawing is shown with EUR Std Plastic sized cartons

Figure 4.3.2-2



Drawing is shown with EUR Std Plastic sized cartons.
* Should be 1.6 m if FMRC Std Plastic is used.
See details of targets in figure 4.

Figure 4.3.2-3

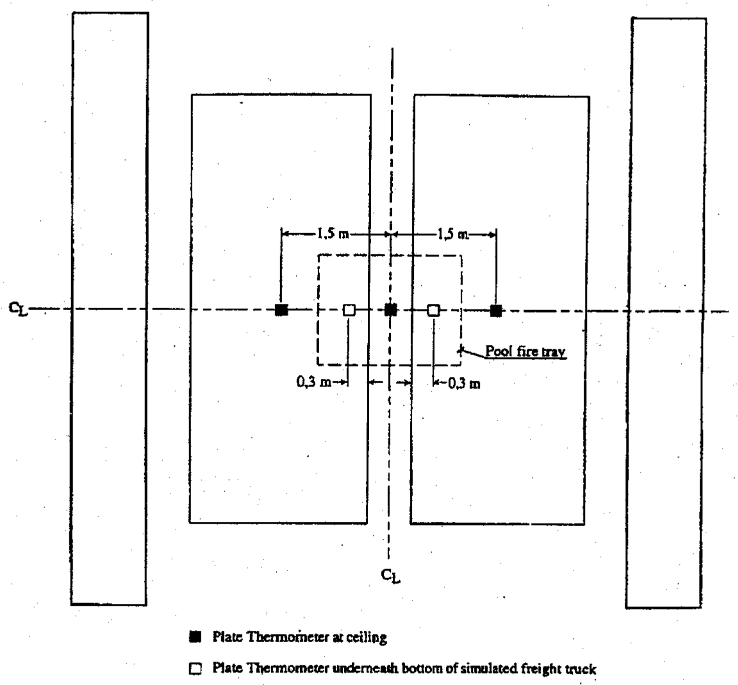

1,5 m
1,5 m
C_L
Pool fire tray
0,3 m
0,3 m
C_L
Plate Thermometer at ceiling
Plate Thermometer underneath bottom of simulated freight truck

Figure 4.5