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Ships and marine technology — Large yachts — Structural fire protection for FRP yachts

Navires et technologie marine — Grands yachts — Protection structurelle contre l'incendie pour les yachts en plastique renforcé

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 12, *Large yachts*.

Introduction

Many existing standards are based on protection of steel and equivalent metallic materials. This International Standard recognizes that FRP is an entirely different material than steel and aluminium, and addresses all of the relevant mechanical, thermal, and physical properties of the insulation and the FRP laminate.

Ships and marine technology — Large yachts — Structural fire protection for FRP yachts

1 Scope

This International Standard applies to the structural fire protection of large FRP yachts of 24 m in length and over, and carrying up to 12 passengers. The International Standard is not applicable to vessels subject to SOLAS.

By using the heat transfer Fourier Number, the International Standard determines the equivalency of any proposed insulated FRP sandwich laminate to the model insulated sandwich laminate based on a fire tested insulated laminate approved in accordance with IMO FTP Code as a fire-resisting division.

The method considers the relevant mechanical, thermal, and physical properties of the insulation and the FRP laminate.

The technology of the elements of the insulation and FRP resistance to heat, smoke, and fire used in the International Standard and the effectiveness of the insulation are applicable in general to insulated FRP as a fire-resistant material.

This International Standard does not cover the heat, fire, smoke resistance of the attachments of insulation to the laminate, of penetrations, doors, windows, hatches, or of any other detail in insulated laminate divisions that might impair the heat, fire, and smoke resistance performance of the divisions.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 834-1:1999 + Amd 1:2012, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 9705:1993, *Fire tests — Full-scale room test for surface products*

3 Terms and definitions

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

3.1
fire-resisting division 30
fire-resisting division classified for moderate fire hazards

Note 1 to entry: Fire-resisting property is the ability of the construction to insulate/protect an area from the influence of a fire in an adjoining area by having a separating performance during a fire. Such constructions are fire-resisting bulkheads, decks, ceilings, linings, and doors.

[SOURCE: IMO FTP Code.Resolution MSC.45(65) “Test Procedures for Fire-Resisting Divisions of High Speed Craft”, Annex]

3.2
fire-resisting division 60
fire-resisting division classified for major fire hazards

Note 1 to entry: Fire-resisting property is the ability of the construction to insulate/protect an area from the influence of a fire in an adjoining area by having a separating performance during a fire. Such constructions are fire-resisting bulkheads, decks, ceilings, linings, and doors.

[SOURCE: IMO FTP Code.Resolution MSC.45(65) "Test Procedures for Fire-Resisting Divisions of High Speed Craft", Annex]

3.3
fire-restricting material
material which has properties complying with the IMO Fire Test Procedures Code

[SOURCE: IMO HSC Code, Chapter 7, Fire Safety]

3.4
length
load line length according the ICLL 1966 as amended

4 Symbols (and abbreviated terms)

Fo	Fourier Number, a number that measures heat flow
FRP	Fibre reinforced plastic
FTP	IMO Code for application of fire test procedures
HTD	Heat deflection temperature
ICLL	International Convention on Load Lines
PVC	Polyvinyl chloride
SAN	Styreneacryonitrile
Tg	Glass transition temperature
Tib_{mw}	Bulkhead insulation thickness of mineral wool
Tid_{mw}	Deck insulation thickness of mineral wool

5 Design criteria

5.1 Tests on models and equivalency

The model insulated sandwich laminate referred to in Annex A shall have a core thickness and core density, and an insulation thickness and density that are taken from the test results of a Rockwool insulated sandwich laminate, tested, and approved in accordance with the IMO FTP Code as a fire-resisting division, as referred to in Annex B.

Required details of insulation of the model insulated FRP sandwich laminate and of the insulated FRP sandwich laminate being assessed for equivalency shall be as given in Annex C.

The report certificate on the equivalency assessment is to provide the information given in Annex D.

Details of the insulation of the model insulated FRP sandwich laminate are to be used to determine the Fourier Number heat flow through the insulation to assess the Fourier Number equivalence of the insulation of any proposed insulated sandwich laminate for consideration as a fire-resisting division.

For equivalency the Fourier Number heat flow through the insulation of the proposed insulated FRP sandwich laminate is not to be greater than the Fourier Number for heat flow through the insulation of the model insulated sandwich laminate.

The HDT of the skins of the model insulated FRP sandwich laminate shall be equal to or less than the HDT of skins of the insulated FRP sandwich laminate being assessed for equivalency and shall be given and identified as to whether not post cured or post cured.

The skins of the sandwich laminates are not to be less than 3 mm.

NOTE The heat, fire, and smoke resistance of the attachments of insulation to the laminate, of penetrations, doors windows, hatches, or of any other detail in insulated laminate divisions that might impair the heat, fire, and smoke resistance performance of the divisions, are not covered by this International Standard.

The equivalency of the insulation of any proposed insulated FRP sandwich laminate, shall be assessed by comparing the Fourier Number, Fo, of that insulation with the Fourier Number of the insulation of the model insulated FRP sandwich laminate.

Equivalency exists when the Fourier Number of the insulation of the proposed insulated sandwich laminate is equal to or less than the Fourier Number of the sandwich laminate model insulation and the FRP sandwich laminate has skins and core not less than the FRP insulated sandwich laminate model.

$$Fo = (k/\rho \cdot Cp) \times (t/x^2) \quad (1)$$

where

k is the thermal conductivity of insulation [J/(s m °K)];

J is in Joules;

s is the time in seconds;

m is measurement in metres;

K is the Kelvin temperature;

ρ is the density of insulation [kg/m^3];

Cp is the thermal heat capacity of insulation [J/(kg °K)];

t is the time of exposure to fire, fire test time [s];

x is the thickness of insulation [m].

The thickness of model insulation mineral wool is given in Table 1. Thermal conductivity and thermal heat capacity of model insulation mineral wool are given in Table 2.

Table 1 — Thickness of model insulation mineral wool (ρ mw, if unknown use 112 kg/m3)

Location	Fire-resisting division 60	Fire-resisting division 30
Bulkhead	tib $_{mw}$ mm	0,70 tib $_{mw}$ mm
Deck	tid $_{mw}$ mm	0,70 tid $_{mw}$ mm

NOTE For determination of tib $_{mw}$ and tid $_{mw}$ see Annex A.

Table 2 — Thermal conductivity (k) and thermal heat capacity (Cp) of model insulation mineral wool (112 Kg/m 3)

Temperature [°C]	k [J/(s m °K)]	Cp [J/(kg °K)]
1 000°	0,40	800
700°	0,15	750

The test temperatures shall be:

— Fire-resisting division 60: 25 °C to 945 °C;

— Fire-resisting division 30: 25 °C to 841 °C.

5.2 Protection against resin ignition

The exposed surface of laminates shall be protected by insulation or coatings.

5.3 Laminate

Where an insulated sandwich laminate has been tested and approved as a fire restricting material as part of fire-resistant division in accordance with the IMO FTP Code, it shall be used to establish the model given in Annex A to verify the equivalence in accordance with this International Standard, of any proposed insulated FRP sandwich laminate having a different type, density, and thickness insulation.

5.4 Insulation

The insulation shall be fitted on the fire exposed side of the laminate. The exposed surface of the insulation shall be protected from splash or spray from fuel oil or other flammable liquids and the method of attachment shall not impair the fire-resistance of the insulation.

Main load: bearing structures within major fire hazard areas and structures supporting control stations shall be insulated such that there will be no collapse of the construction when exposed to fire for the appropriate fire protection time. The class of fire-resisting division shall be as required by the flag administration.

5.5 Other

Other aspects to be considered during the construction connections are the following:

a) quality control;

b) paint systems, surface finish;

c) penetrations, doors, hatches, windows.

6 Material testing

6.1 Qualification of insulated laminate as a fire-restricting material

The model insulated sandwich laminate referred to in Annex A shall have been tested and approved in accordance with the following tests referred to in the IMO FTP Code:

— Corner Room Test IMO MSC 40 (64);

— Room Corner Test of insulated laminate ISO 9705:1993.

The performance required is indicated in Table 3.

Table 3 — Room corner test performance

Criterion measured	Performance required
Average heat release	<100 kW
Maximum heat release	<500 kW
Average smoke production	<1,40 m^2/s
Maximum smoke production	<8,30 m^2/s
Flame spread on walls	No nearer than 0,50 m from floor in area 1,20 m distance from burner
Flaming droplets	None in the area 1,20 m distant from burner

6.2 Qualification of insulated laminate as a fire-resistant division

Compliance with IMO Resolution MSC 45 (65) using IMO Resolution A 754 (18) shall apply to load bearing and non-load bearing insulated laminates.

6.3 Resin ignition tests

The tests shall be developed from IMO FTP Code.

6.4 Resin adhesion to insulation securing pins tests

These tests, or high temperature adhesive tests as alternative, shall be considered.

6.5 Other

Other tests could be requested, depending on the specific situation.

7 Production FRP laminate testing

7.1 Fire tests

Research has shown that the temperature of an FRP laminate at the interface with the insulation varies with the thermal characteristics of the different elements of the laminate. FRP skins and PVC cores are insulants and prevent the transmission of heat through the single skin or sandwich laminate.

This means that where several different FRP laminates, with the same type, density, and thickness insulation, are to be approved by fire tests, it is advantageous to identify the critical laminate elements so that tests can be focused on the critical features of the FRP laminates.

Table 4 identifies the critical elements of the laminates of any group of different laminates, and indicates the laminates that shall be tested to cover the most critical laminate features.

The research addressed the fire protection of GRP laminates, the procedures developed will be equally applicable to other fibre types used to reinforce plastics.

Table 4 — Critical elements to be tested

Laminate	Variant	Laminate to be tested
Single skin GRP	Thickness	Thickest laminate tested
Sandwich GRP	Skin thickness	Thinnest skin laminate tested
Sandwich GRP	Core thickness	Thickest core laminate tested
Sandwich GRP	Core density	Least dense core laminate tested