

**APPENDIX E**  
**Description of Fire Safety Requirements**  
**(HSC Code, Chapter 7)**

The fire safety requirements for HSC are specified in Chapter 7 of HSC Code.

The HSC Code indicate requirements for the following items:

- **Fire Resisting Divisions**, that influence the fire resistance of constructions;
- **Restricted use of combustible materials**, that influence the reaction to fire of materials and products and is related to the use of:
  - Non-combustible materials;
  - Fire-restricting materials.

### **Fire-Resisting Divisions**

*“Fire-resisting divisions are those divisions formed by bulkheads and decks which comply with the following:*

- *they shall be constructed of non-combustible or fire-restricting materials which by insulation or inherent fire-resisting properties satisfy the requirements listed below;*
- *they shall be suitably stiffened;*
- *they shall be so constructed as to be capable of preventing the passage of smoke and flame up to the end of the appropriate fire protection time;*
- *a test of a prototype bulkhead or deck in accordance with the Fire Test Procedures Code shall be required to ensure that it meets the above requirements.”*

*(HSC Code, Paragraph 7.2.1).*

The first means of passive defence consists of dividing the ship (hull, superstructure and deckhouse) into main vertical zones. Each zone is delimited by two structural and thermal bulkheads.

Structural fire protection is a means for minimising the probability of a major fire and the resulting loss of life by designing the structure of the ship to confine any outbreaks of fire to as small an area as possible. This is accomplished by specifying fire endurance capabilities of structural boundaries. Additional items considered are minor bulkheads and penetrations of structural boundaries.

HSC differs from conventional vessels as the construction is mainly made from lightweight materials, such as aluminium alloys.

Characteristics of separating bulkhead and decks change on the basis of the space that need to be separate.

Requirements specified in HSC Code apply to all craft irrespective of construction material.

Fire-resistant bulkheads and decks must be constructed to resist exposure to the standard fire test for a period of 30 minutes for areas of moderate fire hazard and 60 minutes for areas of major fire hazards.

Three different types of fire bulkheads exist:

- “A” Class divisions;
- “B” Class divisions;
- “C” Class divisions.

“A” class divisions are formed by bulkheads and decks which comply with the following:

- constructed of steel or other equivalent material;
- suitably hardened;
- constructed so as to be capable of preventing the passage of smoke and flame after a one-hour standard fire test;
- insulated with approved non-combustible materials such that the average temperature of the unexposed side will not rise more above 140° C in relation to the original temperature. Nor will the temperature at any one point, including any joint, rise more than 180°C above the original temperature, within the time listed below:
  - Class “A-60”: 60 minutes;
  - Class “A-30”: 30 minutes;
  - Class “A-15”: 15 minutes;
  - Class “A-0”: 0 minutes.

“A” Class divisions” can resist to a fire exposure of a period from 30 to 60 minutes.

The other class divisions (B and C) do not resist for 60 or 30 minutes; these types of divisions are not used in HSC design.

Areas of major and moderate fire hazard must be enclosed by fire-resistant divisions as shown in **Table 1** (this table coincides with Table 7.4-1 of HSC Code).

The structural fire protection times (SFP times) separating bulkheads and decks must be in accordance with Table 1 and the structural fire protection times are all based on providing protection for a period of 60 minutes.

The requirements are similar to hourly ratings required by many model building codes.

**Table 1: Structural Fire Protection Times for Separating Bulkhead and Decks of Passenger Craft**

CLASSIFICATION OF SPACE USE		A	B	C	D	E	F
Areas of major fire hazard	A	60 1,2	30 1	3 1,8	3,4 1	3 1	- 1,7,9
Areas of moderate fire hazard	B		30 2	3 8	3,4 60	3 30	- 3
Areas of minor fire hazard	C			3	3,4 30 8,10	3 3	- 3
Control stations	D				3,4 3,4	3 3,4	- 3
Evacuation stations and escape routes	E					3 3	- 3
Open spaces	F						- -

Notes:

The figures on either side of the diagonal line represent the required structural fire protection time for the protection system on the relevant side of the division.

<sup>1</sup> The upper side of the decks of special category spaces, ro-ro spaces and open ro-ro spaces need not be insulated.

<sup>2</sup> Where adjacent spaces are in the same alphabetical category and a note 2 appears, a bulkhead or deck between such spaces need to be fitted if deemed unnecessary by the Administration. For example, a bulkhead is, however, required between a machinery space and a special category space even though both spaces are in the same category.

<sup>3</sup> No structural fire protection requirements; however, a smoke-tight division made of non-combustible or fire-restricting material is required.

<sup>4</sup> Control stations which are also auxiliary machinery spaces should be provided with 30 min structural fire protection.

### Classification of space use

For the purposes of classification of space use in accordance with the fire hazard risks, the following grouping must apply:

- *areas of major fire hazard (A)*, that include the following spaces:
  - machinery spaces;
  - open vehicle spaces;
  - spaces containing dangerous goods;
  - special category spaces;
  - store-rooms containing flammable liquids;
  
- *areas of moderate fire hazard (B)*, that include the following spaces:
  - auxiliary machinery spaces (as defined in 1.4.5 of HSC Code);
  - bond stores containing packaged beverages;

- crew accommodations;
- service spaces;
- *areas of minor fire hazard (C)*, that include the following spaces:
  - auxiliary machinery spaces (as defined in 1.4.6 of HSC Code);
  - cargo spaces;
  - fuel tank compartments;
  - public spaces;
  - tanks, voids and areas of little or no fire risk;
- *control stations (D)*
- *evacuation stations and external escape routes (E)*, including the following areas:
  - external stairs and open decks used for escape routes;
  - muster stations, internal and external;
  - open deck spaces and enclosed promenades forming lifeboat and life-raft embarkation and lowering stations;
  - the craft’s side to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft’s and evacuation slide’s embarkation areas;
  -
- *open spaces (F)*, including the following areas:
  - open spaces locations other than evacuation stations and external escape routes and control stations.”

#### Relationship between SFP time and Evacuation time

The SFP time is very important because the provision for evacuation must be designed so that the craft can be evacuated under controlled conditions in a time of one third of the SFP provided in Table 1 for areas of major fire hazard, after subtracting a period of 7 minutes for initial detection and extinguishing action.

$$\text{Evacuation time} = (\text{SFP}-7)/3 \quad (\text{min}) \quad (1)$$

If any other lesser structural fire protection time is determined for category A craft or cargo craft by (1), then the times specified in table 3 may be amended pro rata. In no case shall the structural fire protection time be less than 30 minutes.

#### **Restricted use of combustible materials**

##### Non-combustible materials

*“Non-combustible material is a material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750°C, this being determined in accordance with the Fire Test Procedures Code” (HSC Code, Paragraph 7.2.3)”.*

The non-combustibility of a material is determined according to the ISO 1182 test method as from FTP Code Part 1 and IMO Res. A.799(19).

The test specimens are cylindrical with diameter  $45^{+0}_{-2}$  mm and height  $50 \pm 3$  mm. If the material thickness is less than 50 mm, the specimens can be made by using a sufficient number of layers of the material.

The testing is performed in an open, vertically positioned cylindrical furnace. The furnace is preheated to 750 °C before the test specimen is introduced. The specimens are cylindrical with diameter 45 mm and height 50 mm.

During the test, the following variables are measured:

- the specimen weight loss;
- the occurrence of sustained flaming;
- temperatures in the furnace and in the specimen before, during and at the end of the test.

According to IMO Res. A.799 (19), a material should be deemed non-combustible if all the following criteria are satisfied:

1. the average furnace thermocouple temperature rise does not exceed 30 °C;
2. the average surface thermocouple temperature rise does not exceed 30 °C.
3. the mean duration of sustained flaming does not exceed 10 seconds.
4. the average mass loss does not exceed 50 %.

#### Fire- Restricting Materials

*Fire-restricting materials* are those materials which have properties complying with the Fire Test Procedures Code.

*“Fire-restricting materials are those materials which have properties complying with the Fire Test Procedures Code (HSC Code, Paragraph 7.2.2)”.*

HSC Code Paragraph 7.4.1.3 requires that the hull, superstructure, structural bulkheads, decks, deck-houses and pillars to be constructed on non-combustible materials (i.e. steel). However, the use of other fire-restricting material may be permitted provided that the requirements of the HSC Code (Chapter 7) are met. Paragraph 7.4.1.3 basically allows further growth in the qualification procedures for fire-restricting materials. Currently, the IMO has recommended use of the ISO 9705 room/corner test as a suitable procedure. Procedures which may allow use of small scale (cone calorimeter) test data in conjunction with mathematical models to predict full scale performance have been developed.

The Code is applicable to all sorts of materials used on board; the most important for fire safety are linings and furniture frames/decorations.

The requirements in paragraph 7.1.4.3 also include strength criteria at elevated temperatures for load bearing structural components.

Fire-restricting materials comply with the following requirements:

- low flame spread characteristics;
- limited rate of heat release, due regard being paid to the risk of fire spread to adjacent compartments;
- gas and smoke should not be emitted in quantities that could be dangerous to the occupants of the craft.

Methods for use in determining the characteristics that qualify a material as “fire-restricting” include the ISO 9705 Full Scale Room Fire Test and the ISO 5660 “Cone Calorimeter”.

IMO Resolution MSC.40(64) specifies the acceptance criteria for ISO 9705 fire test. No acceptance criteria are specified for ISO 5660.

The IMO acceptance criteria for qualifying a surface material or lining as “fire-restricting” (based on ISO 9705) are:

- the time average of the heat release rate (HRR) excluding the ignition source HRR does not exceed 100 kW;
- the maximum HRR (excluding the ignition source HRR) does not exceed 500 kW averaged over any 30 second period of time during the test;
- the time average of the smoke production rate does exceed 1,4 m<sup>2</sup>/s;
- the maximum value of the smoke production rate does not exceed 8,3 m<sup>2</sup>/s averaged over any 60 second period of time during the test;
- flame spread must not reach any further down the walls of the test room than 0,5 m from the floor excluding the area which is within 1,2 m from the corner where the ignition source is located; and
- no flaming drops or debris of the test sample may reach the floor of the test room outside the area which is within 1,2 m from the corner where the ignition source is located.

All six the requirements listed above must be fulfilled in order to qualify as a fire-restricting material. An interim standard for measuring smoke and toxic products of combustion also exists as published by the IMO in Resolution A.653(16) and Resolution MSC.61(67).

**Table 2** resumes the classification criteria.

**Table 2:** Classification Criteria for a “Fire-Restricting Materials”-  
 Room Corner Test - HSC Code

FIRE CHARACTERISTICS	MAXIMUM PEAK	MAXIMUM AVERAGE
Heat Release Rate (kW)	500	100
Smoke Production Rate (m <sup>2</sup> /s)	8.3	1.4
Flame Spread	Not further down the walls than 0.5 m from the floor	
Flaming drops and debris	Not to occur outside the vicinity of the ignition source	

The IMO’s standard for fire-restricting materials is significant because it is the first marine fire test standard to specify the ISO 9705 (Room/corner Test) and the ISO 5660 (Cone Calorimeter Test) test methods, both of which are based on measuring heat release rate of construction products. This is significant because:

- 1) it specifies a full-scale fire test to evaluate the contribution to fire growth provide by the surface product in the shipboard compartments;
- 2) it is a departure from the traditional approach of requiring non-combustible structure; and

- 3) it incorporate two of the most modern of fire test methods at a time when many ship and building codes are still employing 30 and 40 years old flammability standards.