U.S. Department of Homeland Security

United States Coast Guard

Commandant
United States Coast Guard

2100 2nd St SW Stop 7126
Washington DC 20593-7126
Staff Symbol: CG-52
Phone: (202) 372-1392
Fax: (202) 267-1924

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NVIC 9-97, CH - 1

NAVIGATION AND VESSEL INSPECTION CIRCULAR NO. 9-97, CHANGE 1

Subj: CH-1 to NVIC 9-97, GUIDE TO STRUCTURAL FIRE PROTECTION

1. PURPOSE. This change to NVIC 9-97 provides policy guidance and accepted interpretations of the structural fire protection regulations in 46 CFR, Chapter II-2 of SOLAS, the IMO High Speed Craft Code (HSC Code), and the IMO Mobile Offshore Drilling Unit Code (MODU Code) for U.S. flag vessels.

2. ACTION. The Commanding Officer, Marine Safety Center and Officers in Charge, Marine Inspection should use the attached guidance to interpret and apply the structural fire protection regulations. This NVIC is available on the World Wide Web at http://www.uscg.mil/hq/cg5/nvic/. Within the Coast Guard, it will be distributed by electronic means only. Internet release is authorized.

3. DIRECTIVES AFFECTED. This circular and its enclosure supersede Navigation and Vessel Inspection Circular 9-97; PFM 2-98 dated June 19, 1998, *Policy File Memorandum on the Use of Fiber Reinforced Plastic (FRP) Gratings and Cable Tray;* PFM 1-00, dated August 11, 2000, *Implementation of the FTP Code – Acceptance of Structural Fire Protection Materials for U.S. Flag SOLAS Vessels;* PFM 1-03, dated 21 July, 2003, *Acceptance of aluminum helicopter platforms;* and PFM 1-04, dated October, 2004, *Clarification of Fire Damper Policy for U.S. Flag Vessels.*

DISTRIBUTION SDL No. 155

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4. BACKGROUND. This change to the Guide to Structural Fire Protection serves four purposes: (1) It updates the structural fire protection guidance for domestic vessels in NVIC 9-97 to reflect current shipbuilding practices; (2) It adds new guidance on the SOLAS chapter II-2 structural fire protection requirements for U.S. flag vessels on international voyages; (3) It provides an explanation of the type approval requirements for materials approved under the provisions of the Mutual Recognition Agreements on Marine Equipment (MRA); and (4) It provides an explanation of the Coast Guard type approval requirements for structural fire protection materials under the provisions of the IMO International Code for the Application of Fire Test Procedures (FTP Code).

5. DISCUSSION.

a. The guidance in NVIC 9-97 has been updated in this change to reflect recent trends in the shipbuilding industry. Significant progress has been made in the design and approval of structural fire protection materials such as fire resistant glazing, fire resistant furniture and FRP gratings since the publication of NVIC 9-97. In addition, the original guidance in NVIC 9-97 for passenger ships was intended primarily for large ocean-going ships, and did not fully address the 46 CFR Subchapter K requirements for small passenger vessels.

b. The passenger, cargo and tank vessel regulations in 46 CFR provide design criteria for both domestic vessels and those on international voyages. The international requirements in 46 CFR were at one time consistent with chapter II-2 of SOLAS. Thus, if a vessel complied with 46 CFR, it met the associated SOLAS requirements. Over the years, the amendments to SOLAS have outpaced the regulations in 46 CFR. In particular, the 2000 amendments completely reorganized and updated chapter II-2 to the extent that vessels constructed to 46 CFR do not meet all of the criteria in SOLAS. There are also new requirements for items such as the construction of exterior cabin balconies. This new guide to structural fire protection has been prepared with a separate explanation within each subject area, which compares the requirements for domestic vessels with those for vessels on international voyages. The guide also covers requirements specific to the IMO HSC Code.

c. The mutual recognition agreement between the U.S. and the European Community (EC) was signed on February 27, 2004 and became effective on July 1, 2004. The mutual recognition agreement between the U.S. and Norway, Iceland and Liechtenstein which represent the European Economic Area-European Free Trade Association (EEA-EFTA) member states was signed on October 17, 2005 and became effective on March 1, 2006. The MRAs allow a manufacturer to obtain a Coast Guard type approval certificate from an EC or EEA-EFTA Notified Body. Conversely, a European approval and wheelmark for the product can be issued by the Coast Guard. A new section has been added to this NVIC to explain the MRA type approval program.

d. Type approvals for structural fire protection materials tested to the procedures in 46 CFR Part 164, Subchapter Q were previously accepted for vessels in domestic as well as international service, because the SOLAS Convention did not have mandatory fire testing procedures. After the FTP Code became a mandatory part of SOLAS, it was necessary

for the Coast Guard to develop a separate type approval program for materials installed on SOLAS ships, since the Subchapter Q test procedures are not equivalent to those in the FTP Code.

6. IMPLEMENTATION. Officers in Charge, Marine Inspection are encouraged to bring these changes to the attention of appropriate individuals in the marine industry within their zones. The guidance in this change supersedes NVIC 9-97 in its entirety, and may be applied to vessels contracted for on or after October 1, 2010.

7. DISCLAIMER. This guidance is not a substitute for applicable legal requirements, nor is it in itself a regulation. It is not intended to nor does it impose legally-binding requirements on any party. It represents the Coast Guard's current thinking on this topic and is issued for guidance purposes to outline methods of best practice for compliance with the applicable law. You may use an alternative approach if the approach satisfies the requirements of the applicable statutes and regulations. If you wish to discuss alternative approaches (you are not required to do so), you should contact the Chief, Lifesaving and Fire Safety Division (COMDT CG-5214) who is responsible for implementing this guidance at 202-372-1392. This NVIC complies with Executive Order 13422 and associated OMB Bulletin on Agency Good Guidance Practices. *See* 72 FR 3432 (Jan 25, 2007).

8. CHANGES. This NVIC will be posted on the internet at http://www.uscg.mil/hq/cg5/nvic/. Changes to the NVIC will be issued as necessary. Questions or suggestions for improvements to this NVIC should be submitted in writing to Commandant (CG-521).

9. ENVIRONMENTAL ASPECT AND IMPACT CONSIDERATIONS. Environmental considerations were examined in the development of this NVIC and have been determined to be not applicable.

10. FORMS AND REPORTS. None

KEVIN S. COOK
Rear Admiral, U.S. Coast Guard
Director of Prevention Policy

Encl: (1) Guide to Structural Fire Protection

GUIDE TO STRUCTURAL FIRE PROTECTION

Chapter 1 – General Information

Chapter 2 – Type Approval Criteria For Structural Fire Protection Materials

Chapter 3 – Construction and Arrangement

CHAPTER 1 - GENERAL INFORMATION

1.1 Introduction

This document provides guidance on the structural fire protection (SFP) requirements for merchant vessels contained in Title 46 of the Code of Federal Regulations (CFR), as well as chapter II-2 of SOLAS 1974, as amended, including the 2000 Amendments and the International Code for Application of Fire Test Procedures (FTP Code), the IMO Mobile Offshore Drilling Unit Code (MODU Code), and the IMO High Speed Craft Code (HSC Code). This guide provides technical clarification of these requirements. It does not change the intent or the contents of the regulations.

For each subject area, separate explanations of the domestic CFR requirements and the associated international SOLAS requirements are provided to highlight the differences.

1.2 Equivalencies and Design Assumptions

1.2.1 Domestic vessels

Ref: 46 CFR 24.15, 30.15, 70.15, 90.15, 108.105, 114.540, 175.540

The Code of Federal Regulations has provisions that permit deviations from the minimum prescriptive fire protection requirements, provided an equivalent level of safety is demonstrated. Requests for equivalencies should be submitted in accordance with the provisions contained in the above-referenced regulatory cites in each Subchapter. The theory of equivalence is based on the assumption that the requirements in the CFR represent one proven arrangement that affords an acceptable level of safety, and recognizes that other designs and installations may also present an equivalent level of safety for a specific vessel design.

Equivalencies can be justified through the use of calculations, engineering evaluations or test data that show an equivalent or higher level of safety will be provided. Additional information on the process of performing engineering evaluations can be found in NVIC 3-01. This guidance was specifically developed to establish a consistent process for performing engineering evaluations to be used as technical justifications for alternative designs and arrangements on Subchapter K vessels. However, its principles may be considered for application to other types of vessels on a case-by-case basis with prior approval of Coast Guard Headquarters, Lifesaving and Fire Safety Division.

Equivalency evaluations are intended for specific shipboard arrangements and are not accepted in lieu of required approval tests. For example, the type approval tests for structural insulations in 46 CFR 164.007 require that the material must be able to prevent the average temperature rise on the unexposed side of the test assembly from exceeding 139º C (250 º F) during the 60 minute fire test. If a material exceeds the required temperature rise before the 60 minute test period ends, the test is considered a failure and an engineering analysis will not be accepted to demonstrate equivalency.

In some cases, active systems such as automatic sprinklers are proposed to augment the performance of a passive barrier that does not fully meet the regulatory requirements. This arrangement might be accepted as an equivalent level of protection, if the possible failure modes and reliability of the active system are fully evaluated to ensure that the combination of the active and passive fire protection measures will perform as intended.

1.2.2 SOLAS vessels

Ref: SOLAS Regulations I-5, II-2/17

SOLAS regulation I/5 grants the Administration the authority to allow equivalents for any particular fitting, material, appliance or apparatus if it can be demonstrated that the equivalent arrangement is at least as effective as that required by the SOLAS regulations. If such a substitution is permitted, the Administration is required to notify IMO of the decision process involved, and IMO will circulate the information to the other Members of the Organization. Because of the requirement to notify IMO and the other Members, the Coast Guard accepts SOLAS equivalencies under regulation I/5 on a very limited basis.

The 2000 SOLAS amendments provide another means of approval for alternative design and arrangements that does not fall under the provisions of regulation I/5. Regulation II-2/17 allows alternative fire safety design and arrangements to deviate from the prescriptive requirements of SOLAS, if it can be demonstrated that the fire safety objectives and functional requirements of Chapter II-2 are met. This technique allows the use of performance-based fire safety engineering to validate the proposed design. Detailed guidance on regulation II-2/17 and the application of performance-based engineering can be found in IMO MSC/Circ. 1002. The Coast Guard Marine Safety Center should be notified of any alternative design and arrangements proposed under regulation II-2/17, well in advance of plan submittal to allow coordination of the project team with the Safety Center staff.

1.3 Type Approval Categories

1.3.1 Domestic vessels

Inspection Note: The domestic vessel regulations specify that structural fire protection materials must be of an approved type. This requires that they have a valid type approval certificate, based on the testing criteria in 46 CFR Subchapter Q. There are seven type approval categories for materials that are issued certificates of approval. There are also a number of materials that are required by the regulations, for which approval certificates are not issued. These materials include fire doors, fire dampers, penetration seals, and furniture and furnishings such as carpet, mattresses and draperies. These materials are accepted based on product information or test data provided by the manufacturer or the shipyard.

The type approval categories for the SFP materials required on domestic vessels are:

MATERIAL	APPROVAL SERIES
Deck assemblies	164.005
Deck coverings	164.006
Structural insulations	164.007
Bulkhead panels	164.008
Noncombustible materials	164.009
Structural ceilings	164.010
Interior finish	164.012

The testing and approval requirements for these materials are found in 46 CFR Subchapter Q with the exception of approval categories 164.005 and 164.010 which have not yet been incorporated into the regulations. Approval guidance for these materials can be found at http://www.uscg.mil/hq/cg5/cg5214/domestic_sfp.asp

1.3.2 SOLAS vessels

Inspection Note: Materials with either Coast Guard or MRA type approval under the FTP Code may also be used on U.S. flag domestic vessels. However, the fire testing criteria contained in 46 CFR Subchapter Q are not equivalent to the FTP Code or MRA requirements, and are not acceptable on vessels requiring SOLAS compliance.

The Coast Guard has sixteen FTP Code type approval categories for SFP materials that are required on SOLAS vessels. The FTP Code is mandatory for ships constructed on or after July 1, 1998 as required by the 2000 SOLAS Amendments.

The FTP Code contains three sections. Section I is the FTP Code itself. Section II contains the fire test procedures referred to in the FTP Code, which are IMO Resolutions that were adopted at various times prior to the development of the Code. Section III is a set of relevant fire test procedures that address materials and equipment not in the Code.

Section I consists of the FTP Code and its three annexes. Annex 1 presents the required test procedures to be used in testing materials for type approval. Annex 2 is a listing of products which may be installed without testing or type approval. Annex 3 contains grandfather provisions for existing fire test standards, however, the information in Annex 3 is no longer applicable as all of the existing test standards expired on December 31, 2003.

Annex 1 is divided into 9 parts, each dealing with a specific test procedure as follows:

1. Part 1 - Noncombustibility test
2. Part 2 - Smoke and toxicity test
3. Part 3 - Test for "A" and "B" Class divisions
   Appendix 1 – Thermal radiation test supplement
   to fire resistance tests for windows on A and B class divisions
   Appendix 2 – Continuous B class divisions
4. Part 4 - Test for fire door control systems
5. Part 5 - Test for surface flammability
6. Part 6 - Test for primary deck coverings
7. Part 7 - Test for vertically supported textiles and films
8. Part 8 - Test for upholstered furniture
9. Part 9 - Test for bedding components

Each of the nine parts of Annex 1 refers to test procedures described in the Assembly Resolutions contained in Section 2. They also may contain modifications to the referenced test procedures, such as requiring different specimen sizes, test conditions or acceptance criteria. The modified test procedures and acceptance criteria in Annex 1 take precedence over the basic Assembly Resolutions.

SOLAS chapter II-2 does not have regulations that explain the test procedures for approval testing of materials. Instead, chapter II-2 requires the use of approved materials meeting the FTP Code. For example, SOLAS regulation II-2/9.3.2.4 requires certain exposed interior surfaces to "have low flame-spread characteristics in accordance with the Fire Test Procedures Code." To determine which test procedures are applicable, it is necessary to refer to Annex 1 to determine the applicable test requirements. In this case, Part 5 of Annex 1 contains the surface flammability test procedures. The basic test procedure is IMO Res. A.653 (16). Part 5 also contains additional requirements that are to be applied. For example, the acceptable total heat release of floor coverings stated in Res. A.653(16) is modified by paragraph 5.2.1 of Part 5.

The nine parts of Annex 1 of the FTP Code form the basis for the Coast Guard type approval program for materials installed on SOLAS certificated vessels. For simplicity, the same approval series numbering designations used for CFR approvals have been retained for FTP Code type approvals, except that the first digit after the decimal was changed from 0 to 1 to indicate the different service:

MATERIAL	**APPROVAL SERIES**
Deck assemblies	164.105

Primary deck coverings	164.106
Structural insulation	164.107
Bulkhead panels	164.108
Noncombustible materials	164.109
Structural ceilings	164.110
Draperies, curtains and suspended textiles	164.111
Interior finish	164.112
Floor coverings	164.117
Fire doors	164.136
Windows	164.137
Penetration seals	164.138
Fire dampers	164.139
Bedding components	164.142
Upholstered furniture	164.144
Fire door control systems	164.146

1.4 Applicable Regulations

1.4.1 Domestic vessels

Ref: Title 46, Code of Federal Regulations (46 CFR)

The requirements for structural fire protection aboard domestic vessels are contained in Title 46 of the Code of Federal Regulations (46 CFR). Title 46 is divided into subchapters, each dealing with a specific type of vessel or specific aspects of construction. These subchapters may be purchased from:

Superintendent of Documents
U.S. Government Printing Office
710 North Capitol Street, NW
Washington, D.C. 20401

The regulations are also posted on the Government Printing Office (GPO) website:

http://www.gpoaccess.gov/cfr/index.html

The vessel regulations in Title 46 of the Code of Federal Regulations may be found in the following Subchapters and Parts:

Uninspected Vessels	Subchapter C	46 CFR Parts 24-26
Towing Vessels	Subchapter C	46 CFR Part 27
Commercial Fishing Industry Vessels	Subchapter C	46 CFR Part 28
Tank Vessels	Subchapter D	46 CFR Parts 30-40
Passenger Vessels	Subchapter H	46 CFR Parts 70-89
Cargo and Miscellaneous Vessels	Subchapter I	46 CFR Parts 90-106
Mobile Offshore Drilling Units	Subchapter I-A	46 CFR Parts 107-109
Small Passenger Vessels Carrying More Than 150 Passengers or With Overnight Accommodations for More Than 49 Passengers (Under 100 gross tons)	Subchapter K	46 CFR Parts 114-122
Offshore Supply Vessels	Subchapter L	46 CFR Parts 125-134
Equipment, Construction, and Materials: Specifications and approvals	Subchapter Q	46 CFR Parts 159-164
Nautical Schools	Subchapter R	46 CFR Parts 166-169
Small Passenger Vessels (Under 100 Gross Tons)	Subchapter T	46 CFR Parts 175-187
Oceanographic Vessels	Subchapter U	46 CFR Parts 188-196

Most of the domestic vessel regulations contain very little information in regard to structural fire protection. The passenger vessel regulations in Subchapters H and K have comprehensive construction details for items such as fire doors, windows, penetration seals and fire dampers, which are also accepted for use on other domestic vessels including cargo ships, tank ships, MODUs, OCS facilities and OSVs.

1.4.2 SOLAS vessels

Ref: SOLAS Chapter II-2

The requirements for structural fire protection aboard SOLAS vessels are contained in Chapter II-2 of the SOLAS Convention, as amended. Regulatory cites in this NVIC refer to the 2000 SOLAS amendments. The International Code for the Application of Fire Test Procedures (FTP Code) and the International Code for Fire Safety Systems (FSS Code) are stand-alone documents that are referenced in the SOLAS regulations.

The SOLAS Convention and Codes are available from:

The International Maritime Organization
4 Albert Embankment
London SE1 7SR
UK

IMO publications may also be purchased at various bookstores throughout the world. A list of authorized sales agents is posted on the IMO website at www.IMO.org.

1.4.3 Combined service vessels

In cases where a vessel is subject to the domestic structural fire protection regulations as well as SOLAS chapter II-2, the applicable criteria are determined based on the type of vessel being considered. The Coast Guard accepts compliance with SOLAS Method IC using Coast Guard approved structural fire protection materials tested to the FTP Code as equivalent to meeting the CFR requirements in Subpart 92.07 of Subchapters I for cargo ships and Subpart 32.57 of Subchapter D for tank ships. Cargo and tank ships constructed to SOLAS Methods IIC and IIIC which include combustible materials of construction are not eligible for certification as U.S. flag vessels.

Interpretations of the SOLAS regulations that have been approved by IMO may be applied as appropriate (see NVIC 06-05). In situations where the CFR criteria are more conservative than the SOLAS criteria, this document should be consulted for applicable interpretations.

Passenger vessels that comply with the structural fire protection requirements of SOLAS are not considered equivalent to Subchapter H or Subchapter K. If a passenger ship is required to comply with both SOLAS and the CFR regulations, the plan review criteria are determined on a case-by-case basis. In general, when differences between SOLAS requirements and the CFR are encountered, designers should expect the Coast Guard to apply the more conservative requirements.

1.4.4 Alternate Compliance Program

The Alternate Compliance Program (ACP) was developed for ships that must comply with Coast Guard regulations as well as SOLAS and classification society rules. Regulatory supplements have been developed in conjunction with the Coast Guard to allow classification societies to perform one comprehensive plan review, thereby eliminating the need for a duplicate Coast Guard review. The details of this program can be found in 46 CFR 8.4. Vessels that participate in ACP are reviewed to class society rules, SOLAS and the approved U.S. Supplement, which results in an equivalent level of fire protection to that required by the CFR Subchapters.

The Alternate Compliance Program is applicable to passenger ships (but not to passenger ships subject to Subchapters T and K) as well as MODUs and cargo and tank ships constructed to SOLAS Method 1C construction standards.

1.5 Type Approval Procedures

Ref: 46 CFR 159, 46 CFR 164
SOLAS: FTP Code

Inspection Note: All type approval certificates are entered into MISLE after they are signed. The type approval contains more detailed information than is available in CGMIX. Type approvals can be found under the "Approved Equipment" and "CG approved equipment" buttons. The type approval data base is searchable by approval category number. Details of the type approval are listed under the "description" tab, including intended application and any limitations. Drawing numbers, reference to the manufacturer's approved design manual or installation instructions and other details that can be used to verify the correct installation are listed under the "identifying data" tab. Additional information is also available under the "documents" tab for some approvals. If additional drawings or manuals are necessary to perform inspections, they may be requested from the shipyard or installer.

The vessel regulations require all materials installed on U.S. Flag vessels to be Coast Guard approved. There are two accepted type approval programs. A type approval may be issued by the Coast Guard, or a type approval may be issued by a European Notified Body under the Mutual Recognition Agreement on Marine Equipment (MRA). Manufacturers may have only one type approval, issued by either the Coast Guard or an MRA Notified Body, and should not have two type approvals for the same product at the same time under both systems.

Materials intended for special applications or one time only installations may be accepted on a case-by-case basis without type approval. These items are reviewed by Commandant (CG-5214) for application to specific vessels through case-by-case acceptance letters instead of type approval certificates.

Coast Guard Type Approval Program

The Coast Guard does not perform testing of structural fire protection materials for approval. The manufacturer is responsible for submitting the material intended for approval to an independent laboratory that is accepted by the Coast Guard under the provisions in 46 CFR 159. A listing of accepted laboratories can be found at:

http://cgmix.uscg.mil/eqlabs/

Applications for type approvals under both the CFR criteria and the FTP Code criteria follow the same procedures. Manufacturers wishing to apply for type approval should consult our web page at http://www.uscg.mil/hq/cg5/cg5214/sfpguide.asp and review the general information presented regarding type approval procedures. The submittal package should be prepared in accordance with the information provided on our web site. The Coast Guard will review the submittal and advise the manufacturer of any supplemental fire test requirements needed for the specific application. The manufacturer should then contact a Coast Guard accepted independent laboratory to have the testing performed. All materials submitted for type approval must be under the laboratory's production control, or follow-up program (See

NVIC 2-06). This requires the independent laboratory to visit the factory prior to conducting the tests to witness the manufacture of the test specimen. When the laboratory testing is completed, the manufacturer is responsible for submitting copies of the test report, pertinent component drawings, installation instructions and the follow-up services agreement to the Coast Guard for review.

The Coast Guard will review the submitted information to verify compliance with the applicable acceptance criteria, and issue a type approval certificate with the required conditions of the approval. After the type approval certificate is issued, the follow-up program will require the laboratory to make periodic factory visits to ensure that the raw materials and production methods for the approved materials have not changed, and that the materials being produced remain representative of the specimen that was tested.

Type approval certificates are valid for a five year period and may be renewed upon request of the manufacturer. The request for renewal must include certification that the approved product has not been changed, and is under an active follow-up program with the test laboratory.

There is no fee for a type approval certificate issued by the Coast Guard, however, the manufacturer must pay the laboratory directly for all expenses related to the testing and follow-up program. Questions concerning laboratory costs and testing schedules should be directed to the laboratory.

The Coast Guard does not accept the approvals of other governments, classification societies, Marine Equipment Directive (MarED) certificates or EC wheelmarks as being equivalent to Coast Guard type approval. (MarED refers to the European Marine Equipment Directive, and the EC wheelmark is a mark of conformity that is permitted to be affixed to products that comply with the testing requirements of the MarED.)

Mutual Recognition Agreement (MRA) Approval Program

Inspection Note: MRA approvals are issued by European Notified Bodies which may include testing laboratories or classification societies. The Coast Guard does not review the approvals and does not maintain a data base of acceptable materials. Any inspection questions regarding an MRA type approval should be directed to the manufacturer of the material or the organization that issued the approval. A data base of MRA approved materials can be accessed at www.mared.org.

Under the provisions of the US/European Community (EC) MRA signed on February 27, 2004, and the US/ European Economic Area-European Free Trade Association (EEA-EFTA) MRA signed on October 17, 2005, it is possible for a manufacturer to obtain a Coast Guard type approval certificate from an EC or EEA-EFTA Notified Body. Conversely, a European type approval and wheelmark for the product can be issued by the Coast Guard. A Coast Guard type approval issued by a European Notified Body is equivalent to a type approval issued by the Coast Guard and is fully accepted for any application where the regulations require the installation of Coast Guard type approved materials. The MRA type approval

program is intended to offer manufacturers the ability to receive Coast Guard type approval from either organization, thereby reducing testing and administrative costs.

Under the provisions of the MRA, materials that have a type-examination certificate (Module B), and a product quality assurance certificate (Modules D, E, or F) are eligible to receive a Coast Guard type approval.

Approved materials will have both a Notified Body number and a unique product identifier number on the certificate. The format is:

USCG approval category/Notified Body number/ Unique product number

As an example, a Coast Guard approved noncombustible material approval issued by Notified Body 0038 will have approval number:

164.109/EC0038/0500045

The module B certificate for the same material would be:

164.109/EC0038

Since a unique product identifier number does not appear on the Module B certificate, it is an indication that this is not a type approval certificate.

Annex II of the MRA lists the structural fire protection materials that are eligible for approval. The below listed structural fire protection materials that have been tested in accordance with the FTP Code are included in the MRA (see NVIC 08-04 CH-1 for additional details):

MRA Category Description	**USCG Approval Category**	**Council Directive 96/98/EC on Marine Equipment**
Primary deck coverings	164.106	A.1/3.1
A and B-Class division fire integrity	164.105 (deck assembly)	A.1/3.11
	164.107** (structural insulation)	A.1/3.11
	164.108** (bulkhead panels)	A.1/3.11
Structural ceiling	164.110 (structural ceiling)	A.1/3.11
Non-combustible material	164.109	A.1/3.13
Draperies, curtains & other suspended textiles	164.111	A.1/3.19
Surface materials and floor coverings with low flame-spread characteristics	164.112*** (interior finish)	A.1/3.18
	164.117 (floor coverings)	A.1/3.18

Fire doors	164.136*	A.1/3.16
Penetrations through A-class divisions by electric cables, pipes, trunks, ducts etc.	164.138	A.1/3.26
Penetrations through B-class divisions by electric cables, pipes, trunks, ducts etc.	The Coast Guard does not have an approval series designation for B-class penetrations	A.1/3.27
Dampers	164.139	A.1/3.22
Bedding components	164.142	A.1/3.21
Upholstered furniture	164.144	A.1/3.20
Fire door control systems	164.146	A.1/3.17

* Limited to fire doors without windows and doors with total window area of 645 cm^2 (100 in^2), or less, in each door leaf. Approval is limited to the maximum door size and type of frame tested.

** Does not include A or B-class windows.

*** Limited to exposed surfaces of ceilings, walls, and floors. Does not apply to pipes, pipe coverings, or cables.

1.6 Definitions

Definitions applicable to structural fire protection installations are listed in Subchapter H (46 CFR 72.05-5) and Subchapter K (46 CFR 114.400). Additional clarification of these subjects and other issues contained in this NVIC are provided below:

Annealed glass – Regular polished plate, float, sheet, rolled, and some patterned surface glasses are examples of annealed glass. Annealed glass has been subjected to a slow, controlled cooling process during manufacture to control residual stresses so that it can be cut on site. Normally not fire rated.

Approved materials - Materials which have been tested to the criteria in 46 CFR Subchapter Q or the IMO FTP Code and have been assigned a type approval number.

Area of refuge – A safe haven on Subchapter K vessels that is separated from the normally occupied areas, where passengers and crew can take shelter from fire and flooding for the maximum amount of time necessary to evacuate the vessel, or one hour, whichever is less.

Automatic fire damper - A ventilation duct closure device that is closed by a heat actuated mechanism and is also capable of manual operation. Fire dampers are installed in ducts that penetrate fire barriers to prevent fire spread between adjoining areas. Dampers are normally held open by the actuating mechanism and close upon melting of a fusible link, or an electric or pneumatic signal that causes the actuator to close the damper.

Bulkhead panels - Rigid sections of noncombustible panels that are fitted together to form interior spaces. Each panel is joined to adjacent panels and to the overhead and deck with approved joiner construction consisting of metal tracks and connecting pieces. Bulkhead panels are not load bearing members and are approved as B-0 or B-15 divisions.

C-class smoke tight (C' or C prime)- A type of barrier required in certain areas on Subchapter K vessels, typically constructed of sheet metal, to form barriers against smoke movement between spaces adjacent to areas of refuge and embarkation stations. C-class smoke tight construction is made intact with the main structure of the vessel, and any penetrations through the barrier are specifically sealed against the passage of smoke. These barriers are not required to pass any fire endurance testing.

Ceiling - A horizontal partition below the overhead steel deck structure, usually used for decoration. Ceilings may be directly attached to the overhead structure or suspended at a distance below the steel deck. A ceiling is not considered part of the overhead deck but in some designs specific ceiling panels are tested along with the steel deck to form an A-class barrier.

Cold service piping – Piping systems used to deliver refrigerants for refrigeration systems or chilled water for air conditioning systems.

Core – The metal component of A-class divisions. Steel vessels are constructed with bulkheads and decks that have 3-4 mm thick steel plating that is covered with approved structural insulation. The insulation limits heat transfer to the metal core, preventing fire spread to the other side of the division. On aluminum vessels, the insulation also limits the temperature of the core to prevent it from fire damage.

Combustible material - Any material that does not meet the noncombustibility test performance criteria in 46 CFR 164.009 or the FTP Code Annex 1 Part 1, or that does not meet the qualifications as an inherently noncombustible material without testing. See section 2.5.

Concealed Space - The space between bulkhead and ceiling panels and the adjacent structural steel bulkheads or decks. Synonymous with "hidden spaces". Concealed spaces are not void spaces.

Continuous B-Class ceiling - A B-class ceiling assembly that extends throughout the area where it is installed and terminates only at A-Class or B-class bulkheads of the same or higher rating. If a continuous B-class ceiling is installed, the bulkheads beneath may terminate at the ceiling instead of extending to the overhead steel deck. Special approval testing procedures apply to continuous ceilings. See section 2.6.

Deck covering - A structural insulation material approved under 46 CFR 164.006 that is installed on the top side of steel deck plating to form A-class divisions on domestic vessels. Not equivalent to SOLAS primary deck coverings.

Deck overlays - Materials used for leveling or finishing purposes on walking surfaces. The domestic vessel regulations in the CFR permit the use of any material as an overlay if not greater than 9.5 mm (3/8 inch) in thickness. For simplicity, overlays are considered to be the top 9.5 mm of the deck surface and may consist of multiple layers of materials. Deck overlays may be installed above the steel deck or on top of an approved deck covering. There are no equivalent provisions for SOLAS vessels.

Draft stop - A noncombustible barrier installed in the concealed space above ceilings or behind bulkhead linings for the purpose of preventing or slowing fire and smoke spread.

Fiber reinforced plastics (FRP) - A composite laminate of woven glass fabric or chopped fibers held together by a resin binder. The glass fibers are noncombustible, but the resin is

not. Because of this, FRP materials are considered combustible materials. Resins may be general purpose type or fire retardant, which are tested to minimum flame spread standards. Fire retardant resins are required by Subchapter T for the construction of small passenger vessels.

Fire endurance - The ability of a structure or component to prevent the passage of flame, smoke and the transmission of heat for a specified time period. Synonymous with "fire rating".

Fire load - The amount of combustibles within a space that are available for combustion. Fire load is measured by summing the total mass of the combustibles and dividing by the deck area, and is expressed in kg/m^2 or lbs/ft^2.

Fire rated caulking – A flexible sealant used to seal gaps around B-class penetrations. Fire rated caulking materials are components of listed through-penetration firestop systems that are designated as fill, void or cavity materials. These are proprietary materials installed at the job site in accordance with the application instructions provided with the product and with the instructions specified in the individual joint system, perimeter fire containment system or through-penetration firestop system. These materials are not type approved, since their use is generally limited to exposed areas of approximately 12 mm (1/2 inch) or less.

Fire rated glass – Glazing that has been tested to Annex 1, Part 3 of the FTP Code. This type of glass usually consists of several layers of heat treated glass that are laminated together with an interlayer of translucent gel. When the glass is exposed to a fire, the gel turns opaque to prevent the transmission of radiant heat.

Fire resistant furnishings - A term applied to combustible materials such as furniture, carpeting, draperies, and cushions used on domestic vessels. Materials which are qualified as fire resistant furnishings have been tested to minimum standards to ensure that they will not readily ignite when exposed to a limited heat source such as a discarded cigarette. Fire resistant furnishings are not type approved, but are accepted on the basis of manufacturer's data sheets.

Fire risk - A term used to classify the relative fire hazard of similar type spaces that may contain different amounts of combustible materials or ignition sources. For example, auxiliary machinery spaces of little or no fire risk (SOLAS type 10) do not contain machinery having a pressure lubrication system. If a pressure lubrication system is present, the space is considered an auxiliary machinery space of moderate fire risk (SOLAS type 11), which requires the perimeter bulkheads to have a higher fire rating.

Furniture and furnishings of restricted fire risk – Similar to fire resistant furnishings, except on SOLAS vessels. These materials are tested to the FTP Code. Materials which successfully pass the required tests are issued type approvals.

Grounds – Small filler pieces, brackets, framing, etc. used as shims to align and mount bulkhead panels to stiffeners and similar structure.

Incombustible – An obsolete term in the CFR meaning noncombustible.

Independent testing laboratory - A laboratory meeting 46 CFR 159.010. To qualify, a laboratory must demonstrate that they are not owned or controlled by a manufacturer, vendor or supplier of the types of materials they are accepted to test on behalf of the Coast Guard.

Interior finish - The exposed decorative laminate or other surface materials applied to bulkhead and ceiling panels. Interior finishes can be applied to ceilings, walls, doors, and floors although different testing requirements apply in different locations. SOLAS refers to these materials as "exposed surfaces", except that materials located in concealed spaces are called "surfaces".

Joiner construction – B-class or C-class bulkhead panel construction.

Laminated glass – A type of safety glazing composed of two or more pieces of glass, each piece being either tempered glass, heat strengthened glass, annealed glass or wired glass, bonded to an intervening layer or layers of resilient plastic material. Laminated glass does not provide any fire resistance rating unless specifically tested for this purpose.

Lightweight construction – A-class bulkhead panels typically consisting of sandwich construction with noncombustible insulation held between thin sheets of steel. These bulkheads are used in non-load-bearing applications and do not have a steel core plate.

Noncombustible – A material that has been tested in accordance with 46 CFR 164.009, Part 1 of Annex 1 of the IMO FTP Code, or that is inherently noncombustible. See section 2.5.

Open deck - A deck area that is open to the weather on one or more sides via permanent openings. Open deck areas that have a canopy or roof are considered interior or enclosed spaces if any area under the overhead is more than 5 m (15 feet) from the nearest opening to the weather.

Penetration – A term used in this NVIC to describe the passage of shipboard services such as electrical cables and piping through fire rated bulkheads and decks. Approved penetration seals are provided to seal the openings in fire rated bulkheads where they are penetrated by cables and pipes.

Primary deck covering – On SOLAS ships, the primary deck covering is the first layer of material above the steel deck plate. It may or may not be covered by a floor covering. Primary deck coverings do not contribute to the fire endurance of the deck, but have limited surface flammability and smoke and toxic gas production. There is no equivalent material on domestic ships.

Public space - Public spaces are accommodation spaces where passengers would be expected to gather, including halls, dining rooms, lounges, cafes, and other permanently enclosed spaces.

Restricted approval – A type approval that requires the approved material to only be installed in one configuration with the fire hazard on one side, usually because the material was only tested with a fire exposure from one side. For example, certain windows can only be installed in exterior locations because they are non-symmetric construction and were not tested with a fire exposure from both sides.

Safety areas – Safety areas are defined as control stations, stairways and stairtowers, corridors, embarkation stations and areas of refuge. Except for control stations, safety areas are considered areas where passengers would take refuge during a fire including escape routes leading to those areas. Open deck spaces that form part of the escape path to areas of refuge or embarkation stations are considered safety areas, which are type (4) spaces and not type (13) spaces.

Safety glazing or safety glass – Tempered or laminated glass that breaks into small pieces if fractured instead of large sharp sections. Safety glazing is not fire rated unless specifically tested for this purpose.

Stairtower – A vertical means of escape through more than two deck levels. Stairtowers are vertical trunks that are completely enclosed by A-class fire barriers and contain a continuous stairway from the bottom level to the top, with self-closing A-class fire doors at each intervening deck level.

Stairway – A vertical means of escape between two deck levels. Stairways penetrate only one deck, and are enclosed by A- or B-class bulkheads and doors at only one level.

Standard fire test (Subchapter Q) – A fire endurance test of structural insulations and bulkhead panels to determine if they qualify as A-class or B-class divisions. A specimen of the material is mounted in a full scale laboratory furnace with gas burners that are controlled to expose the test specimen to flames and heat that follow a standard time-temperature curve defined as follows:

At the end of 5 minutes	538º C	(1,000 º F)
At the end of 10 minutes	704º C	(1,300 º F)
At the end of 30 minutes	843º C	(1,550 º F)
At the end of 60 minutes	927º C	(1,700 º F)

This test is conducted with the furnace under negative pressure.

Standard fire test (FTP Code) – A fire endurance test of structural insulations, bulkhead panels, doors, windows, fire dampers and penetration seals to determine if they qualify as A-class or B-class divisions. A specimen of the material is mounted in a full scale laboratory furnace with gas burners that are controlled to expose the test specimen to flames and heat that follow a standard time-temperature curve defined as:

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

Where T is the average furnace temperature, and t is the time in minutes. The curve will pass through the following points:

At the end of 5 minutes	576º C	(1,069 º F)
At the end of 10 minutes	679º C	(1,254 º F)
At the end of 30 minutes	841º C	(1,546 º F)
At the end of 60 minutes	945º C	(1,733 º F)

This test is conducted with the furnace under positive pressure.

Steel or equivalent metal – Noncombustible materials that have the same structural strength and fire resistance as steel. In the case of aluminum alloy, this requires the application of structural insulation to both sides of the bulkhead or deck to prevent fire damage (loss of structural strength) to the core. An A-0 steel bulkhead consists of steel plate without applied insulation. An A-0 aluminum bulkhead is aluminum plate insulated on both sides.

Stepped main vertical zone – A configuration where the main vertical zone bulkhead on one deck does not align with the main vertical zone bulkhead on the deck above or below. The deck area between the two bulkheads is considered to form part of the main vertical zone bulkhead and is subject to the higher MVZ bulkhead insulation criteria instead of the ordinary deck insulation criteria.

Structural ceiling – Type approval categories 164.010 and 164.110 for B-class continuous ceiling panels that have been tested in combination with the overhead steel deck to form A-class divisions.

Substrate – The material to which veneers and other surface finishes are applied. Typically an interior finish is applied to a bulkhead panel, which is considered the substrate.

Surface flammability – A relative measure of the speed at which flames propagate over the surface of a combustible material. Interior finishes in some areas are required to have restricted surface flammability, which is synonymous with low flame spread characteristics.

Symmetric – A fire barrier that provides equivalent protection against fire exposure on either side.

Tempered glass – A type of safety glass that is specially heat treated or chemically treated glass that cannot be cut, drilled, ground, or polished after treatment without fracture. When fractured, the entire piece breaks into small particles. Tempered glass is not normally tested for fire endurance and does not provide the same level of protection as fire-rated glass. Certain types of tempered glass in limited sizes may provide some degree of fire resistance.

Tight fitting – A term used in this NVIC to describe the fit between structural elements and openings made in B-class bulkheads for the passage of cables, pipes, ventilation ducts and other services. To prevent the passage of fire through the gaps around the penetrating item, the space between the penetrating item and the bulkhead should not exceed 2.5 mm or should be filled with a fire-rated caulking. Where steel or aluminum is welded to bulkheads and decks, continuous welding is not required.

Trunk – Enclosed vertical shafts for the passage of pipes, electrical cable, ventilation ducts or stairways that pass through more than one deck.

Void spaces - Very low fire load, unoccupied spaces that are separated from adjoining areas by metal bulkheads and decks. Void spaces have no storage of combustibles but may have limited amounts of electric cables. Machinery installation in void spaces is limited to low hazard machinery in accordance with 46 CFR 72.05-5 (d)(2), 46 CFR 114.400 or SOLAS regulation II-2/9.2.2.3.2.2(10).

Wire inserted glass - Glazing that has reinforcing wire mesh embedded during casting. The wire mesh prevents the glass from breaking into separate pieces and falling out of the frame during fire exposure. Also called wired glass.

1.7 Acronyms

ACP……Alternate Compliance Program

ASTM…….American Society for Testing and Materials
CFR…….Code of Federal Regulations
CPSC……..U.S. Consumer Product Safety Commission
FRP……Fiber Reinforced Plastic
FTP……..Fire Test Procedures
HSC……..High Speed Craft
IEEE……..Institute of Electrical and Electronic Engineers
IMO……International Maritime Organization
ISO……..International Organization for Standardization
MarED……Marine Equipment Directive
MISLE…….Marine Information for Safety and Law Enforcement
MODU…….Mobile Offshore Drilling Unit
MRA……..Mutual Recognition Agreement
MVZ……..Main Vertical Zone
NFPA……..National Fire Protection Association
OCMI…….Officer in Charge, Marine Inspection
OCS…….Outer Continental Shelf
OSV……Offshore Supply Vessel
SNAME……Society of Naval Architects and Marine Engineers
SOLAS…….Safety of Life at Sea Treaty
SFP……...Structural Fire Protection
UL……...Underwriters Laboratories, Inc
USSG……United States Standard Gauge

CHAPTER 2 - TYPE APPROVAL CRITERIA FOR STRUCTURAL FIRE PROTECTION MATERIALS

2.1 Deck Assemblies

2.1.1 Domestic vessels

Ref: Approval series 164.005

Deck assemblies, or floating floors, are applied to the top side of decks to form A-60 divisions. These materials are sometimes preferred in accommodation areas to reduce shipboard noise and vibration. Insulation intended for installation to the underside of the deck is approved under approval series 164.007.

Floating floors are typically constructed of a layer of mineral wool applied directly to the steel deck plating, covered by a solid walking surface composed of several layers of noncombustible materials. Specific manufacturer's drawings and installation specifications are noted on the type approval certificates to ensure compliance with the terms of the approval.

The FTP Code requires that materials used in deck assemblies must first be tested for noncombustibility under Annex 1, Part 1. If any adhesives are used in the deck assembly, they are not required to be non-combustible, but they must have low flame spread characteristics as determined by Annex 1, Part 5 of the FTP Code and should be included in the follow-up program. The complete deck assembly must be tested for fire endurance in accordance with the FTP Code, Annex 1, Part 3.

2.1.2 SOLAS vessels

Ref: Approval series 164.105, MRA approval series A.1/3.11, FTP Code Annex 1, Part 3

The testing and approval requirements for deck assemblies are identical for both domestic and SOLAS vessels.

2.2 Deck Coverings

2.2.1 Domestic vessels

Ref: 46 CFR 164.006

Inspection Note: Approved deck coverings are approved for installation at a minimum thickness for an A-60 rating. The minimum required thickness for each approved deck covering is listed on the type approval certificate and in MISLE.

Deck coverings approved under 46 CFR 164.006 are structural insulations that are applied to the topside of decks to form A-60 divisions. They are different from the 164.005 approval category because they usually consist of a single layer of troweled-on mastics. Typical

materials in this category are magnesium oxychloride cements and similar materials that are applied to the topside of the steel deck plating and used to form a level walking surface. The material is secured to the deck with an adhesive layer or steel clips that are covered during installation.

The 46 CFR 164.006 approval test uses a small-scale furnace with a specimen size of 305 mm x 685 mm (12 in by 27 in). The deck covering material is applied to the topside of a 6 mm (1/4 inch) thick steel plate at the manufacturer's recommended thickness for A-60 construction. The assembly is tested without any floor coverings or overlays.

The specimen is installed on the top of the test furnace with the flame exposure applied to the underside of the steel plate. Two tests are conducted. The first test measures the amount of smoke given off when the test furnace is heated to the standard decking curve reaching 740º C (1,700º F) at the end of one hour. The amount of smoke obscuration is limited to 50 % light transmission at the end of one hour. The second test uses the standard ASTM E-119 time temperature curve to verify that the deck covering is capable of limiting the average temperature rise to 139º C (250º F) above the starting temperature. Deck coverings approved in this category are not required to be noncombustible. Instead, a limit of 0.12 grams per cubic centimeter is placed on the organic carbon content of the material to restrict the amount of combustible components in the compound.

2.2.2 SOLAS vessels

Neither SOLAS nor the MRA have equivalent test criteria for A-60 deck covering materials applied to the topside of decks. SOLAS has requirements for primary deck coverings, which are approved under approval series 164.106 (see paragraph 2.7.2), however this test determines the surface flammability, smoke and toxicity characteristics of the material and does not test its ability to function as an A-60 structural insulation. If it is necessary to provide an A-60 rating using materials applied to the top of the steel deck, a deck assembly approved under series 164.105 should be used.

2.3 Structural Insulation

Structural insulation is a noncombustible material that is specifically tested and approved as a component of A-class divisions. Insulation that is used to provide thermal protection to piping is a different material that is addressed in section 2.10.

2.3.1 Domestic vessels

Ref: 46 CFR 164.007

Inspection Note: The approved nominal density and minimum thickness of structural insulations are listed on the type approval certificate and in MISLE. The installed insulation must be within the specified density range, and must equal or exceed the minimum thickness to satisfy the conditions of approval. To allow for typical manufacturing production tolerances, variations of ± 10 % of the nominal density are accepted.

The required type approval tests for A-60 structural insulations are described in 46 CFR 164.007. All materials submitted for approval in this category must first pass the required test for noncombustible materials under 46 CFR 164.009.

46 CFR 164.007 is a small-scale furnace test that evaluates the fire endurance of a 1000 mm x 1500 mm (40 in by 60 in) specimen subjected to a one hour fire exposure. In the test, the insulation is applied to a 5 mm (3/16 inch) steel plate that is mounted in the test furnace with the insulation exposed to the fire. The furnace is then controlled at the ASTM E-119 standard time-temperature curve for a one hour period. The acceptance criteria require that the insulation must prevent the passage of flame and the emission of appreciable volumes of smoke and toxic gases from the unexposed surface during the 60 minute test period, and must also prevent the temperature on the unexposed side of the bulkhead from exceeding an average temperature rise of 139° C (250º F) above ambient, and a maximum temperature rise of 180° C (325º F) above ambient at any one thermocouple.

Structural insulation tested in a vertical (bulkhead) test will be given type approval for application to either bulkheads or decks.

If a manufacturer requests approval for a structural insulation manufactured at different densities, approval tests are conducted on the lowest and highest density. The type approval is valid for the entire range of densities between the two, at the minimum thickness tested. If different densities are tested at different thicknesses, the type approval certificate is restricted to the actual densities and thicknesses tested.

Coast Guard type approval certificates list the minimum approved thickness of insulation needed for an A-60 rating. Additional fire tests are not needed to determine the thickness of insulation required for A-30 and A-15 protection if the insulation is a homogeneous material. In this case, the required thickness needed for A-30 and A-15 divisions can be calculated by multiplying the approved A-60 thickness by 75 % for 30 minutes of protection and by 50 % for 15 minutes of protection. The needed thickness of non-homogeneous A-30 and A-15 insulations is determined through fire testing.

The preferred means of attachment for structural insulation is to use the pins, clips and wire mesh that were used in the approval test and referenced in the manufacturer's approved instructions. However, the Coast Guard will also accept the use of a generic installation method using steel pins 3 mm (1/8 inch) or greater in diameter welded to the bulkhead or deck plate in a 30 cm (12 inch) square grid pattern. The insulation is pushed onto the pins and secured with steel clips, at least 3 cm (1-1/4 inch) in diameter. There is no requirement to install wire mesh in addition to the steel clips, but metal wire mesh may be used if desired.

Inspection Note: The steel clips applied to secure structural insulation should be pushed onto the pins until snug with the insulation surface. The clips should not compress the insulation to less than the required thickness.

Inspection Note: Field application of spray-on insulation is required to follow the approved installation procedures, including the correct mixing ratio of the insulation components, along with specific metal surface cleaning and preparation. Adherence to the approved installation procedures that are listed in the type approval and manufacturer's installation instructions is necessary to ensure proper adhesion of the insulation to the steel core.

2.3.2 SOLAS vessels

Ref: Approval series 164.107, MRA approval series A.1/3.11, FTP Code, Annex 1, Part 3

Inspection Note: Structural insulations approved under approval series 164.107 are subjected to two different tests for application to bulkheads and decks. Typically, a greater thickness of insulation is needed for bulkhead applications than deck installations. The type approval should be consulted to confirm the minimum approved thickness for each orientation.

Inspection Note: Insulation materials approved under approval category 164.107 must be installed in accordance with the approved installation details and manufacturer's instructions to satisfy the conditions of type approval. Deviations from the approved attachment method such as the use of generic steel pins and clips that may be used for insulation approved under 164.007 have not been tested to the more conservative FTP Code requirements.

Structural insulations must first be tested for noncombustibility under Annex 1, Part 1. If any adhesives are used in conjunction with a structural insulation, they are not required to be non-combustible, but they must have low flame spread characteristics as determined by Annex 1, Part 5 of the FTP Code and should be included in the follow-up program.

The insulation must be tested for fire endurance in accordance with the FTP Code, Annex 1, Part 3.

The FTP Code restricts approvals of structural insulations to the orientation in which the material was tested. Thus, separate horizontal and vertical tests are necessary for unrestricted approval.

Bulkheads

Bulkhead insulations are tested under Part 3 in a full-scale furnace with a minimum specimen height of 2500 mm (8.2 feet) and width of 2440 mm (8 feet). (Note that the specimen size required by Part 3 of the FTP Code is larger than that specified by IMO Res. A.754(18).)

Bulkheads are tested with the insulation attached to the unexposed side of a stiffened 4 mm steel plate to simulate a worst-case exposure. Because the test is run with the steel core plate exposed to the furnace, a greater thickness of insulation is needed to pass the FTP Code A-60 bulkhead test, than the 46 CFR 164.007 test.

MSC/Circ. 1120 contains an interpretation of SOLAS regulation II-2/3.2 that allows the approval of lightweight A-class bulkhead panels for use as non load-bearing internal A-class divisions in accommodation and service spaces. A-class lightweight panels are similar to B-class panels, except they are fire tested for a 60 minute test period, but are not required to be tested or installed in combination with a 4 mm thick core plate.

Decks

Decks are tested with a minimum specimen width of 2440 mm (8 feet) and length of 3040 mm (10 feet). For this application, the insulation is attached to the underside of the steel deck plate, and the specimen is mounted in the furnace with the insulation exposed to the furnace heating conditions. The top surface of the steel deck plating is normally left bare during the test. If the test is to qualify aluminum construction, the test specimen should include the primary deck coverings that the manufacturer specifies, as they affect the rate of heat loss on the unexposed side of the assembly, which could lead to test failure. The FTP Code requires that the structural insulation must maintain the temperature rise on the aluminum core plate below 200º C (450º F) during the test. The Coast Guard will also accept testing of insulation for aluminum decks without a topside surface. If the underside insulation is capable of limiting the core temperature to 150º C (300º F), approval will be granted for the use of any deck coverings.

General approval criteria

The acceptance criteria for approval of structural insulations require that the average unexposed face temperature rise should not exceed 140° C, and the temperature rise recorded by any individual thermocouple should not be more than 180° C. In addition, there should be no flaming on the unexposed side and there should be no ignition of the cotton-wool pad around openings. The FTP Code also requires that no significant gaps or openings form in the specimen during the fire test. Two gap gauges are used for this purpose. A 6 mm diameter gauge is inserted in any openings and the test is considered a failure if the gauge can be moved a distance of 150 mm along the opening. The second gauge is 25 mm in diameter, and failure occurs if the large gap gauge can be fully inserted into any opening.

The fire tests are conducted with the minimum thickness of insulation needed to achieve an A-60 rating. This minimum thickness is listed on the type approval certificate, and is the minimum thickness that is acceptable for shipboard installations. If a manufacturer requests approval for a structural insulation for A-30 or A-15 protection, the FTP Code requires additional fire tests to determine the required thickness of the insulation. The FTP Code does not permit the required thickness of structural insulation for A-30 and A-15 divisions to be based on calculations, as is permitted for domestic vessels.

2.4 Bulkhead Panels

2.4.1 Domestic vessels

Ref: 46 CFR 164.008

Inspection Note: Manufacturers of approved bulkhead panels are required to submit joiner details and typical installation drawings as part of the type approval application. Reference to the approved drawings can be found on the type approval certificate and in MISLE. The appropriate drawings are generally noted in the "Identifying data" section. These drawings may be requested from the installer or shipyard to verify correct installation.

The required type approval tests for bulkhead panels are described in 46 CFR 164.008. All materials used for the construction of the bulkhead panels must first pass the test for noncombustible materials under 46 CFR 164.009. The test samples for the noncombustibility test should replicate the actual proportions of materials used in the construction of the bulkhead panels. Bulkhead panels are normally tested without decorative laminates or applied paints, however, if the panels are only manufactured with factory applied laminates, the noncombustibility test specimens should include the laminate and adhesives.

46 CFR 164.008 is a full-scale furnace test that evaluates the fire endurance of a minimum 2440 mm (8 feet) high x 1900 mm (6.25 feet) bulkhead panel specimen. The bulkhead panel is not mounted on a steel core plate, but is instead self-supporting and restrained by a joinerwork system consisting of a bottom and top track, end caps and at least one vertical joint. The joinerwork system is typically constructed of steel channels that are fastened to the test furnace frame. The furnace is then run at the ASTM E-119 standard time-temperature curve.

General approval criteria

In accordance with 46 CFR 164.008, B-0 and B-15 bulkhead panels, and bulkhead panels intended for use as a component of A-15 or A-30 construction are subjected to a 30 minute fire test exposure. Bulkhead panels that will be used as a component of A-60 construction must pass a 60 minute test exposure.

B-15 bulkhead panels and panels that will be used as a component of A-15, A-30 and A-60 construction must be capable of preventing the average temperature rise on the unexposed side of the specimen from exceeding 139° C (250º F), and the maximum temperature rise at any one point, including joints, from exceeding 225° C (405º F) during the first 15 minutes of the test exposure. No temperature rise limitations apply for a B-0 approval.

The manufacturer is required to prepare typical installation drawings as part of the type approval. The minimum level of detail in the drawings includes:

a. a sufficient number of vertical sections extending from deck to overhead showing all installation variations in separate detail. Details should clearly depict the following:

1. Deck and overhead fixation of basic panels, including details of the bulkhead extensions used above ceilings
2. Ceiling or lining attachments (if applicable)
3. Draft stop attachments
4. Basic dimensions and thickness for panels and joinerwork
5. Type, size, and spacing of bolts, screws, and fittings

b. a sufficient number of horizontal sections showing all installation variations in separate detail. Details should clearly depict the following:

1. Two bulkheads joining at a tee
2. Two bulkheads joining at a butt
3. Four bulkheads joining at a cross
4. Outside corner
5. All variations of door jams
6. Bulkhead lining and connection detail

If the bulkhead panel system is designed with internal passages for electric cables or light switches, samples of such configurations should be included in the test specimen.

2.4.2 SOLAS vessels

Ref: Approval series 164.108, MRA approval series A.1/3.11, FTP Code Annex 1, Part 3

The FTP Code requires all bulkhead panels to first be tested for noncombustibility under Annex 1, Part 1. Any adhesives used in the panel construction must have low flame spread characteristics when tested to Part 5 of the FTP Code and should be included in the follow-up program.

Bulkhead panels are tested for fire endurance under Annex 1, Part 3. The FTP Code requires bulkhead panels to be tested in accordance with IMO Res. A.754 (18) for approval as B-0 or B-15 divisions. Although the FTP Code references B-30 approvals, SOLAS has no requirements for such a bulkhead rating, and the Coast Guard does not issue B-30 type approvals. A single 30 minute fire test of a bulkhead prototype is required for B-0 or B-15 Class type approval. The test assembly should include panels with internal passages for electric outlets, light switches, etc. if the bulkhead panel system has provisions for these penetrations.

If the manufacturer requests approval of the bulkhead panels for use as a component of A-60 construction, the approval test duration is increased to 60 minutes and the test is conducted with a steel core plate in conjunction with the bulkhead panels. Two separate tests are conducted; one test with the bulkhead panel facing the fire, and one test with the steel core facing the fire. The minimum separation distance between the steel core plate and the panels used for the approval test is a condition of type approval, applicable to shipboard installations.

General approval criteria

The acceptance criteria for approval of bulkhead panels requires that the average unexposed face temperature rise should not exceed 140° C, and the temperature rise recorded by any individual thermocouple should not be more than 225° C. In addition, there should be no flaming on the unexposed side and there should be no ignition of the cotton-wool pad around openings. The FTP Code also requires that no significant gaps or openings form in the specimen during the fire test, as determined by the insertion of two standard gap gauges.

The Code requires nonsymmetrical panel systems to be installed in the test furnace with the side expected to give inferior performance exposed to the fire. If a determination of which side of the panel should be exposed to the furnace cannot be easily made from a review of the manufacturer's drawings, two tests are required with each side of the panels exposed.

Manufacturers of approved bulkhead panels are required to prepare drawings with typical joiner details as a required part of the approval. The expected level of detail for these drawings is discussed in section 2.4.1. Installation of the panels in accordance with the manufacturer's approved joiner details is a condition of type approval.

IMO Resolution A.754(18) specifies that testing should be conducted on panels without decorative surface finishes or paints. For bulkhead panels that are only manufactured with a superimposed finish, portions of the surface finish on the unexposed side need to be removed to allow mounting of the thermocouples. Decorative surface finishes are approved separately under Parts 2 and 5 of Annex 1 of the FTP Code.

2.5 Noncombustible Materials

2.5.1 Domestic vessels

Ref: 46 CFR 164.009

The test method used to approve noncombustible materials is described in 46 CFR 164.009. Five cylindrical samples of the material, 45 mm in diameter and 50 mm in height, are inserted into a tubular furnace that is pre-heated to 750° C. Temperatures are monitored at several locations to determine the average reaction to the applied heat exposure for the five samples. 46 CFR 164.009 requires the following acceptance criteria to be satisfied for materials to be considered noncombustible:

1. The average furnace temperature must not rise more than 50° C;
2. The specimen average surface temperature must not rise more than 50° C;
3. The average duration of flaming after the specimen is inserted into the furnace must not exceed 10 seconds; and
4. The average specimen weight loss must not exceed 50%.

The temperature rise limits in 1 and 2 above are the difference between the initial stabilized furnace temperature and the maximum furnace or surface temperatures reached during the test.

Composite materials should be tested in their final assembled form. If the thickness of the finished product is less than the required sample size, a thicker sample should be made up using the materials in the same proportions as the finished product. If this is not possible, each of the components of the finished product should be tested individually.

All structural fire protection materials required to be type approved as noncombustible materials must be tested in accordance with 46 CFR 164.009. However, the following materials are considered inherently noncombustible without testing, and are not issued type approval certificates:

1. Glass, clay, ceramics or uncoated glass fiber.
2. All metals except magnesium or magnesium alloys.
3. Portland cement, gypsum, concrete with aggregates of only sand, gravel, vermiculite, silica, perlite, or pumice.
4. Woven or knitted glass fabric containing not more than 2.5 percent lubricant by mass.

2.5.2 SOLAS vessels

Ref: Approval series 164.109, MRA approval series A.1/3.13, FTP Code, Annex 1, Part 1

The FTP Code requires all insulations, bulkhead panels, continuous ceilings, and materials that are used as integral components of panels, doors and windows to be tested for noncombustibilty under Part 1. A separate noncombustibility test may not be necessary if a manufacturer uses components that already have a Coast Guard type approval under 164.109, or if the materials were tested for noncombustibilty within 2 years by the same laboratory, and the laboratory is able to confirm that the materials have not changed.

Part 1 of the FTP Code requires testing to ISO 1182-1990 using the acceptance criteria listed in the FTP Code. The scope of ISO 1182 indicates that the test method is not applicable to materials that are coated, faced or laminated. The Coast Guard does not apply this restriction, and will approve composite materials.

The noncombustibility acceptance criteria are as follows:

1. The average furnace temperature must not rise more than 30° C;
2. The specimen average surface temperature must not rise more than 30° C;
3. The average duration of flaming must not exceed 10 seconds; and
4. The average specimen weight loss must not exceed 50%.

The temperature rise limits are determined by calculating the difference between the maximum furnace or surface temperature recorded during the test and the final furnace or surface temperatures. The initial furnace stabilization temperature is not factored into the calculation.

ISO 1182 specifies that the timing device used to determine the duration of flaming is to be started immediately following insertion of the specimen into the furnace. If the specimen

exhibits open flaming before or during insertion, the test is considered a failure despite the material's reaction after the timer is started.

Materials made only of glass, clay, concrete, ceramic products, natural stone, masonry units, common metals and metal alloys are considered by the FTP Code as inherently noncombustible and no tests are required and no type approval certificates are issued.

MSC/Circ. 1120 contains an interpretation of SOLAS regulation 3.10 that allows combustible adhesives to be used in the construction of C-class bulkheads, if the adhesives meet the FTP Code criteria for surface flammability. This allows the approval of aluminum C-class bulkhead panels constructed of aluminum sheet facing with an aluminum honeycomb core and approved low flame-spread adhesives. As the aluminum honeycomb cores are made of aluminum sheets connected by strips of dry adhesive, the cores are not inherently noncombustible. This is commonly handled by testing the core to Part 1. These bulkhead panels are included in type approval category 164.109.

2.6 Structural Ceilings and Continuous Ceilings

2.6.1 Domestic vessels

Ref: Approval series 164.010

Inspection Note: Figures 3.7 to 3.9 do not apply to materials approved under 164.010. Special installation instructions are included in the type approvals for these materials.

SOLAS permits B-class bulkheads to terminate at the ceiling level instead of extending from deck to deck if the ceiling panels have been tested and approved as a continuous B-class ceiling, and the ceiling is at least of the same fire resistance as the adjoining bulkheads. The domestic vessel regulations in do not have similar criteria for continuous B-class ceilings. A type approval category was, therefore, created for structural ceilings to allow domestic vessels to apply the same criteria for continuous ceilings offered by SOLAS. Since the vessel regulations do not contain approval criteria, the test procedure and acceptance criteria applied are taken from the FTP Code, and are the same as discussed in 2.6.2 below.

Many vessel designs incorporate continuous B-class ceilings with the overhead steel deck to form an A-class deck assembly. The Coast Guard type approval refers to such assemblies as structural ceilings. The continuous ceiling may be used by itself as a B-0 or B-15 division or it can be combined with the steel overhead deck to form a structural A-class division.

2.6.2 SOLAS Vessels

Ref: Approval series 164.110, MRA approval series A.1/3.11, FTP Code Annex 1, Part 3

The FTP Code requires all ceiling panel materials to be tested for noncombustibility under Annex 1, Part 1 except that adhesives used in the panel construction must have low flame spread characteristics when tested to Part 5 of the FTP Code and should be included in the follow-up program. The panels are then tested for fire resistance under Annex 1, Part 3,

Appendix 2. Decorative surface finishes are tested separately under Parts 2 and 5 of the FTP Code.

The FTP Code requires the ceiling test assembly to be mounted in a horizontal furnace, including a short section of bulkhead panels to verify the soundness of the bulkhead / ceiling joint. An initial test of just the ceiling panels is performed to establish the basic details for the ceiling support system. If the ceiling is intended to include lighting fixtures, ventilation system hardware or electrical fittings, a second test is performed with representative samples of these devices installed in the ceiling.

Continuous ceilings may also be used as a component in A-60 deck construction. The fire test is conducted with the ceiling suspended below a steel deck in accordance with the manufacturer's instructions. Temperature measurements are made on top of the ceiling to determine compliance with B-15 criteria and on top of the steel deck to determine compliance with A-60 insulation criteria. The air gap distance between the steel deck in the test furnace and the continuous ceiling below is the minimum separation distance accepted for actual shipboard installations.

Manufacturers are required to submit joint, hanger and support details along with typical installation drawings as part of the type approval application, which are used to verify that shipboard installations conform to the type approval. An important part of the approval is the support system used to mount the ceiling panels beneath the steel overhead and the joiner system used to assemble the panels. Any changes to the approved hangers, joinerwork or support tracks will invalidate the conditions of approval.

2.7 Surface and Interior Finishes

2.7.1 Domestic vessels

Ref: 46 CFR 164.012, 46 CFR 32.56-50, 72.05-15, 92.07-10(d), 108.143, and 116.422

Inspection Note: Interior finishes approved under 46 CFR 164.012 are limited to the maximum thickness tested and the specific type and amount of adhesive tested. The required application limitations are listed on the type approval certificate and in MISLE. In cases where the type approval indicates that the material shall be installed in accordance with the manufacturer's instructions, this information should be requested from the interior finish installer or the shipyard.

The domestic vessel regulations refer to decorative exposed surfaces as interior finishes, which include the surfaces of bulkheads, ceilings, linings, and surfaces in concealed spaces. The exposed surfaces of decks are not considered interior finishes on domestic vessels. Approved interior finishes are required by the regulations in corridors, stairways, escape routes and concealed spaces on all vessels and in rooms containing fire resistant furnishings aboard passenger vessels.

Combustible wood veneers and plastic laminates may be used as interior finishes in other areas within accommodation, service and control spaces without testing if they do not exceed

2 mm (2/28 inch) in thickness. If it is necessary to have an exposed surface finish that is greater than 2 mm (2/28 inch) in thickness, materials that are approved under 164.009 may be used without limitation. The regulations also allow the use of combustible materials for architectural features such as moldings, trim and decorations, as long as the total volume of combustible materials in a room does not exceed a maximum volume that is calculated by multiplying the combined surface area of the walls and ceilings by 2.5 mm (1/10 inch). All combustible interior finish materials, including approved interior finish materials must be included in this calculation.

Approved interior finishes are tested to the criteria in 46 CFR 164.012, which requires a laboratory test of the material using the test apparatus and procedures in ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or NFPA 255, *Method of Test of Surface Burning Characteristics of Building Materials*. A 508 mm x 7320 mm (20 in by 24 feet) specimen of the interior finish material is mounted on a noncombustible substrate and placed upside down on the ceiling of the test tunnel. A gas burner is used to ignite one end of the specimen, and the extent of the flamespread across the surface of the material is measured. The amount of smoke given off during the test is also measured. To be accepted as an approved interior finish material, the measured flame spread must be 20 or less and the smoke classification must be 10 or less.

General approval criteria

All components and adhesives used to install the finish are evaluated as part of the approval test. If a manufacturer produces an interior finish material in varying thicknesses, the normal practice is to test the thickest version. The type approval will then cover all thinner forms of the same material. If an interior finish material is produced in a variety of colors and surface patterns, it is not necessary to test every version. A single representative test is normally sufficient for approval. In cases where approval is required for unique product designs, the Coast Guard should be consulted prior to testing for a determination of the extent of the required program.

Ceiling mounted plastic light diffusers may be installed without surface flammability testing if they are enclosed in a metal light fixture, and if the total surface of the light diffusers does not exceed 35% of the total ceiling area in the space. When installed in stairways, corridors, and control stations, this percentage should not exceed 25% of the total ceiling area.

The regulations permit the use of paint with the only restriction being that the application must be limited to a reasonable number of coats. No testing of the paint is required, and the Coast Guard does not issue type approvals for paints used on domestic vessels.

Inspection Note: The regulations limit acceptable paint thickness to "a reasonable number of coats." A maximum thickness and measurement technique has not been established for this purpose because of the variations in the type of paints used. In cases where the application appears unreasonable, flame spread test data should be requested.

2.7.2 SOLAS vessels

Ref: Approval series 164.112, MRA approval series A.1/3.18 (limited to exposed surfaces of ceilings, bulkheads and decks), FTP Code Annex 1, Part 5

Inspection Note: Interior finishes approved under 46 CFR 164.112 are limited to the maximum thickness tested and the specific type and amount of adhesive tested. The required application limitations are listed on the type approval certificate and in MISLE. In cases where the type approval indicates that the material shall be installed in accordance with the manufacturer's instructions, this information may be requested from the installer or the shipyard.

Inspection Note: Approved interior finishes are applied using a specific type and amount of adhesive that was evaluated during the approval testing. The substitution of other types of adhesives will void the type approval.

SOLAS allows A, B, and C class divisions to be faced with combustible materials, subject to surface flammability limitations related to the location of the materials. This results in four different categories of surface finishes:

1. Exposed surfaces of bulkheads and ceilings
2. Surfaces in concealed spaces
3. Floor coverings
4. Primary deck coverings

Surface flammability, smoke and toxicity - General

SOLAS regulation II-2/5 permits the use of combustible materials for facings, moldings, decorations and veneers, provided, the total volume of combustible materials in a space is limited to a total volume equivalent to a 2.5 mm veneer applied to the combined area of the walls and ceiling. If combustible materials are used in the below listed locations, they must have low surface flammability (FTP Code, annex 1,Part 5) and/or low smoke and toxicity (FTP Code, annex 1,Part 2) characteristics, SOLAS also requires exposed surface finishes to have a calorific value not exceeding 45 MJ/m2 when tested in accordance with ISO 1716 (oxygen bomb) test. The Coast Guard applies this criterion only to finishes that exceed 2 mm (2/28 inch) in thickness.

Passenger ships:

Location	Surface	Test requirements
Corridors and stairways	Exposed surfaces of bulkheads, ceilings, doors, and floor coverings*	FTP Code, Annex 1, Part 2 and Part 5
Accommodation and service areas and control stations	Exposed surfaces of bulkheads, doors, and ceilings	FTP Code, Annex 1, Part 2 and Part 5
Concealed spaces in accommodation and service areas	Surfaces of linings and grounds	FTP Code, Annex 1, Part 5

and control stations		
Rooms containing furniture and furnishings of restricted fire risk	Exposed surfaces of bulkheads, ceilings, doors, and floor coverings*	FTP Code, Annex 1, Part 2 and Part 5
Accommodation and service areas and control stations	Primary deck coverings	FTP Code, Annex 1, Part 2 and Part 6

Cargo ships:

Location	Surface	Test requirements
Corridors and stairways	Exposed surfaces of bulkheads, ceilings, doors, and floor coverings*	FTP Code, Annex 1, Part 2 and Part 5
Accommodation and service areas and control stations	Exposed surfaces of ceilings	FTP Code, Annex 1, Part 2 and Part 5
Concealed spaces in accommodation and service areas and control stations	Surfaces of linings and grounds	FTP Code, Annex 1, Part 5
Accommodation and service areas and control stations	Primary deck coverings	FTP Code, Annex 1, Part 2 and Part 6

* SOLAS considers floor coverings to be exposed surfaces that are subject to surface flammability and/or smoke and toxicity testing.

The FTP Code requires surface finish materials to be tested for surface flammability in accordance with Annex 1, Part 5, and for smoke and toxicity in accordance with Annex 1, Part 2. It is advisable to perform the Part 5 testing first, because Annex 2 of the FTP Code exempts interior finish materials from smoke and toxicity testing under Part 2 if the average surface flammability test results do not exceed a total heat release of 0.2 MJ and a peak heat release of 1.0 kW.

The Part 5 surface flammability testing is conducted in accordance with IMO Res. A.653(16). This test requires a 155 mm x 800 mm specimen to be mounted on a noncombustible refractory insulating substrate (calcium silicate board) that is placed in the furnace in a vertical orientation and exposed to a graduated radiant heat flux. The typical radiant flux ranges from approximately 50 kW/m^2 at the beginning of the exposed end of the specimen to a level of 1.5 kW/m^2 at the 750 mm position.

A small pilot flame is also located at the exposed end of the specimen, arranged at an angle that allows approximately 10 mm clearance between the flame and the specimen surface. Four fire properties are determined during the testing: critical flux at extinguishment, heat for sustained burning, total heat release and peak heat release. Three specimens are tested and the average results for the derived fire characteristics are determined. If the first two samples do not ignite within 10 minutes of the start of the test, the third test is run with the pilot flame angled to impinge on the upper surface of the specimen. If ignition occurs in this configuration, then two additional tests are conducted with the impinging flame.

The following performance criteria must be met for type approval:

Type of surface	**Critical flux at extinguishment (CFE)** **kW/m^2**	**Heat for sustained Burning (Qsb)** **MJ/m^2**	**Total heat Release (Qt)** **MJ**	**Peak heat release rate (q_p)** **kW**	**Burning drops permitted**
Bulkheads ceilings and linings	≥20	≥1.5	≤0.7	≤ 4.0	None
Floor coverings	≥7.0	≥0.25	≤ 2.0	≤ 10.0	10 or less
Primary deck coverings	≥7.0	≥0.25	≤ 2.0	≤10.0	None

Floor finishes

Floor finishes are tested in the same configuration as bulkhead and ceiling linings, however the FTP Code allows less restrictive acceptance criteria based on their intended installation. Bulkhead and ceiling linings are normally flat homogeneous surfaces while floor coverings (particularly carpets) may be three-dimensional textured surfaces that tend to melt and drip when exposed to a heat source. Because of this, an additional acceptance criterion that permits up to 10 burning droplets during the testing of floor finishes is applied.

Primary deck coverings

SOLAS regulations II-2/4.4.4 and II-2/6.3 require primary deck coverings used within accommodation and service spaces and control areas to be materials that will not readily ignite or produce smoke, toxic products or explosive hazards at elevated temperatures. The difference between primary deck coverings and floor finishes relates to the location of the material. The first layer of material installed above the steel deck plating is considered a primary deck covering. Any layers of materials above this are considered floor finishes. Primary deck coverings could also be the only material applied to the deck in which case they are considered to be a floor finish.

The FTP Code requirements for primary deck coverings are listed in Annex 1, Part 6, which requires testing in accordance with Res. A.687(17), using the same test procedures in Res.A. 653(16) for exposed surfaces, except that the specimen is mounted on a 3 mm thick steel plate instead of a calcium silicate panel.

Primary deck coverings that have been successfully tested to Part 6 are accepted as being in compliance with Part 5 and do not need further testing to be used as floor finishes.

General approval criteria

Any adhesives used in applying a surface finish are considered part of the type approval and should be included in the follow-up program. If the application rate or manufacturer of the

adhesive is changed, the type approval fire tests must be repeated with the alternative adhesive.

If a manufacturer produces an interior finish material at different thicknesses, only the maximum thickness needs to be tested. The approval will accept the use of all thicknesses up to the maximum tested.

SOLAS requires paints on exposed interior surfaces to also meet surface flammability and smoke and toxicity criteria. Small amounts of paint on factory finished materials such as bulkhead panel joiner posts, electrical fixtures, etc. need not be approved. If used, these combustible paints should be included in the calculation of the total volume of combustible materials.

Inspection Note: Approved low flame spread paints should be used if factory finished materials will be repainted after installation.

Raised floors for the distribution of electrical cables are not considered floor finishes. Floor finishes are installed in contact with the deck surface or primary deck covering without an intervening air space. Raised floors create a concealed space between the steel deck and the raised floor, where fire spread could occur. Because of this, they are considered analogous to linings, and should be constructed of noncombustible materials.

Smoke and toxicity

The FTP Code smoke and toxicity tests use the ISO 5659:1994, Part 2 smoke chamber, with acceptance criteria listed in the FTP Code. Nine specimens are prepared that are 75 mm x 75 mm on a side, and 25 mm in thickness. If the material being tested is more than 25 mm in thickness, it is cut to that thickness. If the material's nominal thickness is 25 mm or less, it is tested at its full thickness. Six samples are tested at an irradiance of 25 kW/m^2, three with a pilot flame present and three without. Three more specimens are tested at an irradiance of 50 kW/m^2 without a pilot flame. The specific optical density of the smoke produced during the testing is measured with a photometric system.

The acceptance criteria for smoke production for each type of surface finish material are:

Type of Surface	Average maximum Specific Optical Density (Dm)
Exposed surfaces of bulkheads, ceilings and linings	200
Surfaces of floor coverings	500
Surfaces of primary deck coverings	400

A limit is not included for surfaces in concealed spaces, since they are not required to meet smoke and toxicity criteria.

During the specific optical density tests, samples of the smoke from the second or third test specimen at each test condition are taken and analyzed to determine the level of toxic gases produced. The toxic gases are required to be analyzed using a repeatable method such as Fourier Transform Infrared Spectrometer (FTIR) or Gas Chromatography (GC). The maximum acceptable individual toxic gas concentrations measured at each test condition are as follows:

Toxic Gas	**Limit**
CO	1450 ppm
HCL	600 ppm
HF	600 ppm
NOx	350 ppm
HBr	600 ppm
HCN	140 ppm
SO_2	120 ppm (200 ppm for floor coverings)

2.8 Floor coverings, carpet and overlays

2.8.1 Domestic vessels

Ref: 46 CFR 32.57-10(d)(6), 72.05-10(n), 92.07-10(d)(6), 108.423 (h)(i), 116.425

Inspection Note: Carpet installed on domestic cargo vessels is not required to be fire resistant. Carpet installed on domestic passenger vessels installed in stairways, corridors or type 5 or 5a spaces is required to be fire resistant. Fire resistant carpet is not required to be type approved. Instead the fire protection qualifications of the carpet should be checked during installation. The shipyard or carpet installer should provide copies of test reports, certificates, laboratory listings or other manufacturer's data to verify that the required flame spread and smoke criteria are met.

Floor coverings used on domestic vessels are not type approved, but they must meet certain material requirements and construction criteria as explained in the following sections. Floor coverings may be installed directly on the steel deck, or they may be installed over an approved deck covering.

The regulations recognize two types of acceptable floor coverings: overlays and carpet. Overlays include materials such as vinyl tiles, linoleum, anti-skid compounds and teak veneers that are used for the purpose of leveling or finishing the deck surface. Any material may be used as an overlay as long as it does not exceed 9.5 mm (3/8 inch) in thickness. For simplicity, overlays are considered to be the top 9.5 mm of the deck surface and may consist of multiple layers of materials, including adhesives and leveling compounds. Deck overlays are not required to be tested and approved because they do not provide any fire resistance. If an overlay of greater than 9.5 mm (3/8 inch) in thickness is desired, then an approved 164.009 material should be used, or a deck covering approved under 46 CFR 164.006 may be installed beneath the overlay.

Raised floors for the passage of electrical cables are not considered overlays. Overlays are permanent construction installed in contact with the deck surface without an intervening air space. Raised floors create a concealed space between the steel deck and the raised floor, where fire spread could occur. Because of this, they are considered analogous to linings and should be constructed of noncombustible materials.

Carpeting is considered to be a furnishing and not an overlay. The regulations permit the installation of any type of carpet, except in corridors, stairways and spaces with fire resistant furniture and furnishings (Type 5 and 5a spaces) on passenger vessels. In these areas, wool carpet or other materials having equivalent fire resistant properties are required. The Coast Guard uses the following test criteria to determine if carpeting has fire resistant properties equivalent to wool:

1. If the carpet is 100% wool, and made in the United States no additional testing is required;

2. If the carpet is 100% wool and made outside the United States, it must be tested to the Consumer Product Safety Commission methenamine pill test (16 CFR 1630);

3. Carpet not made of wool is acceptable if tested to either:

   a. ASTM E-84 with a flame spread rating of 75 or less and a smoke classification of 100 or less; or

   b. ASTM E-648 with a critical radiant flux not less than 0.8 watts/cm^2, and ASTM E-662 with a specific optical density not to exceed 450 in both flaming and non-flaming modes; or

   c. the FTP Code, Annex 1, Parts 2 and 5.

Any pads or underlayments should be tested with the carpet. If they are tested separately, the pads must meet the same criteria as the carpet.

Carpet is permitted to extend 100 mm (4 inches) up the bulkhead from the deck, or combustible cove molding may be used as part of the flooring/carpet assembly. Carpet should not extend under doors in A-class or B-class divisions.

The use of wood carpet strips is acceptable for securing the carpet to the deck.

2.8.2 SOLAS vessels

Ref: Approval series 164.117, MRA approval series A.1/3.18, FTP Code Annex 1, Part 5

Inspection Note: Carpets installed in corridors, stairways, type 6 spaces and some type 7 spaces on SOLAS vessels are required to be type approved under approval series 164.117. This is different than domestic vessels where type approval is not required. See section 2.8.1.

SOLAS considers carpets and floor coverings to be exposed surfaces. Further explanation and detailed testing criteria for floor finishes are provided in section 2.7.2.

Floor coverings in corridors and stairways on all ships, and in spaces containing furniture and furnishings of restricted fire risk (Type 6 and some Type 7 spaces) on passenger ships are required to be type approved under approval series 164.117 and meet the low surface flammability and smoke and toxicity criteria for floor coverings as explained in section 2.7.2.

2.9 Furniture and Furnishings

2.9.1 Domestic vessels

Ref: 46 CFR 72.05-55, 46 CFR 116.423

Inspection Note: Type approvals are not issued for fire resistant furniture and furnishings intended for use on domestic vessels. Test reports, manufacturer's certificates or other evidence of testing to the required standards should be provided by the shipyard to confirm the acceptability of these materials.

There are no fire protection requirements for furniture and furnishings used onboard cargo ships, tank vessels, MODUs, OCS facilities, OSVs and similar vessels. Passenger vessels are required to meet certain criteria as explained below.

Both Subchapters H and K permit designers the option of designating staterooms and public spaces as Type 5 or 5a spaces if they are fitted with approved interior finish materials and contain only fire resistant furniture and furnishings. By using low fire-risk fire resistant furnishings, the fire ratings of the structural fire protection boundaries may be reduced. (See section 4.2)

Fire resistant furniture and furnishings include:

1. Case furniture such as desks, wardrobes, dressing tables, bureaus and dressers;
2. Free standing furniture such as chairs, sofas and tables;
3. Draperies and curtains;
4. Rugs and carpets; and
5. Trash cans.

The regulations require fire resistant case furniture to be constructed of approved noncombustible materials (typically steel or aluminum). A combustible veneer of maximum thickness 3 mm (1/8 inch) may be applied to the top surface of the furniture.

Individual vanities, sinks, toilets and shower enclosures installed in bathrooms are considered a type of case furniture, and may be constructed of FRP or composite materials, provided fire load calculations are performed to demonstrate that the fire load in the cabin does not exceed 37.5 kg/m^2 (7.5 lb/ft^2).

Freestanding furniture must have noncombustible frames. There are no requirements for the cushions or upholstery. The frame is generally defined as the components that provide structural support. The original type of chairs envisioned by the regulations consisted of a metal frame with a bottom cushion and a back cushion. The materials forming the cushion backing can be combustible materials, such as plywood or fiberglass. Some seating designs use modular or wrap-around construction with a molded plastic back or bottom integral with metal legs. Furniture of this design should not be used in low risk spaces, unless tested to a recognized furniture test method such as CAL TB 133 or the FTP Code, Annex 1, Part 8.

Draperies, curtains and other hanging fabrics should have limited flame propagation properties in conformance with the performance criteria established for either the small-scale (Method I) or large-scale (Method II) tests of NFPA 701. Alternatively, they may be tested in accordance with the FTP Code, Annex 1, Part 7.

Rugs and carpets must meet one of the standards listed in paragraph 2.8.1 .

Trash cans used in interior areas must be noncombustible with no openings in the sides or bottom, typically constructed of sheet metal. In areas such as galleys where rust is an issue, trash receptacles may be lined with plastic or rubber inserts. Trash cans used on open deck areas need not be noncombustible.

Fire resistant furnishings are also required in corridors and stairway enclosures. Any seating in these areas must have fire resistant cushions and upholstery in addition to noncombustible frames. Cushions and other padding are considered fire resistant if they are tested to CAL TB 117 or the FTP Code, Annex 1, Part 8. Upholstery is considered fire resistant if it is tested to either the large or small-scale tests of NFPA 701, or the FTP Code, Annex 1, Part 7.

Additional Subchapter K requirements

Subchapter K applies two additional requirements for furniture and furnishings.

46 CFR 116.423 requires furniture such as chairs and sofas to meet UL 1056. In 2005, UL withdrew standard 1056, and now uses California Technical Bulletin (CAL TB) 133 as an alternate test method, which is acceptable to comply with 46 CFR 116.423. California TB 133 is a composite test that evaluates the fully-assembled furniture. Most furniture consists of foam cushions, fabrics, fiber and other materials. CAL TB 133 determines the performance of the composite system, rather than the performance of individual components.

The test requires a furniture sample to be placed in the test room and exposed to the flame from a gas burner. The ignition source is located between the seatback and bottom cushion.

46 CFR 116.405(j) requires mattresses that do not contain polyurethane to comply with 16 CFR 1632. Mattresses that contain polyurethane foam must comply with the FTP Code. The additional testing for polyurethane mattresses is required because the Consumer Product Safety Commission (CPSC) flammability standards in 16 CFR 1632 (FF 4-72), use a smoldering cigarette ignition test, which is not a reliable flammability test for polyurethane mattresses. In July 2007 the CPSC revised their mattress testing standards to require all mattresses to meet a more conservative open flame ignition test in 16 CFR 1633, in addition to the smoldering test in 16 CFR 1632. Because of this, any mattresses used on U.S. flag vessels after this date may be accepted based on the CPSC standards, and need not comply with the FTP Code, Annex 1, Part 9 (Res. A.688(17)).

2.9.2 SOLAS vessels

Ref: Approval series 164.111 and MRA approval series A.1/3.19 (draperies, curtains and suspended textiles), Approval series 164.117 and MRA approval series A.1/3.18 (floor coverings), Approval series 164.142 and MRA approval series A.1/3.21 (bedding), Approval series 164.144 and MRA approval series A.1/3.20 (upholstered furniture), SOLAS regulations II-2/3.40 and II-2/9

Inspection Note: Type approval certificates are issued for the furniture and furnishings discussed below, except case and free standing furniture which are required to meet listed construction criteria instead of fire test criteria.

There are no fire protection requirements for furniture and furnishings used in general spaces onboard SOLAS passenger ships and cargo ships. However, accommodation spaces on passenger ships may be designated as Type 6 (minor fire risk) or Type 7 (moderate fire risk) accommodation spaces in accordance with regulation II-2/9 if they contain furniture and furnishings of restricted fire risk. The furniture and furnishings that this applies to are defined in regulation II-2/3.40 as:

1. Case furniture such as desks wardrobes, dressing tables, bureaus and dressers;
2. Free standing furniture such as chairs, sofas and tables;
3. Draperies, curtains and other suspended textiles;
4. Floor coverings;
5 Exposed surfaces of bulkheads, ceilings and linings;
6. Upholstered furniture; and
7. Bedding components.

Case furniture must be constructed entirely of approved noncombustible materials. A combustible veneer of maximum thickness 2 mm may be applied to the top surface of the furniture.

Freestanding furniture must have frames of noncombustible materials.

Draperies, curtains and other suspended textiles must be tested to the FTP Code, Annex 1, Part 7.

Floor coverings must be tested to the FTP Code, Annex 1, Part 5.

Upholstered furniture must be tested to the FTP Code, Annex 1, Part 8. This test is a small-scale test intended to assess the ignitability of furniture cushions and coverings when exposed to a cigarette or lighted match. The coverings and cushions are tested as a composite, therefore, separate approvals are not issued for each component. It is not necessary to conduct separate fire tests for different colors of the same furniture.

Bedding components such as blankets, quilts, bedspreads, pillows and mattresses including thin mattresses used on top of other mattresses must be tested to the FTP Code, Annex 1, Part 9. This test is a small-scale test intended to assess the ignitability of bedding components when exposed to a cigarette or lighted match. It is not necessary to conduct separate fire tests for different colors of the same materials. Box springs are not considered bedding components.

2.10 Other Insulation Requirements

2.10.1 Domestic vessels

Ref: 46 CFR 164.009, 46 CFR 32.57-10(d)(7), 72.05-40, 116.430

Inspection Note: There is no type approval category for combustible insulations intended for use on domestic vessels. They are accepted on a case-by-case basis, as explained below.

Insulation installed in accommodation, service and control areas that is used for purposes other than structural fire protection is required to be noncombustible. The regulations permit exceptions for limited amounts of combustible insulation applied to cold service piping for refrigeration systems and chill water piping for air conditioning systems. More efficient combustible insulations may be used on these systems if a non-combustible material such as sheet metal is used to cover the exposed surface of the insulation. Combustible insulations or coverings tested to 164.012 or Annex 1, Part 5 of the FTP Code as low flame spread materials may also be used on cold service piping. Potable water system piping is not considered cold service piping and any insulation used on such systems is required to be noncombustible.

Combustible insulation may be used in exterior areas, cargo holds and refrigerated spaces. However, whenever polyurethane or similar combustible plastic materials are installed, a covering of at least 0.75 mm (22 USSG) thick sheet metal should be installed over the

insulation to prevent accidental ignition of the insulation. The covering should be stenciled with a hot work warning indicating that it protects the combustible insulation from fire.

Combustible pipe and machinery insulation and lagging may also be used in machinery spaces.

2.10.2 SOLAS vessels

Ref: SOLAS Regulation II-2/5.3.1.1

Insulating materials are required to be noncombustible except in cargo spaces, mailrooms, baggage rooms and refrigerated compartments of service spaces. Vapor barriers and adhesives used in conjunction with insulation, and the insulation of cold service piping systems for refrigeration systems and chill water piping for air conditioning systems may be combustible, but should be kept to a minimum. The exposed surfaces of combustible insulations used on cold service piping must be approved low flame spread materials tested to Annex 1, Part 5 of the FTP Code, using the test criteria for ceilings and linings. Materials intended for this purpose are reviewed on a case-by-case basis. Type approval certificates are not issued.

2.11 Fire doors

2.11.1 Domestic vessels

Ref: 46 CFR 72.05-25, 46 CFR 116.435

A-class and B-class fire doors installed on domestic vessels are not required to be fire tested, and are not issued type approvals. Instead, they may be fabricated using the construction standards in Subchapters H and K. Any doors that have been tested to the FTP Code and approved under approval series 164.136 are also acceptable for use on domestic vessels.

The construction standards in the regulations only address the design of horizontal swinging doors. Other types of doors such as sliding or roll-down doors should be submitted to the Marine Safety Center for specific approval. Typically, UL listing or compliance with the FTP Code is accepted for these type doors.

A-0 and B-0 doors may be solid or hollow steel doors. The minimum construction standard for A-class doors is either a single thickness of 3 mm (11 USSG) steel, or a double thickness of 1.5 mm (16 USSG) steel for both the door leaf and frame. The minimum construction standard for B-class doors is either a single thickness of 1.5 mm (16 USSG) steel, or a double thickness of 0.8 mm steel (22 USSG). If the door is required to be rated as a B-15, A-15, A-30 or A-60, the door leaf should be filled with approved structural insulation that is at least one half the approved thickness for A-60 divisions.

Specific construction features for A-class doors:

1. The minimum latch throw must be at least 19 mm (3/4 inch). Standard size doors are typically fitted with a single latch, however, oversize doors may require two or three point latches to ensure they remain closed during fire exposure. If multiple-point latches are provided, each latch should have this minimum latch throw.

2. The bottom of the door may be undercut up to a maximum of 12.7 mm (1/2 inch). A noncombustible sill or gap equal to the width of the door frame is required beneath doors to prevent fire spread along carpet, but vinyl tile and similar floor coverings may pass beneath doors without interruption.

3. The minimum door stop surface on the frame must be at least 12.7 mm (1/2 inch).

4. A window or vision panel up to 645 mm^2 (100 in. sq.) is permitted in an A-class door if the glazing is wire-inserted glass at least 6.5 mm (1/4 inch) in thickness. The glazing must be set in a steel frame and retained by steel clips or angles. See section 2.12 for further details.

5. Hinges, latches and other hardware must be steel or other non-heat sensitive materials.

6. Electric door strikes may be used if they are tested and listed for installation in 1-1/2 hr rated fire doors by an independent laboratory such as Underwriters Laboratories, Inc., and arranged to allow escape in the event of power failure.

7. Combustible veneers may be applied to doors subject to the same thickness limitations applicable to bulkheads and linings (see 46 CFR 72.05-25 (a) (7) and 72.05-15(b) & (e)).

8. Double doors capable of independent operation and latching may have a door leaf gap of up to 3.2 mm (1/8 inch). Double doors that sequentially close must have a 12.7 mm (1/2 inch) doorstop on the inactive leaf.

9. Fire door viewers (peepholes) may be used if they are tested and listed for installation in 1-1/2 hr rated fire doors.

10. Doors may have a self-closing 150 mm by 150 mm (6 inch by 6 inch) hose port located in the lower corner opposite the hinges. The hose port should be of the same construction as the door.

11. Doors opening onto open decks may either meet the above criteria or they may be constructed of 45 mm (1-3/4 inch) thick oak or similar hardwood or aluminum. This provision does not apply to doors that separate interior spaces from qualified refuge areas (QRA) (see NVIC 8-93). It also does not apply to the part of the superstructures of tank vessels that faces the cargo area (see 46 CFR 32.56-20).

12. Hollow metal doors tested and listed to NFPA 252 (UL 10B) as 1-1/2 hour fire doors may be used in A-class divisions. Doors required to be A-15 through A-60 should also be listed for a maximum temperature of 450° F (232° C).

13. Vent grilles or louvers may not be installed in the lower half of A-class doors.

Specific construction features for B-class doors:

1. The minimum latch throw must be at least 9.5 mm (3/8 inch). If multiple-point latches are provided, each latch should have this minimum latch throw.

2. The bottom of the door may be undercut up to a maximum of 25.4 mm (1 inch). A noncombustible sill or gap equal to the width of the door frame is required beneath doors to prevent fire spread along carpet. Vinyl tile and similar floor coverings may pass beneath doors without interruption.

3. The minimum door stop surface on the frame must be at least 12.7 mm (1/2 inch).

4. A window or vision panel up to 8476 cm^2 (1296 in^2) with a maximum dimension in any direction of 1372 mm (54 inches) is permitted in a B-class door if the glazing is wire-inserted glass at least 6.5 mm (1/4 inch) in thickness. The glazing must be set in a steel frame and retained by steel clips or angles. See section 2.12 for further details.

5. Hinges, latches and other hardware must be steel or other non-heat sensitive materials.

6. Electric door strikes may be used if they are tested and listed for installation in 1-1/2 hr rated fire doors by an independent laboratory such as Underwriters Laboratories, Inc., and arranged to allow escape in the event of power failure.

7. Combustible veneers may be applied to doors subject to the same thickness limitations applicable to bulkheads and linings (see 46 CFR 72.05-25 (a) (7) and 72.05-15(b) & (e).

8. Double doors capable of independent operation and latching may have a door leaf gap of up to 3.2 mm (1/8 inch). Double doors that sequentially close must have a 12.7 mm (1/2 inch) doorstop on the inactive leaf.

9. A vent grille or louver of up to 1858 square centimeters (2 sq. ft.) may be installed in the lower half of B-class doors.

10. Fire door viewers (peepholes) may be used if they are laboratory tested and listed for installation in 1-1/2 hr rated fire doors.

11. Doors may have a self-closing 150 mm by 150 mm (6 inch by 6 inch) hose port located in the lower corner opposite the hinges. The hose port should be of the same construction as the door.

12. Hollow metal doors tested and listed to NFPA 252 (UL 10B) as 1 hour fire doors may be used in B-class divisions.

2.11.2 SOLAS Vessels

Ref: Approval series 164.136, MRA approval series A.1/3.16 (limited to doors without windows and doors with windows not exceeding a total area of 645 cm^2), FTP Code, Annex 1, Part 3

Inspection Note: FTP Code fire doors are tested and approved without paint or other added surface finishes. If these materials are added to field installed doors, separate type approval is required for surface flammability, smoke and toxicity. Doors intended for installation in exterior bulkheads or other locations subject to weather may be fitted with additional weather-stripping made of combustible materials to seal between the door leaf and frame. Weather-sealing materials do not require testing or type approval.

Inspection Note: Type approvals issued under approval series 164.136 indicate the approved door frame mounting details. Shipboard installation of the door frames is limited to the mounting method stated in the approval, except that doors that are approved with a bolted frame may be bolted or welded to the bulkhead.

Inspection Note: B-class fire doors installed on SOLAS vessels may have a louver in the lower half, however, the size is restricted to 500 cm^2 (77 in^2).

Inspection Note: Fire door type approvals are limited to the maximum size door leaf that was tested. These limits are stated on the type approval certificate and in MISLE. Larger size fire doors may be acceptable, subject to review and approval by CG-5214.

The FTP Code requires all materials used in the construction of fire doors to first be tested for noncombustibility under Annex 1, Part 1 and then tested for fire resistance under Annex 1, Part 3. Adhesives used in the construction of fire doors need not be noncombustible, but they must be tested for low flame spread characteristics under Annex 1, Part 5 and should be included in the follow-up program.

The maximum size door for which approval is requested should be tested. If the required door size is larger than the test furnace can accommodate, a smaller version of the door should be constructed for the fire test and approval of the oversize door will be based on a comparison of its construction details to the tested door.

The FTP Code requires doors to be mounted in the test bulkhead with the side expected to give inferior performance exposed to the fire. Swinging doors will normally have the poorest

fire performance if they are oriented in the test bulkhead to swing away from the furnace. Sliding doors and other types of doors where it may not be possible to judge which side should be tested may require two tests, with first one side, then the other exposed to the fire. Prior to running the test, the Coast Guard should be contacted to determine the recommended arrangements.

Doors may be tested with an integral window. Hose stream, thermal radiation and temperature rise testing requirements for the glazing may be applicable as indicated in the following table:

Window Dimension	**Door Fire Rating**	**Hose Stream Test Required**	**Radiation Test Required**	**Temperature Rise Test Required**
≤645 cm^2	A-0, A-15, ,A-30, A-60	No	No	No
>645 cm^2	A-15, A-30, A-60	Yes	Yes	Yes
>645 cm^2	A-0	Yes	No	No
≤645 cm^2	B-15	No	No	No
>645 cm^2	B-15	No	Yes	Yes
Any dimension	B-0	No	No	No

The FTP Code requires the surface temperatures on the unexposed side of the door to be measured by thermocouples fixed to the surface of the door leaf. The thermocouples should be located at the center of the door and at the center of each of the four quarters of the door leaf. The thermocouples may be moved, at the discretion of the laboratory, to avoid local hot spots if an integral window is being tested. The thermocouples should also be positioned at least 100 mm away from the edges of the door and from any heat transfer point sources such as latches, hinges or door knobs to prevent interference with the test results. If a temperature rise limitation is applicable to the integral window, thermocouples should be attached to the unexposed surface of the window as specified for the door leaf.

The test acceptance criteria for A-class doors are the same as those required for structural insulations. Doors should be tested with typical hinges, latches, hose ports, electric strikes, viewers and other hardware that the manufacturer intends to use for shipboard applications. The hardware should be constructed of materials having melting points of not less than 950° C (1742° F) for A-class doors, and 850° C (1562° F) for B-class doors. The acceptance criteria for fire doors and related hardware require that the door remain closed for the duration of the fire test and that openings in excess of that permitted by the Code are not allowed to develop. The door and related hardware is not required to be functional after the fire test.

General fire door approval criteria

Watertight doors are not required to be insulated if the bulkhead they are installed in is A-15, A-30 or A-60 class. Watertight doors installed below the bulkhead deck are not required to be tested or approved.

Fire doors may be constructed of mild steel or stainless steel. Type approval will be issued for both materials based on a single fire test of a stainless steel test specimen.

Manufacturers who request type approval for a double door assembly and a single leaf door of the same design are not required to conduct two separate fire tests. The Coast Guard will accept the test results from a double door fire test for both applications, if the size of the single leaf door and all hinges and latches are consistent with the double door. The manufacturer should submit drawings for review prior to the fire test, to allow a determination of equivalent construction.

SOLAS regulation II-2/9.4.1.1.1 requires all openings in A-class divisions to be fitted with permanently attached means of closing which shall be at least as effective for resisting fires as the division in which they are fitted, except access hatches, escape hatches, tonnage opening covers, and similar openings. The Coast Guard has determined that hatch covers do not need to be tested to the FTP Code or type approved if they meet all of the following:

1. The closure is secured by dogs or bolts of suitable steel construction or equivalent. Single or multipoint door latches do not meet these criteria. Hinges and securing devices employing materials, such as low friction bearing devices, should be equivalent to steel and arranged to maintain the fire integrity of the closure.

2. The closure is constructed of steel of at least 4 mm (0.16 in) thickness and suitably stiffened or of the same material and thickness as the boundary.

3. The seal for the closure is flat construction type. Knife edge type closure seals may also be acceptable provided the seal material is noncombustible.

4. If the opening is in an A-15, A-30 or A-60 boundary, the closure must be insulated to provide the same level of fire protection as the boundary. Seals, hinges and dogs should be insulated to a level commensurate with the operation of the closure.

MSC/Circ. 917 specifies that access doors, hatches or panels (e.g., openable hinged ventilation units) should be provided in bulkheads, linings or ceilings to facilitate inspection and repair of cabin services and survey of ship's structure. Such openings are important not only for inspection and repair, but may enable early location of a void space fire (e.g., in cabling) or preventative measures against the spread of fire from adjacent spaces. Accesses should normally be provided from the corridor. Access doors and inspection hatches in B-class divisions should have a fire rating equivalent to the bulkhead in which they are installed, and tested in accordance with the FTP Code Annex 1 Part 3.

SOLAS permits B-class doors to have a louver in the lower half, not to exceed 500 square centimeters (0.54 square feet). (note that this is less than the 1858 square centimeters (2 feet square) permitted for domestic B-class doors). The louver should be included in the tested door specimen and should be in the open position at the start of the test. Thermocouples should not be applied to the louver area.

2.12 Windows and Glazing

2.12.1 Domestic vessels

Ref: 46 CFR 32.56-21 thru 25, 72.05-30, 108.131 thru 108.145, 116.433

Inspection Note: On domestic vessels, windows are not required to be type approved. In certain locations, glazing is required to meet minimum fire resistance standards. The shipyard or window manufacturer should provide the necessary test reports, certificates or other documentation to allow confirmation that the windows meet the appropriate criteria.

The requirements in Subchapters H and K specify that wire inserted glass of at least 6.5 mm (1/4 in) thickness must be used for windows. These construction standards were taken from shipbuilding practices in use for many years, and are based on design standards for windows of limited size and application and do not require testing or type approval. Windows installed in critical locations are also required to have steel shutters to maintain the integrity of the fire barrier.

Modern construction practices have shown a preference for the use of windows without wire reinforcement, or of a much larger size. The regulations do not include provisions to allow the use of these novel designs. Additionally, the glazing industry has developed more efficient types of fire resistant glass that can be safely used without steel shutters. These alternative type window arrangements may be accepted as explained in the following sections.

46 CFR 116.433(a) requires the use of tempered or laminated glass. The intent of this requirement is to provide safety glass in areas where passengers may fall against the windows. Tempered or laminated glass normally does not provide any fire protection and should only be used as explained below. If fire rated windows are required in locations where safety glass is specified, glass that meets the necessary fire protection criteria should be installed, which is also certified to meet 16 CFR 1201 or ANSI Z97.1-2004.

Laboratory fire tests evaluate four separate properties relating to a window's ability to remain in place and prevent fire spread:

1. fire integrity;
2. ability to pass the hose stream test;
3. temperature rise on the unexposed surface; and
4. radiation limitation through the window.

The different test methods are intended to provide different levels of certification for windows, based on the expected fire risk and personnel safety hazards where the windows will be located.

The regulations do not give any size limits for windows, or limit the number of windows that may be installed in a bulkhead since at the time the regulations were developed it was uncommon to use large windows or a large number of windows. The following sections discuss area limitations that are based on the window's demonstrated level of performance. Windows capable of meeting more stringent criteria are accepted for larger applications.

There are four types of windows accepted for installation onboard domestic vessels and offshore facilities: ordinary glass, wire inserted glass, laboratory listed fire protection-rated glazing and Coast Guard type approved windows covered under approval series 164.137.

Ordinary glass

Ordinary glass includes annealed glass, tempered glass and laminated glass. This type of glazing has little or no fire resistance and should only be used in locations where fire spread is not a concern, typically in bulkheads on the sideshell or that separate interior spaces from open deck areas where there is no adjacent structure.

Wire inserted glass

Wire inserted polished glass, also known as wired glass, has been used in fire rated divisions for many years, and is the primary type of glazing recognized by the regulations. The wire reinforcing helps to maintain the glass in place during a fire, but does not stop the transfer of heat through the window. Because of this, the regulations limit the size of windows that may be used.

Fire protection rated glazing

Fire-protection-rated glazing materials are tested to the requirements in NFPA 257 (UL 9), and may or may not include a hose stream test and temperature rise criteria. Windows in this category usually are constructed of laminated glass and ceramic fillers. The ceramic element is clear at ambient temperature and turns opaque when exposed to heat. This change effectively blocks heat transfer through the window, allowing the use of larger size windows. The marking convention used for listed glazing is as follows:

D – glass that is suitable for use in fire doors

O – glass that is suitable for use in windows

H – glass that has passed the hose stream test

NH - glass that has not passed the hose stream test

T – glass with a temperature rating (not to exceed 450° F (232° C))

NT - glass without a temperature rating

All of these markings are followed by the approved fire rating of the glass, e.g., 30 minutes of protection.

Coast Guard approved windows

Approved windows are tested in accordance with the FTP Code (see section 2.12.2), and may be used at any location within the limitations of the type approval, up to the maximum size window tested.

There is one other type of commercially available glazing, called fire resistance-rated glazing. These windows have been tested to the same fire test criteria as fire rated walls (NFPA 251 / UL 263), and are used to construct glass walls in buildings. Consideration of fire resistance-rated glazing will be given on a case-by-case basis, since many of these window designs have only been tested in masonry walls and may not be suitable for marine applications.

2.12.1.1 Windows in fire doors

The regulations permit the use of wire inserted glass in both A-class and B-class doors. Windows up to 654 cm^2 (100 in^2) may be used in A-class doors. Windows in B-class doors should be limited to 8476 cm^2 (1296 in^2), with a maximum dimension of 1372 mm (54 inches) in any dimension. Doors that open onto weather decks may have a window of any size unless the door is adjacent to or below a qualified refuge area, embarkation station, or escape route.

Fire-protection-rated glazing materials may also be used in accordance with their laboratory listing. For A-class doors, glazing materials should be at least DH – 60. For B-class doors, acceptable glazing should be at least DH – 30. The glazing must be installed in the door in accordance with the manufacturer's instructions and the limitations for the individual listing of each material. The maximum window surface area, the maximum height, the maximum width, the required depth of the groove in the frame and the minimum depth of the groove are all limited by the requirements stated in the listing.

Fire doors that are type approved under approval series 164.136 and hollow metal doors tested and listed to NFPA 252 (UL 10B) that have been tested with integral windows may also be installed on domestic vessels in accordance with the limitations of the type approval.

2.12.1.2 Windows in interior bulkheads

The vessel regulations require that windows located in A-class and B-class bulkheads must be wire inserted glass installed in steel frames with steel retaining angles or glazing beads. Aluminum frames and resilient gaskets may be used if steel retaining clips are installed in the bulkhead to keep the window in place if fire damages the gasket. Additional protection is required by 46 CFR 72-05 and 116.433 for specific applications as follows:

Windows in A-class bulkheads – A steel or equivalent metal shutter, capable of manual and automatic operation from the fire door release system shall be installed to protect the window opening. If the bulkhead is A-15, A-30 or A-60 class, the shutter must be insulated to the same standard. No area limitations are applied.

Windows in B-class bulkheads – The maximum size wire-inserted glass window in B-class bulkheads should not exceed 8476 cm^2 (1296 in^2) with a maximum dimension in any direction of 1372 mm (54 inches). Windows installed in B-15 bulkheads must also have a steel or equivalent metal shutter, capable of manual and automatic operation.

In lieu of wire inserted glazing and steel shutters, listed fire-protection-rated glazing materials may be used in accordance with the criteria stated in the individual laboratory listings. A-class windows should be at least DH-60, and B-class should be DH-30. Windows classified as OH-60 and OH-30 may also be used if they were tested with steel construction. There is no limit on the number of windows that may be installed in a common bulkhead, however, the total area of windows should not exceed 25% of the bulkhead surface area.

2.12.1.3 Windows in exterior bulkheads

Ordinary annealed or laminated type glass is acceptable without limit for installation in the sideshell or in bulkheads facing general exterior areas where there are no adjacent accommodation areas, service areas or control stations within 5 m. If the windows face occupied structures they should not exceed a maximum area of 7.8 m^2 (84 ft^2) with no dimension exceeding 3.65 m (12 ft).

In lieu of ordinary glazing, listed fire-protection-rated glazing materials may be used in accordance with the criteria stated in the individual listings up to the maximum size allowed by the listing. There is no limit on the number of windows that may be installed in a bulkhead.

2.12.1.4 Windows at embarkation stations, escape routes, stairtowers and qualified refuge areas.

The regulations permit wire inserted glass up to 654 cm^2 (100 in^2) to be installed at these locations. There is no limit on the amount of wire inserted glass that may be installed in an A-0 class steel bulkhead if 11 USSG steel shutters capable of manual and automatic operation by a fusible link are provided. A listed 1-1/2 hour rolling steel fire door or Coast Guard approved A-class rolling steel door may also be used for this purpose. In lieu of wire inserted glass, listed fire-protection-rated glazing materials with a 450° F (232° C) temperature rating may be used in accordance with the criteria stated in the individual listings up to the maximum size allowed by the listing. Windows installed in divisions required to be A-60 class are limited to 25 % of the area of the bulkhead.

2.12.2 SOLAS vessels

Ref: Approval series 164.137, FTP Code, Annex 1, Part 1 and 3

Inspection Note: Type approvals for windows are limited to the largest size windows tested. Some approved windows are unsymmetrical due to the arrangement of different layers of glazing, air gaps and insulating materials. The installation of these windows is restricted to the orientation tested. This information is listed on the type approval certificate and in MISLE. Type approved windows are approved as a system that includes the glazing, frame, gaskets, spacers and attachment provisions that were examined during the laboratory fire tests. Parts from other approved windows should not be intermixed.

Only type approvals issued by the Coast Guard are valid for windows, as they are not included in the Mutual Recognition Agreements.

The FTP Code requires windows to be tested for fire resistance under Annex 1, Part 3. All materials used to mount the glazing in the window frame must be tested for noncombustibility under Annex 1, Part 1. For practical reasons, small amounts of intumescent or other combustible sealants are permitted without testing, at the discretion of the laboratory. Windows exceeding 645 cm^2 in area must also meet the thermal radiation test supplement to fire resistance, as outlined in Appendix 1 of Part 3 of the FTP Code, and the hose stream test of paragraph 5 of Appendix A.1 of Res. A.754(18). Both tests are conducted during and immediately after the normal fire resistance test.

The intent of the thermal radiation test is to limit the radiant heat that passes through transparent glazing to no more than would be transferred from a typical A or B-class bulkhead.

The maximum peak heat flux values in kW/m^2 for A and B-class divisions are as follows:

A-0	56.5
A-15	2.34 for the first 15 minutes, thereafter a maximum of 8.0
A-30	2.34 for the first 30 minutes, thereafter a maximum of 6.4
A-60	2.34
B-0	36.9
B-15	2. 34 for the first 15 minutes, thereafter a maximum of 4.3

The hose stream test is intended to place a thermal stress on the window assembly and is a measure of its ability to remain in place after fire exposure.

The FTP Code requires that the hose stream test be started no more than 1-1/2 minutes after the fire test is concluded. Many laboratories have difficulty removing the test specimen and frame from the furnace to begin the hose stream test within this time period. The Coast Guard has determined that hose stream testing that begins within 3 minutes of the end of the fire test is acceptable for type approval.

Window fire tests are conducted with the window installed in a test bulkhead with the stiffeners and bulkhead insulation exposed to the furnace. This configuration is intended to represent exposure of the window to an interior fire scenario, as would be expected on a passenger ship. For windows intended for other applications, it may be necessary to test the sample with the insulation and stiffeners on the unexposed side of the assembly. Windows tested as such may be installed in any bulkhead application. This situation may exist for windows installed on tankers where the fire exposure may come from an exterior fire source.

2.13 Penetration seals

2.13.1 Domestic vessels

Cable Penetrations

Inspection Note: The laboratory listing for cable penetration systems provide detailed information on the limits of the approval, including the maximum diameter of the penetrating cables, the maximum per cent cable fill, the minimum annular space between the cables and the frame or sleeve, the required length of sleeve, and the required thickness of fire stop and caulking material. This information should be provided by the seal manufacturer or the shipyard to allow confirmation of the correct installation of the materials.

Subchapters H and K do not list any standard construction specifications for cable penetration seals. At one time, the Coast Guard maintained a generic list of acceptable penetration seal manufacturers. This program is no longer in effect.

Testing and laboratory listing to ASTM standard E-814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, in a steel bulkhead or deck (or aluminum, if applicable), or testing to the FTP Code under approval series 164.138 is acceptable for cable penetrations of A-class divisions.

Penetration seals that pass the ASTM E-814 test method are assigned an F rating and a T rating. The F rating indicates the length of time the seal can prevent the passage of flame, which for A-class divisions should be a minimum of 60 minutes. The T rating designates the length of time the seal can prevent the transfer of heat to the unexposed side of the bulkhead. Seals installed in A-60 class divisions should have both an F and a T rating of 60 minutes. Alternatively, generic insulation methods are accepted for penetration seals in steel divisions without a 60 minute T rating. Penetration seals that have a 60 minute F rating may be installed in A-60 divisions if approved A-60 structural insulation is applied to the seal and is wrapped around and between the cables for a distance of at least 300 mm (12 inches) on the insulated side of the division (see Figure 2.13.1). For deck applications, the insulation should be applied to the underside of the deck, and a suitable means of support should be provided for the insulation, such as encasing in wire mesh welded to the steel plating.

Depending on their location, some penetration seals are required to be watertight in addition to being fire resistant. Watertight integrity testing is carried out separately from fire testing, and is not required as a condition of laboratory listing. ASTM standard F-1196 and MIL-P-

24705 are references that provide additional information concerning watertight integrity testing.

STANDARD INSULATION DETAIL FOR ELECTRICAL PENETRATION OF A-60 BULKHEADS

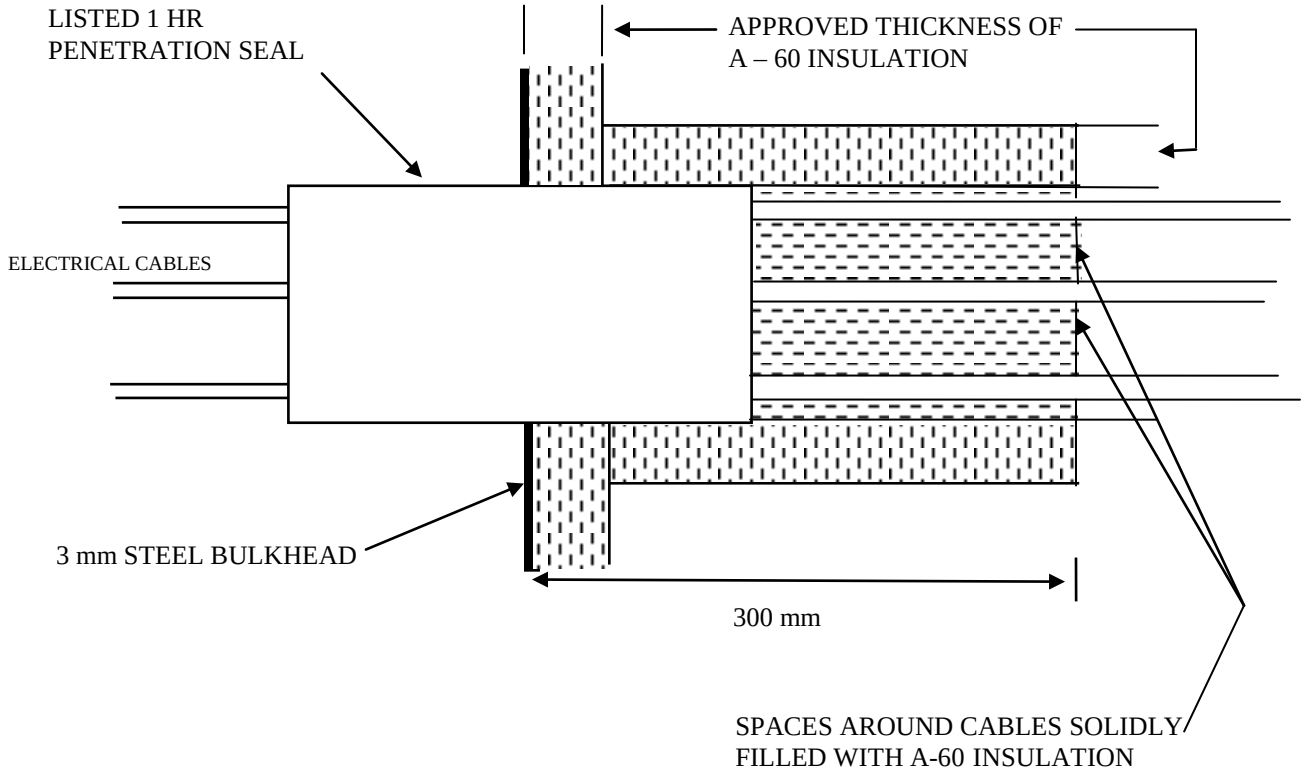


FIGURE 2.13.1

Piping Penetrations

Steel piping penetrations in A-class divisions may either be continuously welded on one side of the division, routed through a tight fitting steel sleeve of at least 3 mm (11 USSG) thickness, or bolted to a flanged spool piece at least 3 mm thick. If the pipe passes through an A-60 division, approved structural insulation should be applied to the pipe on the insulated side of the division for a distance of at least 300 mm (12 inches) away from the division, to limit point source heat transfer. The 300 mm distance is generally taken as a linear measurement along the pipe.

Metallic materials having a melting point of 925º C (1,700º F) or less are considered heat sensitive. Heat sensitive piping, aluminum piping and plastic piping could fail under fire exposure and allow fire to pass through A-class divisions. A steel spool piece or sleeve at least 600 mm (24 inches) in length (preferably equally divided on each side of the division) arranged in accordance with figures 2.13.3 or 2.13.5 should be used to ensure the integrity of fire rated divisions penetrated by such materials.

Piping that penetrates B-class divisions should be tight fitting, meaning that the gap between the pipe and the bulkhead panel is 2.5 mm (1/8 inch) or less. Listed fire seal caulking can also be used to seal small gaps around piping penetrations.

Penetrations of aluminum bulkheads and decks require special consideration because of the need to maintain the division core temperature rise below 200º C (360º F). The design of these penetrations should be based on fire test data for the specific configuration of the penetration.

Figures 2.13.2 through 2.13.5 show typical piping penetration details that are accepted for steel bulkheads and decks or approved B-class bulkhead panels.

Ventilation Duct Penetrations

Ventilation ducts are permitted to penetrate A-class divisions if they are fitted with fire dampers to prevent fire spread through the division (see section 2.14.1 for further details).

Ducts that pass through a space without serving that space do not require fire dampers at the boundaries if the duct is constructed of steel at least 3 mm thick, and passes completely through the space without opening to the space. For example, a duct may pass from the fan room through several intervening spaces and then ultimately discharge with only a single fire damper located either at the fan room boundary or the space where the duct discharges.

Ventilation ducting of at least 0.73 mm thick steel (22 USSG) that penetrates B-class bulkheads is not required to have a fire damper, if the penetration is tight fitting.

TYPICAL STEEL PIPE PENETRATIONS IN STEEL A-0 CLASS BULKHEADS

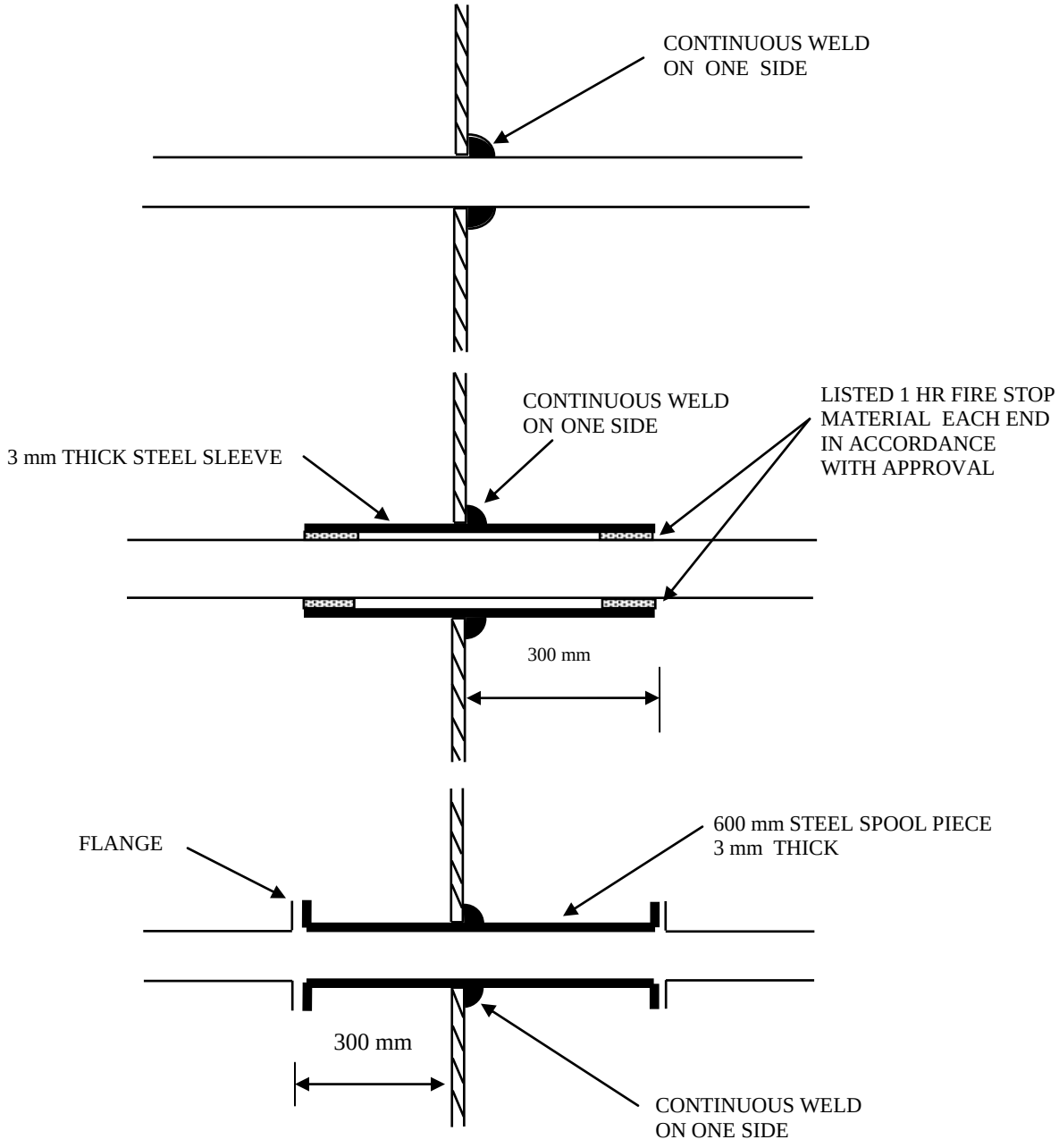


FIGURE 2.13.2

TYPICAL HEAT SENSITIVE PIPE PENETRATIONS OF STEEL A-0 CLASS BULKHEADS

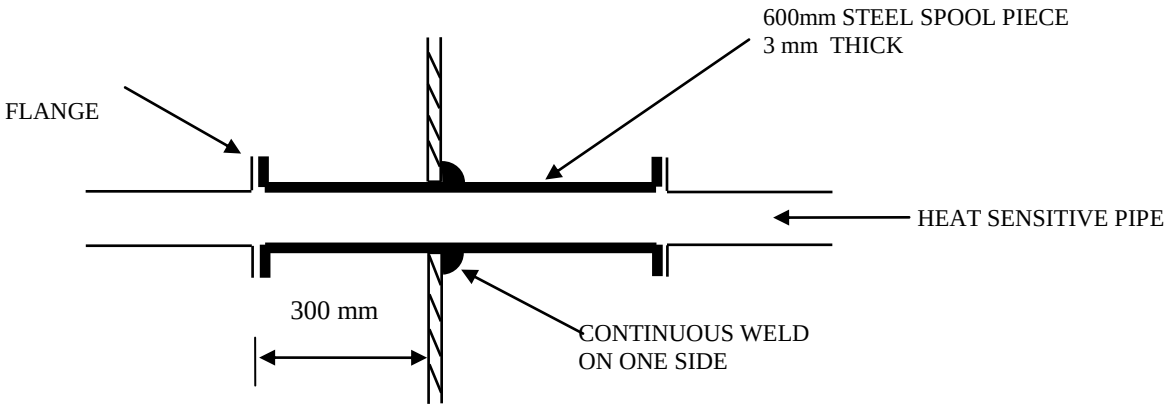


FIGURE 2.13.3

TYPICAL STEEL PIPE PENETRATIONS IN B - CLASS BULKHEADS

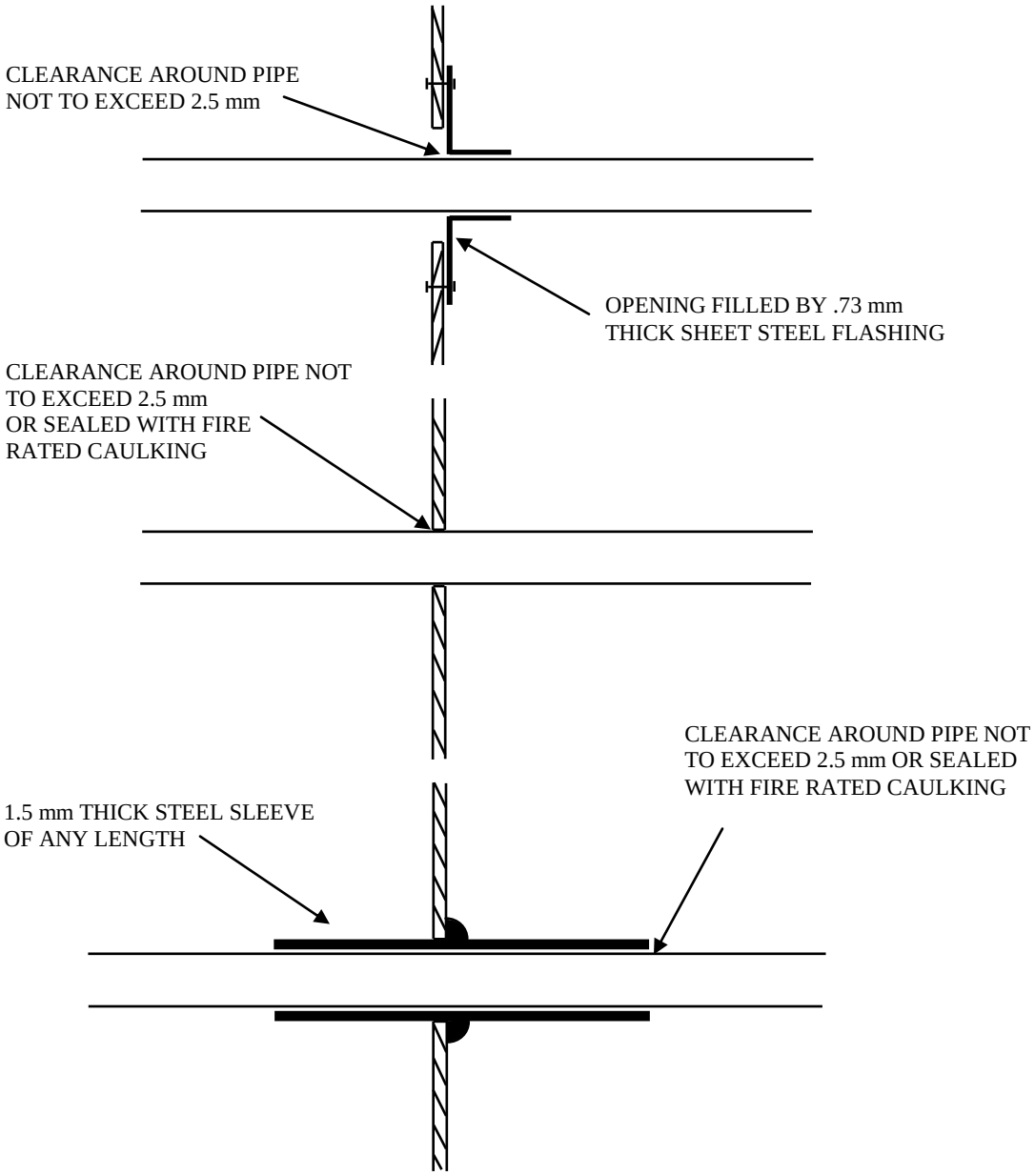
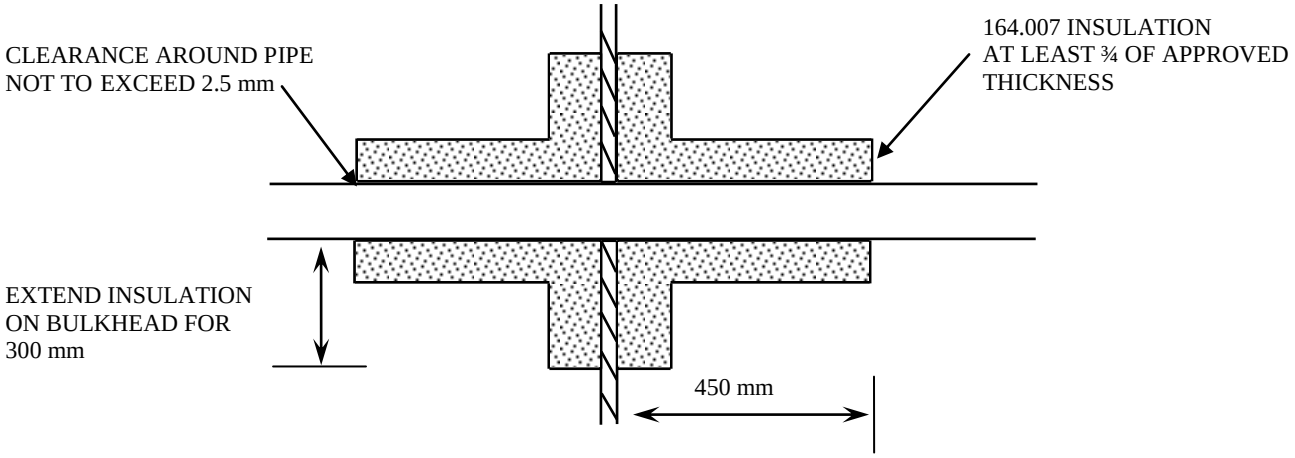


FIGURE 2.13.4

TYPICAL HEAT SENSITIVE PIPING PENETRATIONS OF B-CLASS BULKHEADS



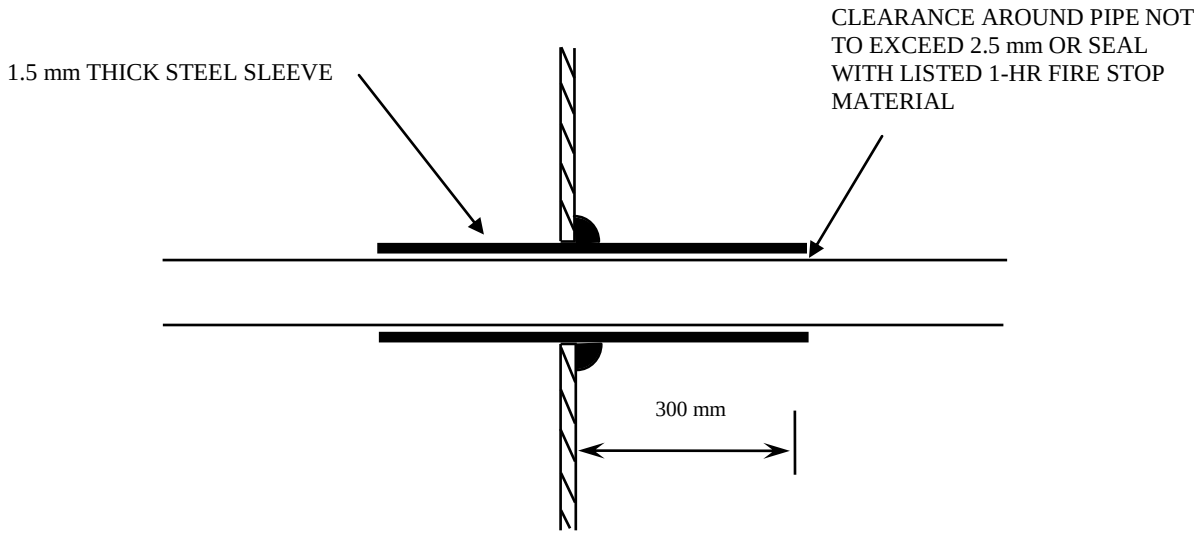


FIGURE 2.13.5

2.13.2 SOLAS Vessels

Ref: Approval series 164.138, MRA approval series A.1/3.26 (A-class) and A.1/3.27 (B-class), FTP Code, Annex 1, Part 3.

Penetrations must be tested in accordance with Annex 1, Part 3 of the FTP Code and Appendices A.III and A.IV of Res. A.754(18). Both the integrity and temperature rise performance criteria must be met for type approval. Penetration seal components are not required to be noncombustible materials and they do not have to meet surface flammability or smoke and toxicity criteria.

Fire rated penetration seals that must also be watertight are tested separately for their watertight properties. The seals do not need to be tested for water tightness after they have undergone fire testing.

Cable Penetrations

Inspection Note: Type approvals issued under approval series 164.138 indicate the approved penetration sleeve or frame mounting details. Shipboard installation of the seals is limited to the mounting method stated in the approval, except that seals that are approved with a bolted frame may be bolted or welded to the bulkhead. Penetration seal type approvals are limited to the maximum size frame, cable fill density and maximum cable diameter listed in the approval. The insulation arrangements for penetrations installed in divisions required to be A-15, A-30 or A-60-class are specified in the type approved installation instructions. The use of the generic insulation details shown in figure 2.13.1 are not an acceptable alternative. Penetrations installed in bulkheads have different approval limits than penetrations installed in decks. The approval limits for each seal design are listed on the type approval certificate and in MISLE.

The FTP Code requires two fire tests for an unrestricted approval; one in a vertical furnace for bulkhead penetrations and the other in a horizontal furnace to evaluate deck installations. The test bulkhead is mounted in the furnace with its stiffeners and insulation on the unexposed surface, while the deck test specimen is mounted with the insulation and stiffeners on the bottom or exposed side. The FTP Code requires that penetrations must be installed in the top half of the test bulkhead to simulate actual fire exposure conditions, however, the Coast Guard will accept tests with penetrations installed below the midheight of the test bulkhead if the laboratory adjusts the neutral plane of the furnace below the level of the penetrations to ensure that all of the test specimens are exposed to positive furnace pressure.

The minimum and maximum size (length x width, cross sectional area or diameter) seal for which approval is requested must be tested. Shipboard installation of penetration seals is limited to the maximum size tested. For multi-cable transits the maximum face area of the seal tested is considered the installation size limit. For example if a standard size 8 frame is tested in an 8 x 2 configuration, that is the maximum size seal that can be installed in accordance with the type approval. The test results cannot be extrapolated to an 8 x 4 or larger size seal. Penetration seals are tested with the manufacturer's recommended minimum separation distance between adjacent cables and between the cables and the inside of the

frame. The minimum separation distances used in the tests are a condition of type approval and are applicable to shipboard installations.

The FTP Code requires a minimum separation of 200 mm (8 inches) between adjacent penetrations, and between the penetrations and the edge of the test bulkhead. For insulated specimens, the 200 mm distance is measured from the outer border of the insulation. The 200 mm separation is not an installation requirement, but is a laboratory requirement that is intended to prevent heat transfer from influencing the performance of adjacent items during testing.

Shipboard cable penetrations typically involve a large number of sizes and shapes of different cables. It is unrealistic to test every possible configuration, therefore, the manufacturer should test a representative number of sizes and arrangements to allow installation flexibility. The FTP Code requires that cable penetration seals must be tested with typical shipboard cables having different numbers and types of conductors as well as a variety of insulation and jacket materials. Type approvals are limited to the largest diameter cables tested. Armored and continuous aluminum metal clad cables (CLX type) should be included in the test program to be covered by the type approval. Electrical penetration seals may be welded or bolted to the test assembly. Manufacturers need not test every size and configuration in the welded and bolted pattern. Both means of attachment will be accepted if representative specimens of each are included in the fire test.

The FTP Code requires that penetration seals must be tested with no more than 40% of the inside cross-sectional area occupied by cables. This is considered a maximum fill limit, and penetration seals installed on the ship are acceptable with any fill density up to the maximum tested. The percent fill of cables is determined by adding the cross sectional area of each cable and dividing by the face area of the frame. For multi-cable transits, the calculation of the overall frame area does not need to consider the area occupied by the end packing and compression plate.

Some approved penetration seals require the application of approved noncombustible A-60 insulation around or over the penetration in addition to the sealant material. The extent of insulation tested is part of the type approval, and is applicable to shipboard installations.

Typical installation drawings should be prepared as part of the type approval application to show the installation restrictions determined during the laboratory approval testing. These drawings will be referenced on the type approval certificate. The typical installation drawings should include:

1. all installation restrictions;
2. the minimum and maximum acceptable seal dimensions;
3. the acceptable cable types;
4. the maximum acceptable cable diameter;
5. the minimum allowable separation between cables;
6. the minimum acceptable separation between cables and the frame;
7. the maximum acceptable per cent fill; and

8. the required insulation details.

Piping Penetrations

SOLAS regulation II-2/9 allows steel piping of at least 3mm thickness with no openings within 450 mm of the bulkhead to be installed without testing. Other piping penetrations of A-class divisions must be fire tested in accordance with Appendix A.III of Res. A.754 (18). Two fire tests are required, one in a vertical furnace for bulkhead penetrations and the other in a horizontal furnace for deck penetrations. The test bulkhead must be arranged in the furnace with its stiffeners and insulation on the unexposed surface; the deck test specimen is mounted with the insulation and stiffeners on the bottom or exposed side. The FTP Code requires that penetrations must be installed in the top half of the test bulkhead to simulate actual convective heat exposure conditions. However, the Coast Guard will accept tests with penetrations installed below the midheight of the test bulkhead if the laboratory adjusts the neutral plane of the furnace below the level of the penetrating devices to ensure that all of the test specimens are exposed to positive furnace pressure.

The tested piping sections must extend at least 500 mm (20 inches) beyond each side of the core plate and should be capped on the furnace side to prevent internal fire spread. The pipes must be fixed to a support frame that is independent of the test bulkhead or deck to restrain them from moving during the fire test.

The manufacturer should test a representative range of pipe sizes and arrangements to allow installation flexibility. The smallest and largest sizes of penetrations for which approval is requested should be tested. Piping penetration seals may be welded or bolted to the test assembly. Manufacturers need not test every size and configuration in the welded and bolted pattern. Both means of attachment will be accepted if representative specimens of each are included in the fire test.

The number of pipes contained in a seal may vary from a single pipe to the maximum available fill ratio. The maximum cross-sectional area of the seal that is occupied by the penetrating pipes during testing will be used as an installation limit. Also the minimum annular space between the pipes and the sleeve will be limited to that tested. The manufacturer may also specify the type of piping materials to be tested, for example, steel, stainless steel, copper, copper-nickel, etc.

Some approved penetration seals require the application of approved noncombustible A-60 insulation around or over the penetration in addition to the sealant material. The additional insulation used in the type approval test is considered part of the approval and is applicable to shipboard installations.

Typical installation drawings should be prepared as part of the type approval application to show the installation restrictions determined during the laboratory approval testing. These drawings will be referenced on the type approval certificate. The typical installation drawings should include:

1. all installation restrictions;
2. the minimum and maximum acceptable seal dimensions;
3. the acceptable piping types;
4. the maximum acceptable pipe diameter;
5. the minimum allowable separation between pipes;
6. the minimum acceptable separation between pipes and the frame;
7. the maximum acceptable per cent fill; and
8. the required insulation details.

Ventilation Duct Penetrations

Where ventilation ducts penetrate A-class and B-class barriers, specific protection measures are required by SOLAS regulations II-2/9.7.3 and II-2/9.7.4. For further information see section 3.7.

2.14 Fire Dampers

2.14.1 Domestic vessels

Ref: 46 CFR 72.05-50, 116.610

The construction specifications in Subchapters H and K may be applied to fire dampers installed in A-class divisions on all domestic vessels. The regulations require fire dampers to have a casing and blade constructed of at least 3 mm (11 USSG) thick steel, with a maximum gap of 3 mm (1/8 inch) between the blade and the casing. The operating components of the damper such as springs and hinges must be stainless steel or equivalent corrosion resistant construction.

The damper may be bolted or welded to the division penetrated. Alternatively a 3 mm (1/8 inch) thick steel sleeve may be installed between the damper casing and the division. If the division penetrated is required to be A-15, A-30 or A-60 class, the damper and section of sleeve between the damper and the division should be insulated to the same level of protection, however the damper blade does not need to be insulated.

All dampers must be capable of manual operation. Dampers installed in main vertical zone bulkheads must also be capable of automatic operation by a fusible link or other type operator.

UL Listed 1-1/2 hour dampers that have been tested in a steel bulkhead or deck will be accepted for use in A-class divisions. Fire dampers approved under approval series 164.139 may also be installed onboard domestic vessels.

Ventilation ducting of at least 0.73 mm thick steel (22 USSG) that penetrates B-class bulkheads is not required to have a fire damper, if the penetration is made tight fitting. If thinner ducting is used, fire dampers should be provided.

B-class fire dampers are constructed the same as A-class dampers, except the damper casing and blade may be constructed of 1.5 mm (16 USSG) thick steel.

2.14.2 SOLAS Vessels

Ref: Approval series 164.139, MRA approval series A.1/3.22, FTP Code, Annex 1, Part 3

Inspection Note: Fire dampers approved under approval series 164.139 may be approved with a variety of mechanical, pneumatic and electrical actuators that are mounted directly on the damper frame. The type approval certificate has a specific reference to the acceptable types of actuators for direct mounting, since the actuator design may influence the fire resistance of the damper. The actuators may also be remotely mounted using a stand-off bracket that provides several inches of clearance between the actuator mechanism and the damper. In this case, the actuator does not affect the fire resistance of the damper, and any actuators may be installed. Specific details are listed on the type approval certificate and in MISLE.

Automatic fire dampers must be tested and type approved in accordance with Annex 1, Part 3 of the FTP Code and Appendix A.II of Res. A.754(18). Two fire tests are required, one in a vertical furnace for bulkhead penetrations and the other in a horizontal furnace for deck penetrations. The Coast Guard applies only the integrity performance criteria of Res. A.754(18) for the approval of dampers. Temperature rise criteria are not applied, since it has been determined that insulation of the damper sleeve to the same standard as the division penetrated will provide an equivalent level of protection for installation in A-60, A-30 or A-15 class divisions.

The test bulkhead is mounted in the furnace with its stiffeners and insulation on the unexposed surface; the deck test specimen is mounted with the insulation and stiffeners on the bottom or exposed side. The FTP Code requires that penetrations must only be installed in the top half of the test bulkhead to simulate actual fire exposure conditions. However, the Coast Guard will accept tests with penetrations installed below the midheight of the test bulkhead if the laboratory adjusts the neutral plane of the furnace below the level of the penetrating devices to ensure that all of the penetrations are exposed to positive furnace pressure.

The minimum and maximum size dampers for which approval is requested should be tested. SOLAS requires fire dampers to automatically close, thus the type approval test assembly must include an automatic damper actuator or operator. Most manufacturers use either spring, electric motor, or pneumatic operators. If the manufacturer wishes to use a variety of operators they should be included in the fire tests. Manufacturers need not test every damper size and configuration with each operator. The test program will be considered representative of the range of possible damper variations, if it includes at least one variant of the type of steel used, the thickness of steel used, and type of operators used. Dampers that are tested with only a fusible link operator are limited to the use of fusible links.

The FTP Code requires that fire dampers must be in the open position at the start of the test and close automatically. Manual closure of the dampers during the test is not acceptable.

2.15 Fire Restricting Materials for High Speed Craft

Ref: Approval series 164.201, FTP Code, Annex 1, Part 10, IMO High Speed Craft Code, Chapter 7

This category of materials is applicable to vessels built to the IMO High Speed Craft Code (HSC Code). The Coast Guard does not have separate regulations for domestic high speed craft, and uses the IMO HSC Code for the approval of both SOLAS and domestic vessels.

The High Speed Craft (HSC) Code requires fire-restricting materials to have properties complying with the Fire Test Procedures (FTP) Code. The FTP Code Annex 1, Part 10 is the test standard for fire-restricting materials on high-speed craft. Part 10 was approved by Resolution MSC./101(73), and does not appear in the early print editions of the FTP Code. HSC Code regulation 7.4 requires the hull, superstructure, structural bulkheads, decks, deckhouses, and pillars be constructed of approved non-combustible materials or fire-restricting materials that comply with the Fire Test Procedures (FTP) Code.

Fire restricting materials are combustible materials such as FRP, intumescent materials and other composites that have been shown to have limited heat release properties.

Fire restricting materials including surface materials on bulkheads, and wall and ceiling linings including their supporting structure are tested and evaluated in accordance with ISO 9705, *The Room/Corner Test* specified by IMO Resolution MSC.40(64) as amended by IMO Resolution MSC. 90(71). Furniture and other structural or interior components are tested to ISO 5660, *The Cone Calorimeter Test*. Vertically supported textiles, upholstery and bedding components are tested to Parts 7, 8 and 9, respectively of Annex 1 of the FTP Code.

The tests for fire restricting surface materials are performed in accordance with the ISO 9705 room/corner test. This is a test intended to evaluate the contribution to fire growth provided by a surface product when it is exposed to a standard fire source. The test uses a full-scale room mock-up 3.6 m (12 ft) in length, 2.4 m (8 ft) in width and 2.4 m (8 ft) in height. An open doorway is located on the 2.4 m wall. The test specimen is attached to the three walls opposite the doorway and the ceiling. A propane fuelled sand burner is placed on the floor in one of the corners opposite the doorway. A vent hood is positioned over the open doorway to collect the smoke and products of combustion given off during the test. Instrumentation is provided in the exhaust duct from the hood to measure the amount of oxygen consumed, along with other data needed to calculate the heat release rate of the material being tested. The optical density of the smoke produced is determined using a light obscuration photocell system.

There are six performance criteria listed in the FTP Code that surface materials must meet in order to be approved as fire restricting materials:

1. The average heat release rate, excluding the heat release from the ignition source must be less than 100 kW;

2. The maximum heat release rate, excluding the heat release from the ignition source must not exceed 500 kW for any 30 second period;

3. The average smoke production rate must be less than 1.4 m^2/s;

4. The maximum smoke production rate cannot exceed 8.3 m^2/s averaged over any 60 second period;

5. Flame spread should not reach any further down the walls than 0.5 m from the floor, excluding the area within 1.2 m of the fire source; and

6. No flaming drops or debris may reach the floor outside the area 1.2 m from the fire source.

Furniture and other structural or interior components not intended to be installed as linings are tested to ISO 5660, the cone calorimeter. This is a small scale test done in a laboratory apparatus where a 100 mm x 100 mm specimen is exposed to a radiant heat panel. A small hood and duct arrangement is provided to collect the products of combustion driven off from the specimen during exposure. The FTP Code requires meeting the following four performance criteria to be considered as a fire restricting material:

1. The time to ignition must be greater than 20 seconds;

2. The maximum 30-second sliding average heat release rate does not exceed 60 kW/m^2;

3. The total heat release rate does not exceed 20 MJ/ m^2; and

4. The time average smoke production rate does not exceed 0.005 m^2/s.

For high speed craft, materials which qualify as fire restricting materials are considered to also comply with Parts 2 and 5 of Annex 1 of the FTP Code without further testing.

2.16 Fire Resisting Divisions for High Speed Craft

Ref: Approval series 164.207, FTP Code, Annex 1, Part 11, IMO High Speed Craft Code, Chapter 7

This category of materials is applicable to vessels built to the IMO High Speed Craft Code (HSC Code). The Coast Guard does not have separate regulations for domestic high speed craft, and uses the IMO HSC Code for the approval of both SOLAS and domestic vessels.

HSC Code regulation 7.4.2 requires bulkheads, decks, ceilings, linings and doors to have fire resisting properties. Fire-resisting divisions must comply with the FTP Code Annex 1, Part 11. Part 11 was approved by Resolution MSC.101(73), and does not appear in the early print editions of the FTP Code. Part 11 requires fire resisting divisions to be tested and evaluated in accordance with the fire test procedures specified in IMO Resolution MSC.45(65), *Test Procedures for Fire-Resisting Divisions of High Speed Craft*. The test procedure is identical

to Part 3 of Annex 1 of the FTP Code, except that the materials of construction may be either noncombustible materials meeting Part 1 of Annex 1 or they may also be fire restricting materials under Part 10 of Annex 1. This allows the use of lightweight composite materials for the construction of high speed craft.

Fire resisting divisions that separate moderate fire hazards are classified as fire resisting divisions 30. Those that separate major fire hazard areas are classified as fire resisting divisions 60.

Fire resisting divisions are also classified as load-bearing or non-load-bearing divisions. Non-load-bearing divisions are tested in accordance with the Res. A.754(18) procedures for B-class divisions. Load-bearing divisions with a structural metal core plate are tested in accordance with the Res. A.754(18) procedures for A-class divisions. Other load-bearing divisions (e.g., lightweight sandwich panels) are tested in accordance with the procedures for B-class divisions, except they are also subjected to an applied static load during the fire test. The deformation of the test panel is monitored as the heat is applied to verify that the assembly is able to support the test load for the required test period.

2.17 Fiber Reinforced Plastic (FRP) Grating

Ref: Approval series 164.040

2.17.1 Domestic vessels

The use of fiber reinforced plastic (FRP) gratings is not specifically addressed in the vessel regulations. In response to industry requests, the Coast Guard has developed a policy to allow the use of FRP gratings onboard vessels, mobile offshore drilling units (MODUs) and floating production platforms as explained below. FRP gratings are permitted in machinery spaces, cargo areas and on-deck areas, but not within accommodation, service and control spaces.

FRP gratings are tested and approved under type approval series 164.040. The type approval criteria for FRP gratings have been developed based on the expected fire hazard the gratings could be exposed to, in conjunction with requirements for means of escape and fire brigade access to the area where the gratings will be located. The type approval and testing requirements for the specific locations are summarized in Table 2.17.1.

The type approval requirements include two separate tests; a structural integrity test and a surface flammability test. The tests should be conducted on each complete FRP material system. Any changes in the type, amount, and/or architecture of either the reinforcement materials, resin matrix, coatings, or manufacturing process are considered significant differences that require separate testing.

All approved FRP gratings should be permanently marked with the type approval number and approved level (L1, L2, L3) for the future use of inspectors. The label may be molded into the grating, or included on a permanently attached label.

All FRP gratings are required to have low flame spread characteristics. Two test methods are accepted for demonstrating these characteristics of FRP gratings. The first is ASTM E-84 *Standard Test Method for the Surface Burning Characteristics of Building Materials*. Type approved gratings tested to this procedure are required to have a flame spread rating of 20 or less.

The Coast Guard will also accept the test methods in the International Maritime Organization's (IMO) Fire Test Procedures Code (FTP Code). The gratings should be tested to the procedures in the FTP Code Annex 1, Part 5 for surface flammability of materials used as bulkheads, linings, or ceilings. If a manufacturer wishes to test a product to Part 5 of the FTP Code, Coast Guard Headquarters should be consulted for a determination of the test specimen configuration.

The type approval program for FRP gratings requires gratings to be tested to three different levels of structural fire integrity, with Level 1 providing the highest level of protection and Level 3 providing the lowest. The structural integrity test is a one hour fire exposure, followed by the application of different loads to the test specimens that are dependent on the level of approval being requested:

> Level 1 (L1): FRP gratings meeting the L1 performance criteria provide the highest degree of safety and are intended for use in escape routes or in areas where access for firefighting, emergency operation or rescue is needed after a significant fire exposure that may weaken the gratings. Level 1 gratings may also be used in any areas requiring level 2 or level 3 gratings.
>
> Level 2 (L2): FRP gratings meeting the L2 performance criteria are intended for use in areas where personnel may need to assemble after the grating has been exposed to a fire, and are tested to ensure that they will able to sustain a post-fire structural loading. Areas where L2 gratings are specified include temporary safe refuge or lifeboat embarkation stations. Level 2 gratings may also be used in any areas requiring level 3 gratings.
>
> Level 3 (L3): FRP gratings meeting the L3 performance criteria are intended for use in areas used as egress routes or that may require access for firefighting, emergency operations or rescue during or shortly after exposure to a very limited fire, not likely involving flammable liquids. It is not expected that gratings in L3 areas would be compromised by the fire exposure.

Not all FRP gratings need to be approved. Gratings used in the following applications may be used without restriction:

(a) as deck overlays over solid steel plating (i.e. machinery spaces, open decks/areas)
(b) sea chest coverings
(c) small sundeck awnings and supports
(d) lifeboat bilge flooring
(e) electrical control flooring

(f) pipe guards on deck, in cargo holds, and in engine rooms
(g) removable guards over hawseholes, anchor hawse pipes, and scuppers
(h) personnel barriers, such as protection for electrical panels
(i) ship staging and work platforms

The structural integrity test for Level 3 requires the gratings to be subjected to fire tests conducted in accordance with ASTM E-119, *Standard Test Method for Tests of Building Construction and Materials*. Two separate tests are conducted with a minimum of two test specimens for each grating design. The first fire test is conducted with each grating pre-loaded with a fixed weight before fire exposure to determine the grating's capability of supporting a load during a fire. The second test applies a specified load after the fire test is completed to simulate personnel re-entering an area after the fire is extinguished.

Specific test criteria are as follows:

(a) Each test specimen should be 300-350 mm in width to allow for the differences in the spacing of longitudinal supporting members. The length of each test specimen should be the maximum length to be seen in service plus 200 mm.

(b) Test one - Pre-loaded Test:

1. Two test specimens should be placed adjacent to one another in the furnace, simply supported on I-beams, with a minimum flange width of 100 mm. The I-beams should be perpendicular to the gratings. The gratings should be at an elevation of at least one half of the furnace height or a minimum of 300 mm above the burners;

2. The specimens should be placed on the I-beams with 100 mm of each end of the gratings resting on each of the two I-beams;

3. A 40 kg static load consisting of a square steel container with an area of 0.09 m^2 filled with sand should be placed at the midpoint of each of the gratings;

4. The preloaded specimens should then be exposed to the ASTM E-119 time-temperature curve until the deflection from horizontal of each of the gratings exceeds a distance equal to the length of the unsupported span divided by 10 (L/10).

5. During the test, the average furnace temperature should be recorded at one minute intervals until the gratings have deflected a distance of L/10 from the horizontal.

6. The test is considered successful if the integrated area* under the furnace time-temperature curve is not less than 25,000° F•min when the deflection reaches L/10.

* The integrated area under the curve should be calculated using the trapezoidal approximation rule.

(c) Test two - Post-loaded Test:

1. Two test specimens should be placed adjacent to one another in the furnace, simply supported on I-beams, with a minimum flange width of 100 mm. The I-beams should be perpendicular to the gratings. The gratings should be at an elevation of at least one half of the furnace height or a minimum of 300 mm above the burners;

2. The specimens should be placed on the I-beams with 100 mm of each end of the gratings resting on each of the two I-beams;

3. The specimens should then be subjected to the ASTM E-119 time-temperature curve for a period of 60 minutes.

4. At the end of the 60 minutes, the specimens should be allowed to cool and the 40 kg static load specified in the pre-loaded test above, should be placed at the midpoint of the gratings.

5. The test will be considered successful if the specimens remain intact at the end of the test and do not collapse under the 40 kg load.

The approval criteria for Level 2 structural integrity require the grating specimens to first successfully pass all elements of the L3 testing. Following that, the two L3 test specimens that were subjected to the post-loaded test are uniformly loaded in increments not exceeding 20 kg, until a uniform load of 4.5 kN/m^2 (94 lbf/ft^2) is reached. The L2 test is considered successful if the two L3 grating specimens remain intact with this additional uniform load applied.

The approval criteria for Level 1 structural integrity require the grating specimens to successfully pass all of the L2 testing. The grating specimens used for the L2 testing are then unloaded and subjected to impact testing in accordance with ASTM E-695, *Standard Method of Measuring Resistance of Wall, Floor, and Roof Construction to Impact Loading* for horizontal specimens. The test specimens should be secured as required in section 8.3 of ASTM E-695 except that the span should be 200 mm less than the specimen length. A lead shot bag with a mass of 40 kg mass should be dropped one time on each grating from a height of 2 m, such that the point of impact is the midpoint of the span. Following this, the specimens should again be uniformly loaded as required by the L2 test procedures. The L1 test will be considered successful if both test specimens remain intact without structural failure after being subjected to the impact test and the second L2 loading test.

Table 2.17.1

Location	Service	Fire Integrity	Flame Spread	Smoke Generation
Machinery Spaces	Walkways or areas which may be used for escape, or access for firefighting, emergency operation or rescue	L1[1]	X	
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	L3	X	
Cargo Pump Rooms	All personnel walkways, catwalks, ladders, platforms or access areas	L1	X	
Cargo Holds	Walkways or areas which may be used for escape, or access for firefighting, emergency operation or rescue	L1	X	
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	Not required	X	
Cargo Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	Not required[2]	X	
Fuel Oil Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	Not required[2]	X	
Ballast Water Tanks	All personnel walkways, catwalks, ladders, platforms or access areas	Not required[3]	X	
Cofferdams, void spaces, double bottoms, pipe tunnels, etc.	All personnel walkways, catwalks, ladders, platforms or access areas	Not required[3]	X	
Accommodation, service, and control spaces	All personnel walkways, catwalks, ladders, platforms or access areas	Not permitted		
Lifeboat embarkation or temporary safe refuge stations in open deck areas	All personnel walkways, catwalks, ladders, platforms or access areas	L2	X	
Open Decks or semi-enclosed areas	Operational areas and access routes for deck foam firefighting systems on tank vessels	L1		
	Walkways or areas which may be used for escape, or access for firefighting systems and AFFF hose reels, emergency operation or rescue on MODUs and production platforms	L2		

	Walkways or areas which may be used for escape, or access for firefighting systems, emergency operation or rescue other than those described above	L3		
	Personnel walkways, catwalks, ladders, platforms or access areas other than those described above	None required		

[1]If the machinery space does not contain any internal combustion machinery, other oil burning, oil heating, or oil pumping units, fuel oil filling stations, or other potential hydrocarbon fire sources and has not more than 2.5 kg/m^2 of combustible storage, gratings of L3 integrity may be used in lieu of L1.

[2]If these spaces are normally entered when underway, gratings of L1 integrity are required.

[3]If these spaces are normally entered when underway, gratings of L3 integrity are required.

2.17.2 SOLAS vessels

FRP gratings may be installed on U.S. flag SOLAS vessels as discussed in Section 2.17.1.

2.18 Fiber Reinforced Plastic Cable Trays

2.18.1 Domestic Vessels

The vessel regulations do not have provisions to allow the use of fiber reinforced plastic (FRP) cable trays. However, the Coast Guard has developed a policy to allow the use of FRP cable trays onboard vessels, mobile offshore drilling units (MODUs) and floating production platforms, provided they meet minimum flame spread and smoke generation criteria.

There is no type approval category for FRP cable trays. Instead, Commandant (CG-5214) maintains a listing of accepted products. All accepted FRP cable trays should have low flame spread characteristics, and if the cable trays will be installed within accommodation, service and control spaces, they should also have a limited smoke generation potential.

Two test methods are accepted for demonstrating these characteristics of FRP cable tray systems. The first is ASTM E-84 *Standard Test Method for the Surface Burning Characteristics of Building Materials*. Cable trays tested to this procedure are required to have a flame spread rating of 20 or less, and if required, a smoke developed rating of 10 or less.

The Coast Guard will also accept the surface flammability testing in the FTP Code. The cable trays should be tested to the procedures in the FTP Code Annex 1, Part 5 for surface flammability, and if required, Annex 1, Part 2 for smoke generation. Cable tray systems tested to these procedures are approved using the performance criteria in the FTP Code for materials used as bulkheads, linings, or ceilings. The acceptance tests should be conducted on the complete FRP cable tray system. Any changes in the type, amount, and/or architecture, of either the reinforcement materials, resin matrix, coatings, or manufacturing process are

considered significant differences that require retesting. A follow-up program is not required for FRP cable trays.

All FRP cable trays should be supported by metal hangers as required by Section 20.5 of IEEE Standard 45, 'Recommended Practice for Electric Installations on Shipboard' and arranged so that their failure will not cause the cables they are supporting to fall and hinder escape or access by firefighters.

FRP cable trays installed in hazardous locations should be electrically conductive. This requires the cable trays to be subjected to a resistivity test.

2.18.2 SOLAS Vessels

FRP cable trays may be installed on U.S. flag SOLAS vessels as discussed in Section 2.18.1.

CHAPTER 3 - CONSTRUCTION AND ARRANGEMENT

3.1 A-Class Bulkheads

3.1.1 Domestic vessels

Ref: 46 CFR 32.57-10, 72.05-10, 92.07-10, 108.133-143, 116.415

Inspection Note: The insulation arrangements in Figures 3.1 through 3.5 include several designs without insulation on one side of the bulkhead, where the note "No source of fire from this side" appears. The intent of this limitation is to install these arrangements in locations where the bare steel side of the division borders tanks, voids or the side shell of the vessel. These bulkhead assemblies should not be used in general areas, as they do not have the appropriate A-class rating for a fire exposure occurring on both sides of the division.

A-class bulkheads constructed of flat or corrugated steel plate are used as the main structural members of a vessel. These bulkheads run from deck to deck and are used to subdivide the accommodation and service areas into separate rooms and areas. A-0 class bulkheads are required on cargo ships, tank vessels, MODUs, floating OCS facilities, research vessels and OSVs to separate galleys, paint lockers, emergency generator rooms, store rooms and stairtowers from the adjoining accommodation and control areas. They are also used to separate the accommodation and control areas from machinery spaces and cargo holds.

On passenger vessels, additional A-class insulation may be required for bulkheads based on the expected fire risk in the adjoining spaces. Subchapters H and K each contain SFP tables that delineate the required fire rating of A-class bulkheads that separate different areas.

Tank vessels have additional insulation requirements for the protection of exterior boundaries facing the cargo area, and boundaries that separate machinery spaces and cargo pumprooms from accommodation, service or control spaces (see 46 CFR 32.56).

Previous testing done by the Coast Guard has shown that 3 mm (11 USSG) thick stiffened steel plate will successfully pass the 46 CFR 164.007 standard fire test for 60 minutes. Uninsulated steel bulkheads of this minimum thickness are accepted as A-0 class bulkheads without testing or type approval. Approved structural insulation (46 CFR 164.007), bulkhead panels (46 CFR 164.008) and air gaps can be used in a variety of combinations to form A-15, A-30 and A-60 class bulkheads, as shown in figures 3.1 through 3.5 without testing. The nomenclature used in the figures refers to the necessary thickness of structural insulation for an A-60 rating as "S", and the necessary thickness of bulkhead panels for a B-15 rating as "P". Any approved B-15 panel may be used in A-15 and A-30 divisions, however, only B-15 panels that were specifically tested for 60 minutes of fire integrity may be used as a component of A-60 construction.

Structural insulation is attached to the steel plate using the manufacturer's approved instructions, or it may be fastened with steel pins and clips as discussed in paragraph 2.3.1. The insulation should be tight-fitting against the steel plate and should cover any stiffeners. The thickness of insulation can be reduced by one half when covering stiffeners. Any

structural elements, deep webs, braces, pipes and similar metal components that attach to or pass through the bulkhead could cause point-source heat transfer through the core plate. To avoid this, all penetrating items should be insulated with the full required thickness of insulation for a distance of at least 300 mm away from the insulated side of the bulkhead. The same heat transfer concerns apply to any uninsulated bulkheads tied to the insulated bulkhead. In such a case, the insulation should extend at least 300 mm past the intersection of the two bulkheads. Insulation installed on corrugated bulkheads should conform to the surface of the steel plate at the full approved thickness. If rigid insulation is used, it need not be shaped to conform to the surface, since the air gaps between the insulation and the steel plate will provide additional protection to the assembly.

3.1.2 SOLAS vessels

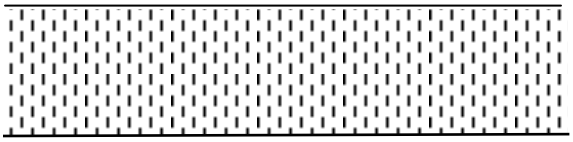
Ref: SOLAS regulation II-2/9.2.2.3, II-2/9.2.2.4, II-2/9.2.3 and II-2/9.2.4

A-class bulkheads are required onboard SOLAS vessels in accordance with regulation II-2/9. Onboard passenger ships, main vertical zone bulkheads are required to be A-60 class divisions, except where a type 5, 9 or 10 space is on one side of the bulkhead, or where fuel oil tanks are on both sides of the division. In these cases the standard may be reduced to A-0. Regulation II-2/9 provides tables that specify the additional insulation requirements for bulkheads within main vertical zones, based on the expected fire risk in the adjoining spaces. Similar tables that define the required fire resistance of bulkheads are also provided for cargo ships and tankers. Insulation applied to A-class bulkheads must be Coast Guard approved, tested and installed in accordance with the FTP Code. The generic arrangements shown in figures 3.1 through 3.5 are not applicable to SOLAS vessels. The FTP Code requires steel plate to be 4 mm or more in thickness to qualify as an A-class division without testing, instead of the 3 mm thick plate accepted on domestic vessels.

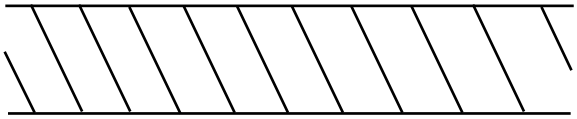
To limit point source heat transmission through insulated bulkheads, SOLAS requires approved structural insulation to be applied to any pipes, structural supports, uninsulated bulkheads and other items that penetrate or attach to the bulkhead for a distance of at least 450 mm (18 inches) past the point of connection. If two bulkheads of different fire rating intersect, the insulation with the higher value must continue for at least 450 mm along the bulkhead insulated to the lower value.

MSC/Circ. 1120 provides an interpretation of SOLAS regulation II-2/3.2 for the approval of A-class bulkhead panels without a 4 mm thick core plate. The interpretation refers to this type construction as lightweight A-class divisions. Light-weight A-class divisions of steel or equivalent material may be used as non load-bearing internal A-class divisions in accommodation and service spaces, except for main vertical zone bulkheads and stairway enclosures on passenger ships, provided they have successfully passed the standard one hour fire test according to resolution A.754(18). The Coast Guard issues type approvals for lightweight A-class bulkheads under approval series 164.107.

LEGEND:



APPROVED STRUCTURAL INSULATION " S "
46 CFR 164.007



APPROVED BULKHEAD PANEL " P "
46 CFR 164.008

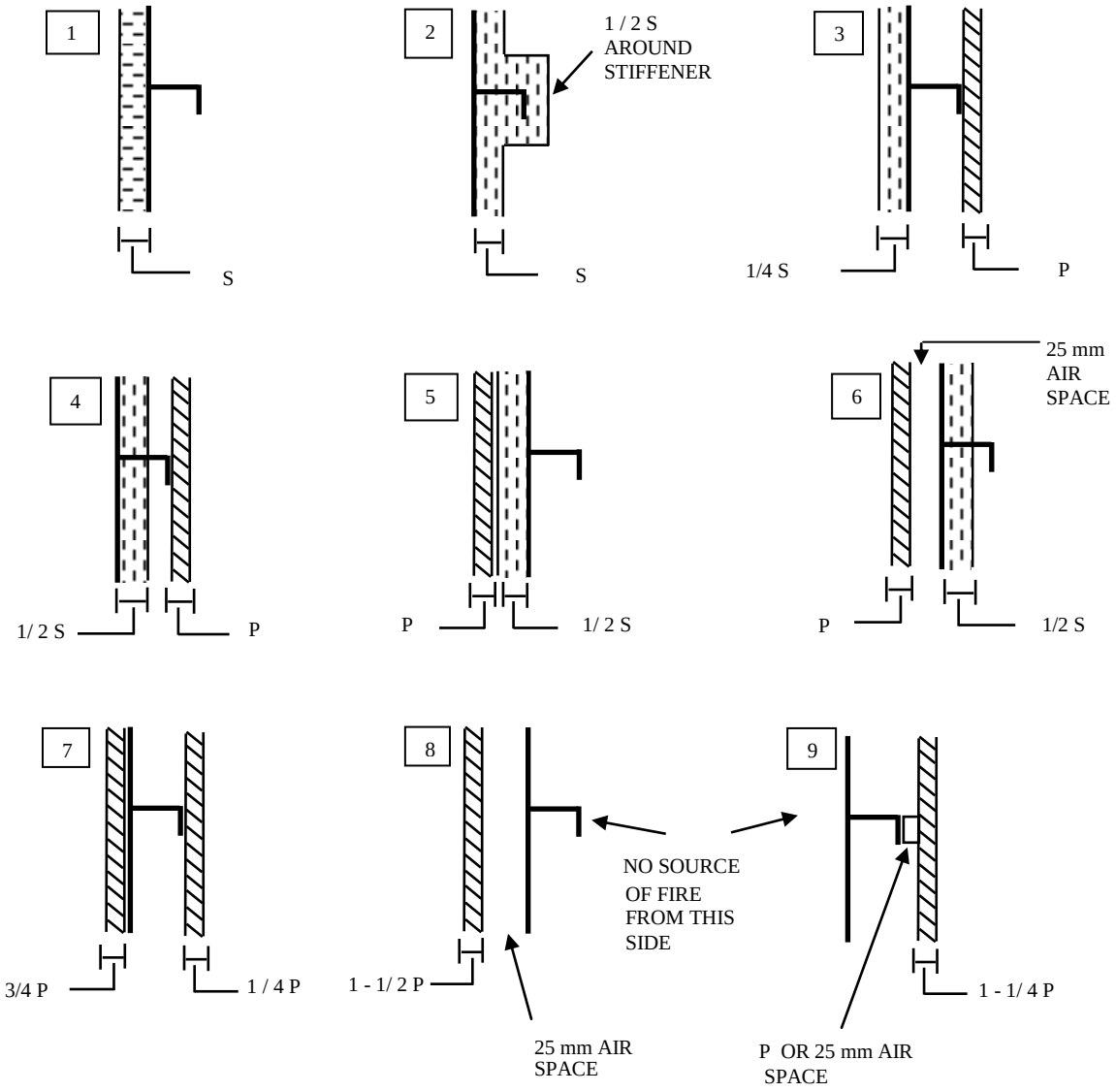
3 mm STEEL PLATE

S = THICKNESS OF APPROVED STRUCTURAL INSULATION TO MEET CLASS A - 60 REQUIREMENTS WITHOUT OTHER INSULATING MATERIALS

P = THICKNESS OF APPROVED BULKHEAD PANEL TO MEET CLASS B -15 REQUIREMENTS. THE USE OF FRACTIONAL VALUES OF P WILL BE ACCEPTED FOR HOMOGENEOUS MATERIALS ONLY

INSULATION ARRANGEMENTS

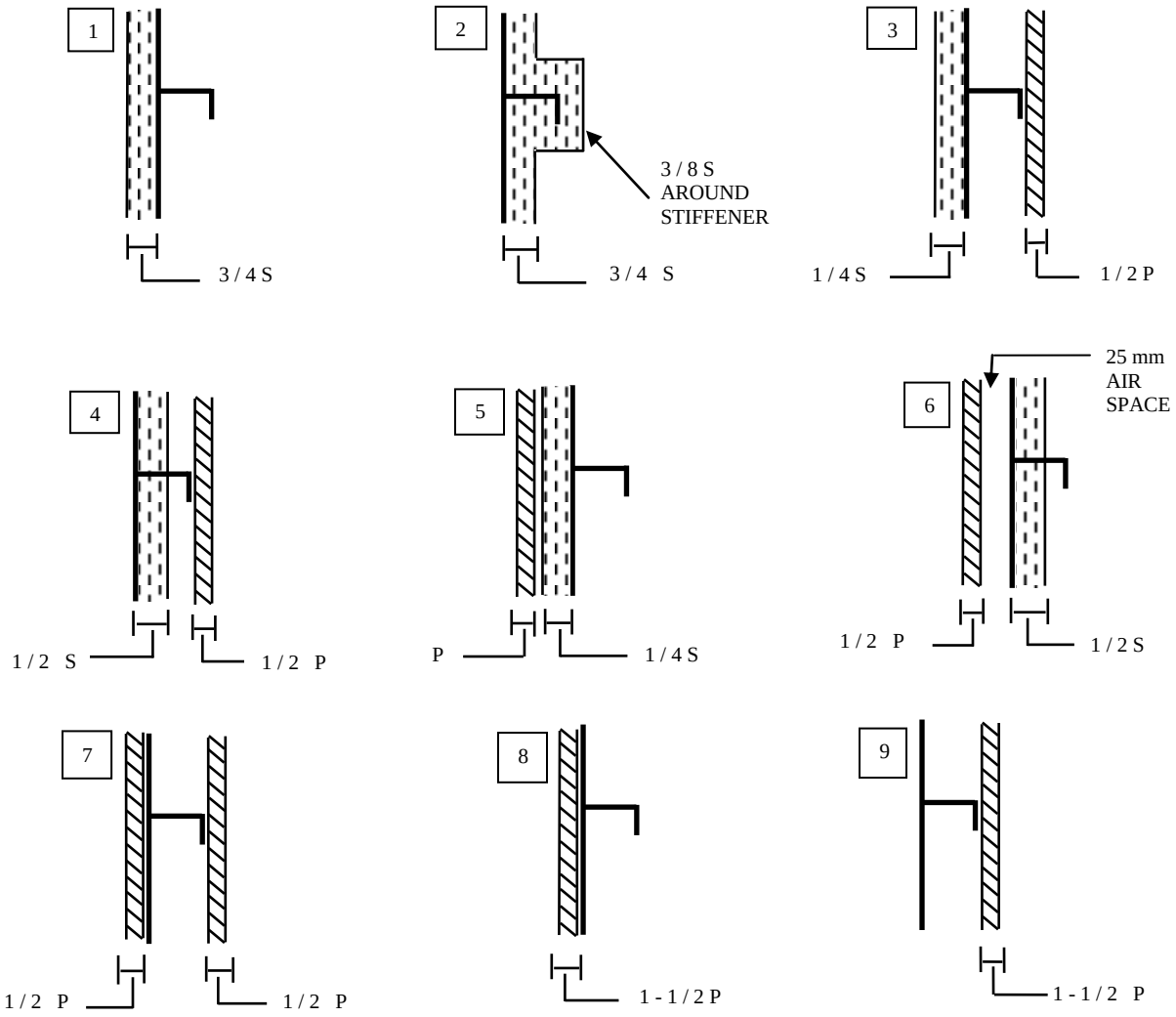
A-60 CLASS BULKHEADS



INSULATION ARRANGEMENTS

FIGURE 3.2

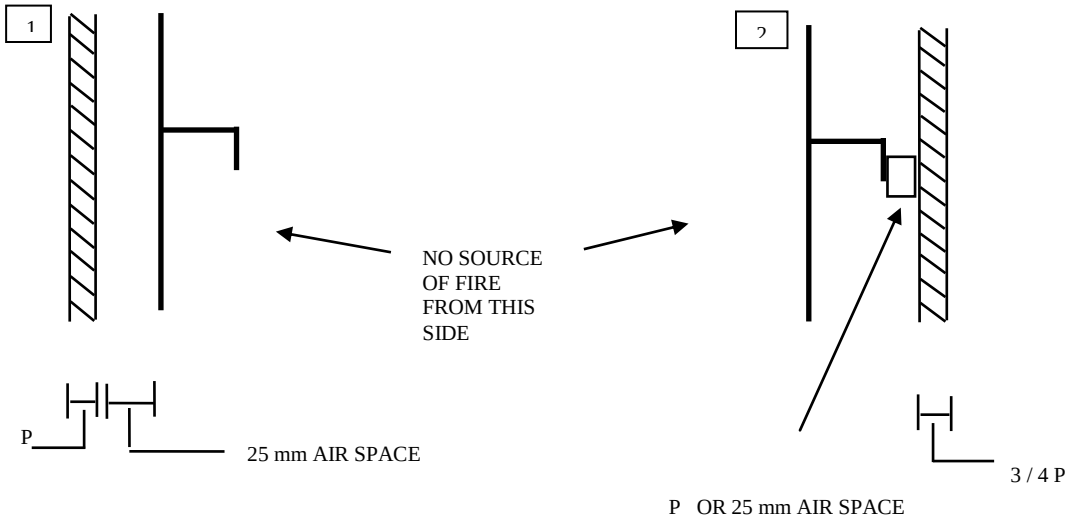
A - 30 CLASS BULKHEADS



INSULATION ARRANGEMENTS

FIGURE 3.3

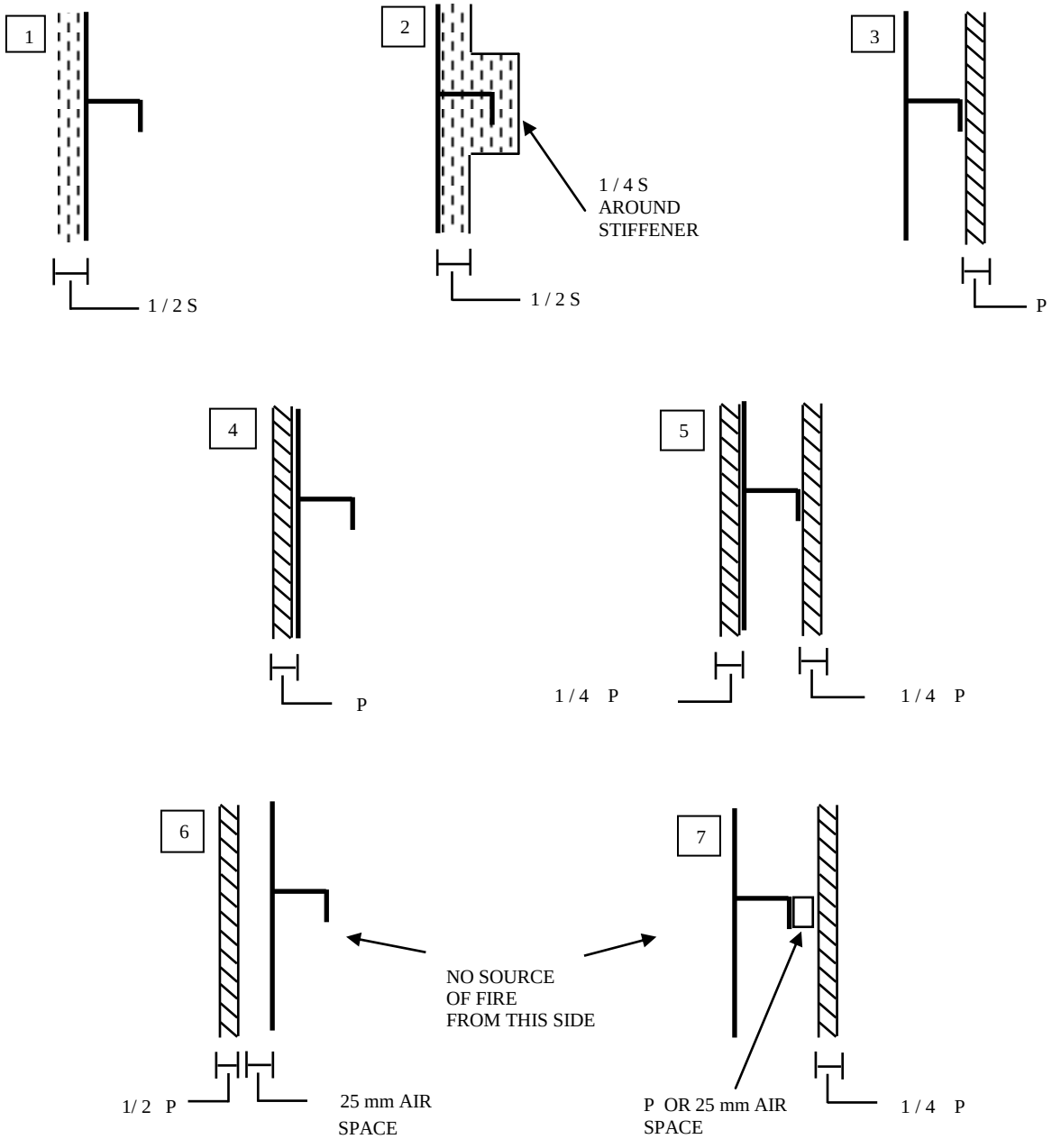
A - 30 CLASS BULKHEADS



INSULATION ARRANGEMENTS

FIGURE 3.4

A - 15 CLASS BULKHEADS



INSULATION ARRANGEMENTS

FIGURE 3. 5

3.2 B-Class Bulkheads

3.2.1 Domestic vessels

Ref: 46 CFR 32.57-10 (d), 72.05-10 (h) through (j), 92.07-10 (d), 108.143, 116.415

Inspection Note: Bulkhead panels and their joinerwork system are tested and approved as a system. The bulkhead panels must be installed with the same joinerwork system that was tested to satisfy the conditions of type approval. Joinerwork systems are not interchangeable with other manufacturer's products.

Inspection Note: If steel curtains are used to extend B-class corridor bulkhead panels to the deck above, the steel curtain should be tight fitting and riveted, bolted or welded in place. If welded, the weld need not be continuous.

B-class bulkheads are used to subdivide larger fire areas and to form the boundaries of rooms and corridors that are not required to be A-class. 1.5 mm thick steel plate (16 USSG) or greater is accepted as meeting B-0 class criteria without testing. The most common shipboard installations do not use steel for B-class bulkheads, instead a bulkhead panel and joinerwork system is typically used. The panels may be constructed of either vermiculite, calcium silicate, steel or glass faced-gypsum, or steel or aluminum faced mineral wool panels. The panels are usually finished with a decorative laminate that may require approval under 46 CFR 164.012, depending on the location of the bulkhead. The panels are erected in place using a joinerwork system, consisting of steel bottom and top tracks and end caps that are attached to the vessel's steel decks and outer shell. The connector joint between panels is usually either an H-post or spline joint arrangement.

Paper-faced gypsum board is available with a noncombustible core, however the facing is combustible and is considered an inherent component of the panel. The paper facing is not considered a surface finish. Thus, paper-faced gypsum board does not meet the noncombustibility requirements in 46 CFR 164.009 and is not acceptable for shipboard use.

On domestic vessels, corridor bulkheads are required to extend deck to deck. However, the Coast Guard will accept the use of steel curtains above the ceiling instead of using B-class panels. It is acceptable to stop the bulkhead panels at the ceiling level, and install a continuous 1.5 mm steel (16 USSG) curtain between the top cap of the joiner panels and the underside of the deck. If the corridor bulkheads are required to be B-15 class, the steel extension curtain is not required to be insulated. B-0 class extensions of the bulkhead above the ceiling are acceptable. Another alternative is to install an approved B-class continuous ceiling throughout the area, in which case the corridor bulkheads may stop at the ceiling and no extension above is necessary.

3.2.2 SOLAS vessels

Ref: SOLAS Regulation II-2/9.2.2.2

Inspection Note: All B-class bulkheads on SOLAS ships are required to extend deck to deck and sideshell to sideshell. If an approved B-class continuous ceiling is installed, the bulkheads may terminate at the ceiling. The use of steel curtains to extend B-class bulkheads above the ceiling is not acceptable, unless the specific configuration has been tested and approved to the FTP Code, Annex 1, Part 3.

B-class bulkheads, including those constructed of steel plate, used onboard SOLAS vessels must be tested and approved to the FTP Code. B-class panel and joinerwork systems for use on SOLAS applications are similar to those used on domestic vessels except for different approval fire tests.

On SOLAS vessels, all B-class bulkheads are required to extend deck to deck and sideshell to sideshell. The only exception to this requirement is where an approved continuous B-class ceiling is installed, the bulkheads may terminate at the ceiling.

3.3. C-Class Bulkheads

3.3.1 Domestic vessels

Ref: 46 CFR 32.57-5 (d), 72.05-10 (c) (3) and 72.05-15 (f), 92.07-5 (d), 108.131 (b)(4), 116.415 (a) (2) (v) & (vi)

Inspection Note: All penetrations in C' (C prime) bulkheads for the passage of cables, piping, etc. need to be sealed to ensure that the boundary remains smoke-tight. The openings may be welded or sealed with a listed caulking material. The less restrictive "tight-fitting" criteria applied to B-class divisions is not acceptable for C' bulkheads.

C-class bulkheads are required to be constructed of steel, aluminum or approved noncombustible materials, and may have a decorative surface laminate. If the bulkhead is located in a concealed space, the surface finish must be approved under 46 CFR 164.012. The Coast Guard does not issue type approvals for C-class bulkheads. C-class bulkheads may be used on cargo ships, MODUs, floating OCS facilities and research vessels in any location where A-class or B-class boundaries are not required, such as between adjacent staterooms. On passenger ships, C-class bulkheads may be used where permitted by tables 72.05-10 (d) & (e) and 116.415 (b).

Certain areas on Subchapter K vessels may be separated from adjacent spaces by C' (C prime) bulkheads. These are C-class bulkheads that are intended to restrict the passage of smoke. Typically, these are steel or aluminum bulkheads that extend to the main structure of the vessel.

3.3.2 SOLAS vessels

Ref: SOLAS regulation II-2/3.10

SOLAS requires C-class bulkheads to be constructed of approved noncombustible materials, except for any applied surface laminates. Depending on the location of the bulkhead, surface flammability, smoke and toxicity requirements may apply to the laminate, in accordance with regulation II-2/5.3.2.4. C-class bulkheads may be used where permitted by SOLAS regulation II-2/ Tables 9.1, 9.3, 9.5 and 9.7.

MSC/Circ. 1120 provides an interpretation of regulation II-2/3.10 that permits the use of combustible adhesives in the construction of C-class bulkheads if the adhesive meets the surface flammability requirements of Part 5 of Annex 1 of the FTP Code. This allows the approval of C-class bulkhead panels constructed of a noncombustible core (164.109 material or aluminum honeycomb) with steel or aluminum sheet face panels bonded by an approved low flame spread adhesive. The Coast Guard issues type approvals for this type of panel as noncombustible materials under approval series 164.109. Type approvals are not issued for C-class bulkhead panels, and they are not covered under the U.S./EC MRA.

3.4 A-Class decks

3.4.1 Domestic vessels

Ref: 46 CFR 32.57-10, 72.05-10, 92.07-10, 108.133-143, 116.415

Inspection Note: The deck insulation arrangements shown in Figures 3.6 through 3.9 that include approved bulkhead panels are acceptable if the joinerwork and support system for the bulkhead panels have been fire tested in a horizontal orientation and specifically approved for such applications. Typical joinerwork systems used for bulkhead panels are tested only in a vertical plane and will not support the expected load of the panels when installed as ceilings.

A-0 class decks are required on cargo ships, tank vessels, MODUs, floating OCS facilities and research vessels to separate galleys, paint lockers, emergency generator rooms, store rooms and stairtowers from accommodation and control areas. They are also used to separate the accommodation and control areas from machinery spaces and cargo holds.

On passenger vessels, additional A-class insulation is required for decks, based on the expected fire risk in the spaces above and below. Subchapters H and K provide tables with the required fire rating of A-class decks located between different spaces (see 46 CFR 72.05-10 and 116.415).

Tank vessels also have additional insulation requirements for the protection of exterior boundaries facing the cargo area, and boundaries that separate machinery spaces and cargo pumprooms from accommodation, service or control spaces (see 46 CFR 32.56).

Passenger vessels are required to be subdivided by main vertical zone bulkheads every 40 meters. In cases where the main vertical zone bulkheads on one deck do not align with those on the decks below or above, the main vertical zone is offset or "stepped" by including a short section of deck in the main vertical zone boundary. Because of this, the deck is insulated to the higher standards required for main vertical zone bulkheads. If the vessel must comply with Subchapter H, the deck insulation requirements of Table 72.05-10 (d) apply to the step. If the vessel is designed to Subchapter K, the criteria in 46 CFR 116.415 (d) regarding deck insulation apply to the step.

Uninsulated steel deck plating of 3 mm minimum thickness is accepted as A-0 class without testing. Approved structural insulation (46 CFR 164.007), bulkhead panels (46 CFR 164.008), deck assemblies (164.005), deck coverings (164.006), structural ceilings (164.010) and air gaps can be used in a variety of combinations to form A-15, A-30 and A-60 class decks. Any approved B-15 panel may be used in A-15 and A-30 divisions, however, only B-15 panels that were specifically tested for 60 minutes of fire integrity may be used as a component of A-60 construction.

Figures 3.6 through 3.9 show acceptable combinations of these materials that may be used to form A-class decks without testing of the combined assembly.

Structural insulation should be attached to the underside of the steel plate using the same pin and clip method used for bulkheads, including extending the insulation past the intersection with the surrounding bulkheads and along any penetrating pipes or structures for at least 300 mm. If an approved A-60 deck covering or floating floor is installed on the top side of the deck, the insulation may end at the perimeter bulkheads. Penetrations that are routed through the deck should be insulated for 300 mm below the deck. No additional insulation is required on the uninsulated bottom side of the steel deck plate around the penetrating items.

Deck coverings (164.006) may be installed on the top surfaces of the steel deck plating to provide A-60 protection. Deck covering type approval certificates state the minimum thickness of material necessary to provide A-60 protection. Deck coverings are usually not the final floor finish, and other materials such as vinyl tile or leveling compounds are installed on top of the deck covering. The regulations refer to these materials as overlays, and the regulations permit the use of any material for this purpose up to a maximum thickness of 9.5 mm. Overlays are not required to meet any fire protection test criteria.

Approved deck assemblies or floating floors (164.005) may be installed on the top side of decks in accordance with the manufacturer's approved instructions. Floating floors generally consist of two components, a layer of fibrous or mastic insulation that is applied on the top side of the deck plate covered by a steel finish floor assembly. Overlays and floor coverings approved under 164.117 may also be applied to the top surface of the floating floor if desired.

Approved continuous B-class ceilings may be installed beneath the steel deck plate as part of the A-class deck insulation system, in accordance with the manufacturer's approved instructions. Figures 3.6 through 3.9 do not contain provisions for continuous B-class ceilings, as they are installed suspended well below (typically 300-600 mm) the steel deck and stiffeners. The type approval for each continuous B-class ceiling specifies the minimum

required separation distance between the ceiling and the steel deck, as well as the approved frame and support details.

3.4.2 SOLAS vessels

Ref: SOLAS regulations II-2/9.2.2.3, II-2/9.2.2.4, II-2/9.2.3 and II-2/9.2.4

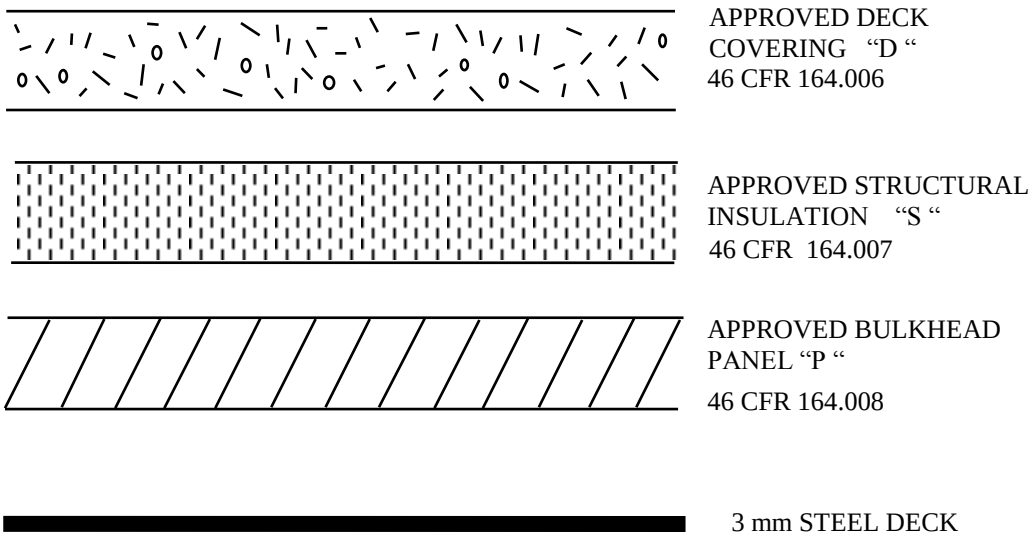
Inspection Note: The generic arrangements shown in figures 3.6 through 3.9 have not been tested to the FTP Code, and are not acceptable for use on SOLAS vessels.

Inspection Note: Structural insulations approved under approval series 164.107 are tested in different orientations for both bulkhead and deck applications. As a result, the required A-60 thickness of insulation for bulkheads is greater than required for decks. The difference in required insulation thickness is noted on the type approval and in MISLE.

A-class decks are required on SOLAS vessels in accordance with regulation II-2/9. Onboard ro-ro passenger ships, decks designated as main horizontal zones are required to be A-60 class divisions, except where a type 5, 9 or 10 space is on one side of the deck, or where fuel oil tanks are on both sides of the division. In these cases the standard may be reduced to A-0. Regulation II-2/9 provides tables that specify the required classification for decks, based on the expected fire risk in spaces above and below. Similar tables that define the required fire resistance of decks are also provided for cargo ships and tankers. Insulation applied to A-class decks must be tested, approved, and installed in accordance with the FTP Code. Approved structural insulation (46 CFR 164.107), deck assemblies (164.105), and structural ceilings (164.110) can be used to construct A-class decks. The steel plate used on SOLAS vessels is required to be 4 mm thick to qualify as an A-class deck without testing, instead of the 3 mm thick plate accepted on domestic vessels.

Primary deck coverings (164.106) and floor coverings (164.117) are interior finish materials that are required to meet surface flammability and smoke and toxicity test criteria when installed in certain areas. They are not structural insulations and do not contribute to the A-class rating of decks.

LEGEND:



D = THICKNESS OF APPROVED DECK COVERING TO MEET CLASS A - 60 REQUIREMENTS WITHOUT OTHER INSULATING MATERIALS

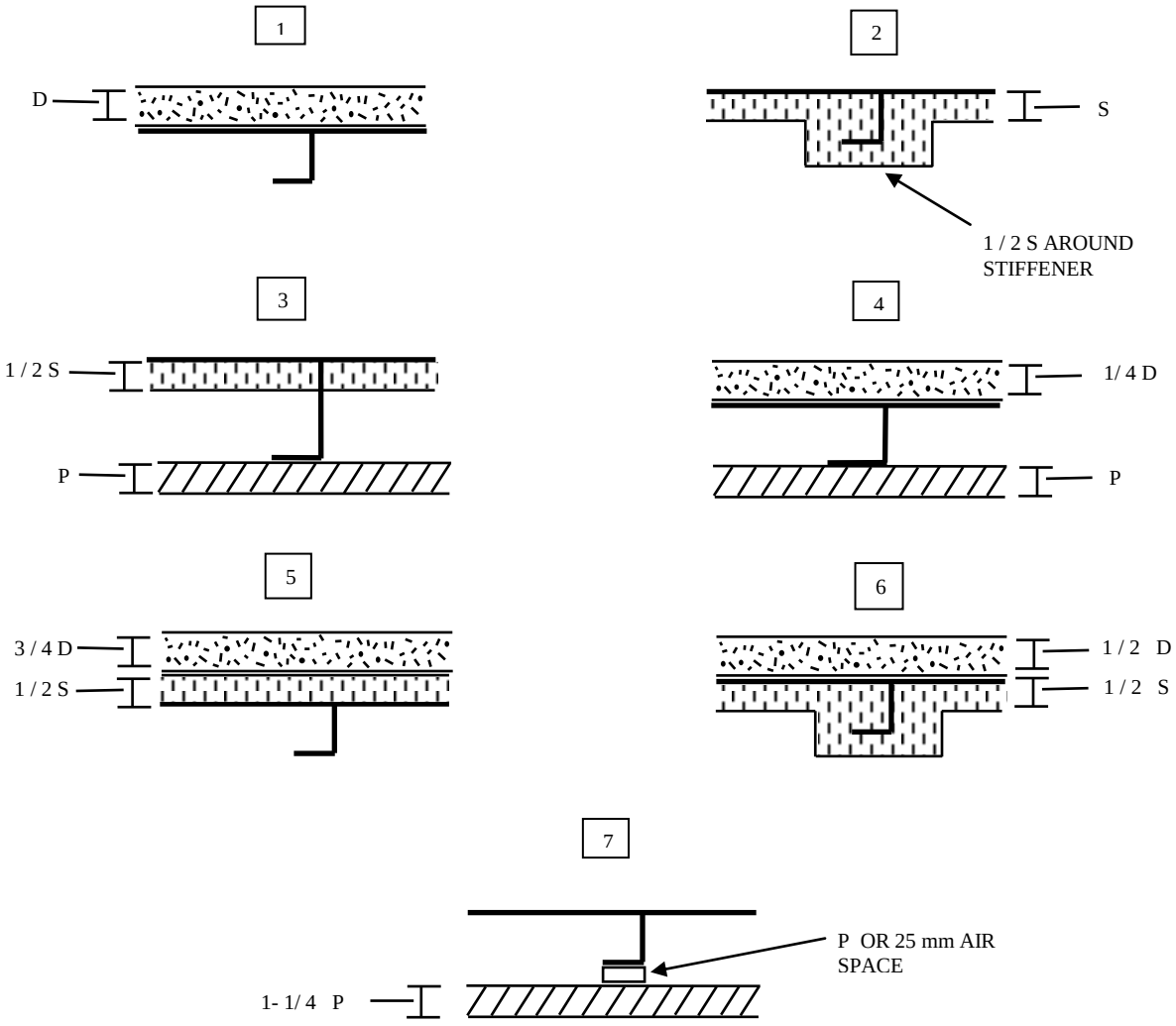
S = THICKNESS OF APPROVED STRUCTURAL INSULATION TO MEET CLASS A - 60 REQUIREMENTS WITHOUT OTHER INSULATING MATERIALS

P = THICKNESS OF APPROVED BULKHEAD PANEL TO MEET CLASS B -15 REQUIREMENTS. THE USE OF FRACTIONAL VALUES OF P WILL BE ACCEPTED FOR HOMOGENEOUS MATERIALS ONLY

INSULATION ARRANGEMENTS

FIGURE 3.6

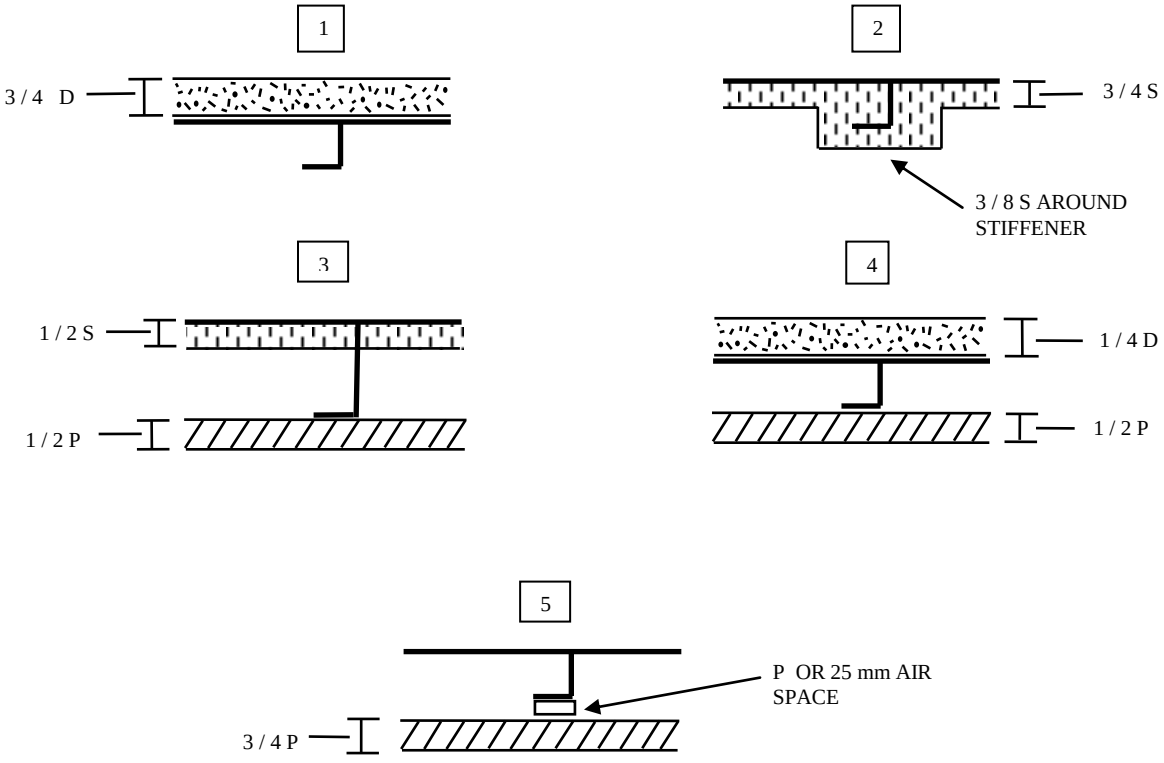
CLASS A-60 DECKS



INSULATION ARRANGEMENTS

FIGURE 3.7

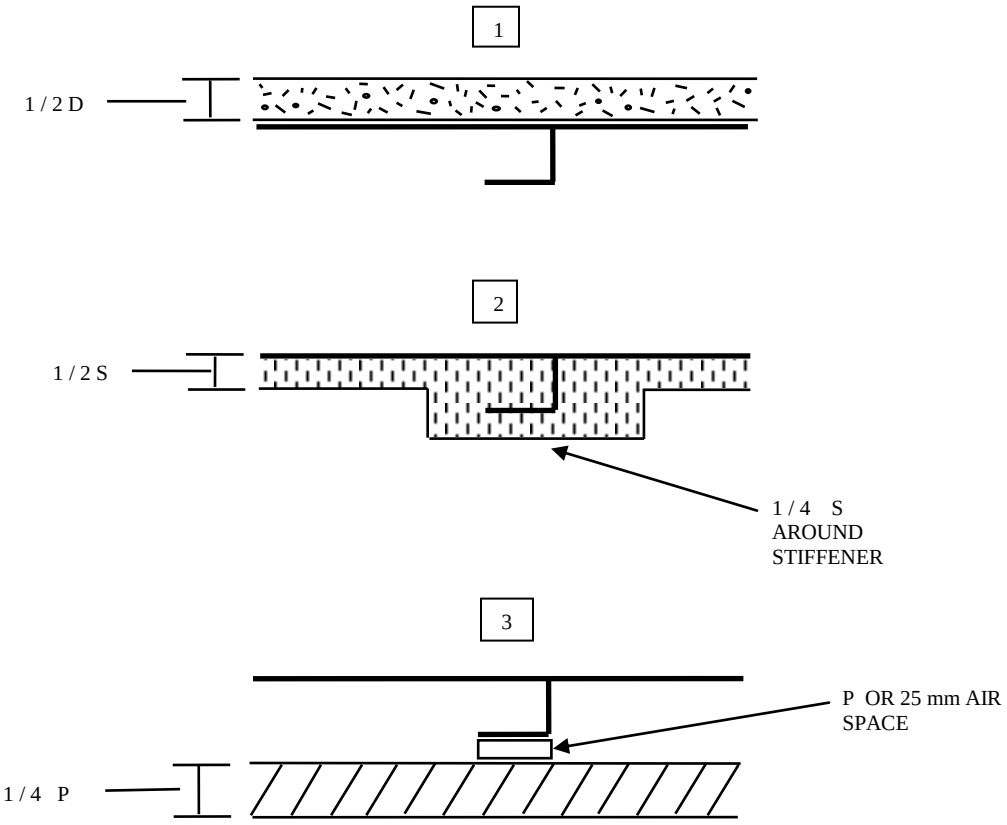
CLASS A - 30 DECKS



INSULATION ARRANGEMENTS

FIGURE 3.8

CLASS A - 15 DECKS



INSULATION ARRANGEMENTS

FIGURE 3.9

3.5 Draft stops

3.5.1 Domestic vessels

Ref: 46 CFR 32.56-45, 72-05-10 (h), 116.415 (e) & (f)

B-class panels are used to construct rooms within the shaped steel hull. The use of this construction method results in the formation of irregular shaped concealed spaces behind the panels. The concealed spaces may range in depth from a few inches to several feet. Normally, these areas are used to route shipboard piping and cables. To limit the fire risk in these spaces within accommodation and service areas and control stations, the regulations require all surface finishes to be approved low flame spread materials, and tight fitting draft stops must be installed every 14 m horizontally and at every deck level vertically. Draft stops are required on passenger ships (Subchapters H & K) and Tank vessels (Subchapter D). The regulations permit an exception for large public spaces on Subchapter K vessels that do not have overnight accommodations, if the area is surrounded by A-class bulkheads and is relatively unobstructed (see 46 CFR 116.415(f)).

The regulations require draft stops to be at least B-0 class construction. Approved bulkhead panels may be used for this purpose, or sheet steel of at least 0.75 mm (22 USSG) thickness is acceptable as an alternative.

3.5.2 SOLAS vessels

Ref: SOLAS regulation II-2/8.4

SOLAS requires draft stops in the concealed spaces behind ceilings, paneling and linings on all passenger ships, cargo ships and MODUs. The spacing of draft stops is the same as required on domestic vessels, every 14 m horizontally and at every deck level for vertical trunks and stairways. The acceptable materials for draft stops on SOLAS vessels include:

.1 Approved B-class bulkhead panels;

.2 C-class bulkhead panels;

.3 1 mm thick steel sheet, intermittently welded to the ship structure and the top profile of the bulkhead panel system, or mechanically fastened;

.4 Rigid noncombustible board, mechanically fastened; or

.5 Noncombustible mineral wool at least 20 mm thick, faced on each side with expanded metal mesh or a combination of metal mesh on one side and glass cloth on the other side, designed to ensure an acceptable level of rigidity.

An interpretation in MSC/Circ. 1120 eliminates the requirements for draft stops above the ceilings in public spaces if the ceiling is perforated and the cumulative openings equal 40% or more of the total ceiling surface area.

3.6 Means of escape

3.6.1 Domestic vessels

Ref: 46 CFR 32.02-1, 72.10, 92.10, 108.151 through 108.167, 116.438, 116.500, 127.240

Inspection Note: Emergency evacuation plans are examined during the plan review of Subchapter K vessels based on the construction drawings provided at that time. During construction, design changes may occur that result in the final design of the vessel being slightly different than originally proposed. While these minor changes may not affect the approved fire protection features, they could impact the effectiveness of the emergency evacuation plan. Additionally there are many factors that cannot be checked during plan review that can adversely affect an evacuation. This could include features such as heavy reinforced doors that are difficult to open, the addition of furnishings or decorations that restrict the escape path, uneven or irregular flooring surfaces or improperly placed emergency lighting. A walkdown of the emergency evacuation plan is necessary to verify that it is appropriate for the final design and outfitting of the vessel.

Coordination of the vessel security plan with the emergency evacuation plan should also be verified to ensure that all required primary and secondary means of escape can be opened from the egress side without the need for keys or special security arrangements.

Inspection Note: There are two types of stairways that are discussed in the regulations. Stairs that connect only two decks are considered stairways. A stairway is required to maintain deck to deck fire integrity by the use of A-class or B-class bulkheads and self-closing doors at one level. Stairways are intended to link only two deck levels. If the vertical means of escape connects multiple levels, a stairtower should be provided. Stairtowers are constructed as continuous A-class vertical trunks with self-closing A-class doors at every level. Stairtowers are protected exit enclosures that provide safe refuge from the point of entry to the embarkation station. If multiple stairways are arranged to connect several decks, the occupants must leave the protected enclosure at every other level and could be exposed to heat and smoke while transiting the intervening deck areas. Such an arrangement does not provide an equivalent level of protection as a stairtower.

Inspection Note: Where deck scuttles or windows are permitted as a means of escape on Subchapter K or T vessels, they should be capable of being opened by one person from either side with permanently attached handles or dogs. The means of opening should be obvious and not require any additional tools. Any handholds, footholds or ladders necessary for escape should be rigid materials of adequate strength fixed in the correct position. Permanently installed folding devices are also acceptable. The arrangement of the means of escape should allow able-bodied passengers to evacuate without the need for crewmembers to physically assist them.

Inspection Note: The clear width of a door opening is measured as the distance between the inside of the door frame (on the latch side) and the surface of the fully open door leaf (on the hinge side). The projection of the door knob or panic bar should not be included. The clear opening width is less than the width of the door leaf.

General

The regulations require at least two means of escape from all general areas accessible to passengers or where the crew is normally quartered or employed. The means of escape are intended to provide a protected escape path leading from the normally occupied areas to the embarkation stations or to the refuge areas. The regulations require enhanced structural fire protection measures to protect the means of escape because of this important safety role. Different levels of protection are required depending on the service of the vessel, with passenger vessels subject to the highest safety levels.

Below the bulkhead deck, the regulations require one of the two means of escape to be arranged so that passage through watertight doors is unnecessary. Above the bulkhead deck, the means of escape should be arranged to provide direct access to the embarkation stations or refuge areas. Stairways, ladders and gratings are required to be steel construction to ensure that they will not be damaged during a fire and impede escape from the area. (Subchapter K permits an exception to this requirement for aluminum vessels, see 46 CFR 116.438 (i).) The two means of escape should be located as far apart as the vessel design will permit, to prevent a fire from affecting both escape paths. The two exits are typically located on the opposite ends of a space, or as remote as practical. The escape paths from the space are then led in two different directions to satisfy the criterion that a single fire should not affect both escape paths.

The requirement for two means of escape is applied to general shipboard areas, not individual spaces, except that two exits are required from a public space, such as a mess hall or lounge, when the deck area exceeds 28 m^2 (300 ft^2). Smaller accommodation rooms may be arranged with a single exit door from each cabin that opens onto a corridor that allows the occupants to then travel in two directions. Doors in the travel path should swing in the direction of exit travel, and should be operable without the use of a key from the egress side of the doors. If a lock is required on a door in the escape path, panic bar hardware should be provided.

Dead end corridors are passageways where there is no means of escape from one end, and their use should be minimized. Dead end corridors increase the escape time because persons who enter the corridor can only escape by retracing their path back to the point of entry. The regulations generally permit dead end corridors up to 12.2 m (40 ft) in length, except for Subchapter K vessels which are limited to 6.1 m (20 ft). The maximum dead end corridor travel distance is measured from the point where escape in two directions is possible to the most remote point in the corridor. Travel distance within the rooms connecting to the corridor should not be included in the dead end corridor travel limitation.

Total travel distance limitations, i.e., the walking distance from the most remote point in an area to the nearest stairway, stairtower or door that leads directly to an area of refuge or

embarkation station are applied only to Subchapter K vessels and vessels with long main vertical zones (LMVZ) (see NVIC 8-93). On Subchapter K vessels, this limit is 46 m (150 feet), measured from the most remote area, including rooms connected to a corridor. On vessels with LMVZs, the limit is 22 m (72 feet).

Stairways, stairtowers and any connecting lobbies and interior corridors leading to the assembly stations and embarkation stations are considered safety areas. If the escape routes pass through any open deck areas or exterior stairways, they are considered part of the escape path and should meet the structural fire protection requirements for type (4) spaces instead of type (13) spaces.

Penetration of shipboard services through stairways and stairtowers should be kept to the minimum needed to provide lighting, communications, alarms and ventilation for the enclosure. Ventilation systems for stairways and stairtowers are not permitted to serve other spaces to minimize the chances for smoke infiltration if a fire occurs in the adjacent areas. The regulations permit wire inserted glass windows in stairtower doors up to a maximum of 645 cm^2 (100 in^2). Any larger windows installed in stairtower doors should be type approved windows tested to the same standard required for the enclosure bulkheads.

Stairways and stairtowers should be constructed using rectangular treads of consistent width and depth. Curved, spiral or winding stairways should not be used because the variation in tread geometry reduces the effective width of the stair. Furniture should not be located in a means of escape unless it is fire resistant in accordance with 46 CFR 72.05-55.

Subchapter H vessels

The means of escape requirements for Subchapter H passenger vessels have been developed for ocean-going ships that are expected to routinely operate at sea where outside help is normally not available. The regulations require at least one stairtower in each main vertical zone that connects to all other decks within the MVZ. The stairtowers must be arranged to provide a ready and direct access to the lifeboat embarkation stations, or to a weatherdeck having exterior access to the embarkation stations. The regulations permit the use of horizontal doors, passageways, stairways and stairtowers as the means of escape from passenger areas.

The escape routes on Subchapter H vessels are arranged to provide a direct escape path to the assembly areas (also called muster stations). The assembly areas are large public spaces such as restaurants or lounges that are usually located adjacent to the embarkation stations. The escape paths are sized to permit a rapid evacuation to the assembly areas, where the passengers can be accounted for by the crew and given further instructions. If the situation eventually leads to abandonment of the vessel, the passengers are directed from the assembly area to the various embarkation stations and survival craft. During this phase of the evacuation, the passengers travel in smaller groups to their assigned embarkation stations, thus the widths of the escape paths from the assembly areas to the embarkation stations are sized for the number of persons expected to use those paths for debarkation.

Criteria for the design and capacity of stairways and stairtowers are listed in 46 CFR 72.05-20. The width and capacity of the means of escape are determined based on the number of passengers in each space and the total expected occupant load on each deck in each main vertical zone. The number of persons assumed to occupy each space is first calculated using the occupant load factors for the various types of spaces given in the regulations. After the total number of persons on each deck is established, the minimum required width of the stairways and doors serving that area is determined using the tables in 46 CFR 72.05-20. The required width must not decrease in the direction of normal escape, even if the intervening decks have a lower occupant load. If more than one stairtower is provided in a main vertical zone, the number of occupants in that zone may be distributed among the stairtowers to determine the required width.

Subchapter H prohibits the means of escape from accommodation spaces and other enclosed rooms from discharging directly into stairtowers. They are required to pass through corridors leading to the stairtowers to minimize the chance of fire exposure and smoke spread into the stairtowers. The intervening corridors are expected to act as a buffer area between the fire hazard areas and the protected stairtowers. Large public spaces greater than 28 m^2 (300 ft^2) may be provided with direct access, if needed to eliminate queuing effects caused by having to travel through two successive doors.

Subchapter H also requires a landing at each deck level within a stairtower to allow a significant number of passengers to take shelter within the protected enclosure. The landings must have a minimum deck area determined by multiplying the number of persons from that deck using the stairtower by a factor of 0.111 m^2/person (1.2 ft^2/person).

Subchapter K vessels

Subchapter K vessels typically operate in protected waters, close to shore where search and rescue forces are readily available. Because of this, the means of escape requirements allow for more flexibility than on Subchapter H vessels. Stairtowers are only required for vessels with more than two decks, each having enclosed or partially enclosed accommodation areas other than open decks or toilet spaces. The means of escape may consist of horizontal doors, passageways and stairways, as well as ladders, deck scuttles and windows (see 46 CFR 116.500).

Stairways and stairtowers on Subchapter K vessels are not designed for passengers to take shelter within the protected enclosure. Instead, they are a means to immediately evacuate the fire affected space to areas of refuge. The areas of refuge are locations where the passengers and crew can be sheltered until the fire is extinguished or until the passengers can disembark. Subchapter K requires that qualified areas of refuge must provide separation from the effects of fire or flooding for the amount of time required to completely evacuate the vessel or one hour, whichever is less. Typically this is provided by enclosing the refuge areas with A-60 construction.

The Coast Guard has developed several acceptable design options for meeting the required separation criteria between the occupied areas and the areas of refuge, as follows:

For vessels with only one main vertical zone, where the areas of refuge are located in the fire affected main vertical zone and are located above the occupied areas, there are three acceptable options depending on the vessel arrangement:

1. If the areas of refuge are separated from the occupied area by an intervening deck, the structural fire protection requirements in Tables 46 CFR 116.415(b) and (c) may be applied;

2. If the areas of refuge are located internally and directly above the occupied area, they should be enclosed by A-60 barriers, except that bulkheads and decks adjacent to open deck areas, tanks and voids may be A-0; and

3. If the areas of refuge are located on an open deck directly above the occupied area, the intervening deck should be A-60 and any common bulkheads should be protected to the requirements in Table 46 CFR 116.415(b) for type (4) spaces.

If the vessel has two or more main vertical zones, and the areas of refuge are located in a different main vertical zone than the fire affected main vertical zone, there are three options:

1. If the areas of refuge are separated from the occupied area by an intervening main vertical zone, the structural fire protection requirements in Tables 46 CFR 116.415(b) and (c) may be applied (vessels with at least 3 MVZs);

2. If the areas of refuge are located internally and are in a main vertical zone directly adjacent to the occupied area, the structural fire protection requirements in Tables 46 CFR 116.415(b) and (c) should be applied. In addition, the main vertical zone boundaries between the two MVZs should be A-60 barriers on every level. 46 CFR 116.415(d) should not be applied, except that MVZ bulkheads and decks adjacent to open deck areas, tanks and voids may be A-0; and

3. If the areas of refuge are located on the open deck and are in a main vertical zone directly adjacent to the occupied area, the structural fire protection requirements in Tables 46 CFR 116.415(b) and (c) should be applied, and main vertical zone boundaries should meet 46 CFR 116.415(d).

Other structural fire protection arrangements may be considered as satisfying the required separation criteria if it can be shown through a quantitative egress analysis, fire modeling and an evacuation demonstration that a lesser protection time is appropriate.

Vessels constructed to the very low fire risk criteria for type 5A spaces should meet the structural fire protection criteria listed in section 4.2.

Criteria for the design and capacity of stairways and stairtowers are listed in 46 CFR 116.438. The width and capacity of the means of escape from the normally occupied areas to the areas of refuge are calculated based on the number of passengers in each space and the total expected occupant load on each deck within each main vertical zone. The number of persons assumed to occupy each space is first calculated using the occupant load factors given in the regulations for the various types of spaces. The minimum required width of the stairways and doors is determined by multiplying the total number of persons on each deck by a factor of 8.4 mm/person (0.33 in/person). The minimum required width of the escape path must not decrease in the direction of the refuge areas, even if the intervening decks have a lower occupant load. In all cases, the minimum stairway tread width in passenger areas must be at least 910 mm (36 inches), and the minimum clear opening of doors and passageways must be at least 810 mm (32 inches). If more than one stairtower is provided in a main vertical zone, the number of occupants in that zone may be distributed among the stairtowers to determine the required width.

Subchapter K requires the stairtowers to be designed as an egress route to the refuge areas, and does not anticipate that they would be used to shelter large numbers of passengers waiting to board the survival craft. Intermediate landings must be at least equal to the square of the tread width. The minimum landing area is not related to the number of passengers using the stairway.

The capacity and size of the egress routes from the areas of refuge to the embarkation stations is determined based on the maximum number of persons expected to occupy the refuge areas, which is a maximum of one person for every 0.47 m^2 (5 ft^2) of deck area. The egress routes to the embarkation stations may be different from the paths taken to reach the refuge areas, or may involve a different number of persons. Thus additional calculations are required to determine if their capacity is adequate. The same factor of 8.4 mm/person (0.33 in/person) should be used to determine the minimum required width of the egress routes to the embarkation stations. 46 CFR 116.438(n)(3) permits a relaxation in the required width of the egress routes from the refuge areas to the embarkation stations, if landing areas or other areas such as exterior passageways are available where the passengers can be expected to distribute themselves during the evacuation. Such arrangements are considered on a case by case basis.

Subchapter K requires that stairtowers must not be directly accessed from overnight accommodation spaces or type 9, 10, 11 or 12 spaces to lessen the chance of fire and smoke spread into the means of escape from these higher hazard areas. Exit travel from these types of spaces should first lead to corridors that give access to the stairtowers.

An emergency evacuation plan is required to be submitted for approval during plan review. Emergency evacuation plans are intended to be performance based documents that are specific to the design and permitted route of each vessel.

The minimum information provided in the emergency evacuation plan should include:

1. Identification of the number of persons assumed in each space and how that number was derived;

2. Identification of the primary and secondary means of escape from each space;

3. Detailed procedures for moving the passengers out of each occupied space of the vessel to the refuge areas, including crewmember responsibilities;

3. The locations and capacities of the refuge areas;

4. The structural fire protection ratings of the bulkheads and decks that separate the refuge areas from the adjacent areas;

5. Identification of the embarkation stations and the escape routes from the refuge areas to each embarkation station;

6. Detailed procedures for abandoning ship with the maximum number of passengers in the refuge areas, considering the vessel's permitted route;

7. Identification of possible flooding scenarios and the muster and evacuations procedures for each; and

8. Details of the safety briefing given before departure to inform the passengers of their expected actions in case of fire or flooding.

The regulations require stairways, ladders, platforms and landings to be constructed of steel to ensure that they will be able to remain functional as a means of escape during a fire, and to also provide access for the fire brigade. Since many Subchapter K vessels are constructed of aluminum alloy, the regulations also recognize that there are means to protect stairways constructed of aluminum that achieve an acceptable level of protection. 46 CFR 116.438(b)(3)(i) provides an exception to allow aluminum stairways and stairtowers if they are located within fully insulated enclosures complying with the bulkhead and deck requirements in 46 CFR 116.415(b) and (c). Insulating the bottom of an exposed stairway does not provide an equivalent level of protection. Exterior ladders located in areas not used as a means of escape or access for firefighting may also be constructed of aluminum. Exterior ladders that provide access to the refuge areas or embarkation stations should be steel.

The maximum travel distance for the escape paths on Subchapter K vessels, measured as actual walking distance is limited to 46 m (150 ft). If the means of escape from an area cannot meet this criterion, additional exits or stairways should be provided.

3.6.2 SOLAS Vessels

Ref: SOLAS regulation II-2/13, chapter 13 of the Fire Safety Systems Code.

In general, all ships are required to have at least two means of escape from all areas accessible to passengers or where the crew is normally quartered or employed. Below the

bulkhead deck, one of the two means of escape must be arranged so that passage through watertight doors is unnecessary. Above the bulkhead deck, the means of escape should be arranged to provide direct access to the assembly stations and survival craft embarkation deck. The two means of escape should be located as far apart as the vessel design will permit, to prevent a single event from affecting both escape paths.

SOLAS applies the general requirement for two means of escape to "all spaces or groups of spaces." The SOLAS regulations do not clearly delineate between spaces where a single means of escape is acceptable and spaces requiring two means of escape. Typically, passenger cabins are arranged with a single exit door from each cabin that opens onto a corridor that allows the occupants to then travel in two directions. Areas where several spaces are interconnected may be classified as "groups of spaces" and in general should have two means of escape. However as the size of a room increases, there is no clear guidance for when a single exit is no longer acceptable. The Coast Guard has considered that public areas where 50 or more occupants could be present should generally have two means of escape.

3.7 Ventilation Systems

3.7.1 Domestic vessels

Ref: 46 CFR 32.56-60, 72.05-50 & 72.15, 92.15-10, 108.181, 116.610

Inspection Note: A-class fire dampers should be located at the boundary penetrated. If it is not possible to locate the dampers at the boundary because of interference with other equipment, they may be located in the duct close to the boundary penetrated, provided a 3 mm steel sleeve is fitted between the boundary and the fire damper. The 3 mm sleeve is considered an extension of the penetrated boundary, thus if the boundary is insulated, the insulation should be extended from the boundary at least 300 mm along the sleeve. If the distance from the boundary to the end of the damper casing is less than 300 mm, the insulation should be extended to fully cover the damper.

Accommodation area ventilation systems are typically arranged to supply conditioned air to each passenger cabin through individual supply ducts. The air is then exhausted through door louvers or vents built into the sanitary unit that return the air to the corridor and eventually to a common return at the fan room. Some newer designs may also have dedicated supply and return ducting for each space.

The regulations contain only minor details on ventilation system design, however, requirements for the subdivision of the ship into individual spaces by A-class and B-class barriers are specified in each subchapter. If the ventilation ducts penetrate any of the required fire barriers, then precautions must be taken to ensure that their fire integrity has not been impacted.

Ventilation ducts are constructed of steel or other noncombustible materials. Generally, sheet metal is used for this purpose, however, short sections of combustible ductwork which meet the criteria for low flame spread materials may be used at the termination of a duct, usually between the rigid sheet metal supply duct and a ceiling mounted diffuser. The total

length of the combustible duct should not exceed 2 meters and the combustible duct material should not be located within 600 mm of an opening through A or B-class divisions, including continuous B-class ceilings.

All ventilation ducts that penetrate required A-class barriers must be fitted with a manually operated fire damper. Ventilation systems should not serve spaces in two different main vertical zones, however, if it is necessary to route ventilation ducting through a main vertical zone bulkhead, an automatic fire damper is required.

Ducts that pass through a space without serving that space do not require fire dampers if the duct is constructed of steel at least 3 mm thick, and passes completely through the space without serving the space. However, this exception is not intended to allow a duct to pass from a fan room through one or more intervening spaces and then serve a space without any fire dampers in the duct. At least one fire damper is necessary to account for possible fire spread from the fan room to the space ultimately being served by the duct.

A-class fire dampers should be constructed in accordance with the details given in 46 CFR 72.05-50 or 46 CFR 116.610. Fire dampers are not type approved, and do not need to be tested. Alternatively, UL Listed 1-1/2 hour rated fire dampers may be used if installed in accordance with their listing. If the boundary penetrated is insulated to A-15, A-30 or A-60 standards, the damper casing and sleeve (but not the damper blade) should be insulated to the same standard for a distance of at least 300 mm on the insulated side of the boundary. Some specific locations may require more extensive insulation. See 46 CFR 72.05-50 (g) and 46 CFR 32.56-60.

The regulations require that each ventilation system must have a means for shutting off the passage of air to the space or groups of spaces served by the system in the event of fire. This typically requires a manual damper or steel cover on the main supply and exhaust ducts, operable from outside the spaces served.

Within the accommodation and service areas, the regulations require corridor bulkheads to be minimum B-class construction, intact from deck to deck. If it is necessary for ventilation ducts to pass through corridor bulkheads, manual fire dampers should be installed at each penetration of the bulkhead, unless the duct is constructed of at least 0.8 mm thick steel (22 USSG). All ventilation duct penetrations through the bulkhead should be made tight fitting.

The regulations permit an air transfer opening of 2 square feet or less in the bottom half of B-class stateroom doors. It is also acceptable for the air transfer opening to be located in the lower half of the bath unit bulkhead in each cabin. Other than the return grilles permitted in B-class doors, non-ducted air transfer openings, including jumper or balancing ducts, are not permitted by the regulations through A-class or B-class divisions.

If the fan room is separated from the corridor by B-class bulkheads (see section 5.2), the use of non-ducted corridor air returns is acceptable, provided that the HVAC system is designed to fully exhaust the air returned from the accommodation areas. If the HVAC system is designed to recirculate conditioned air, duct smoke detectors should be installed in the air

handler common return and supply ducts downstream of the filters, arranged to stop all HVAC fans upon detection of smoke.

The provisions in SOLAS regulation II-2/9.7 for fire damper placement may also be applied to domestic ships and offshore facilities that comply with chapter II-2. This allows construction of the ship with fire dampers only at select locations, as detailed below.

Regulation II-2/9.7.3.1.2 requires that automatically operated fire dampers shall be installed in all ducts that exceed 0.075 m^2 in cross sectional area and pass through A-class boundaries. Ducts that are less than 0.075 m^2 but larger than 0.02 m^2 may pass through A-class boundaries without fire dampers if they are routed through 3 mm thick steel sleeves at least 450 mm in length on each side of the division. This requirement is considered applicable only to ducts of uniform dimension that pass through fire boundaries. A large duct should not be subdivided into multiple smaller ducts when passing through a fire boundary to avoid the requirement to install automatic fire dampers.

U.S. flag passenger vessels, cargo ships, MODUs, offshore supply vessels, oceanographic research vessels and OCS facilities that will not be certificated to SOLAS or the MODU Code may be built using the duct penetration and automatic fire damper arrangements in SOLAS regulation II-2/9.7 or the MODU Code regulations 9.2.11 through 9.2.18, provided that all of the additional fire protection measures specified below are satisfied. In addition, all structural fire protection materials and fire dampers must be tested, approved, and installed in accordance with the FTP Code. The additional measures apply to the entire vessel, not just selected areas.

Passenger vessels – in lieu of meeting the requirements in 46 CFR 72.05 and 76.05-1 (Subchapter H) or 46 CFR Part 116.400 through 116.438, 116.500, 116.600 and 116.610 (Subchapter K), the following SOLAS regulations may be applied.

II-2/5.2	Control of air supply and flammable liquid to the space
II-2/5.3	Fire protection materials
II-2/6	Smoke generation potential and toxicity
II-2/7.5.2 & 7.5.3	Smoke detection system
II-2/8.2	Protection of control stations
II-2/8.4	Draft stops
II-2/8.5	Atrium smoke extraction
II-2/9	Containment of fire
II-2/13	Means of escape

Cargo ships – in lieu of meeting the requirements in 46 CFR 92.07 and 95.05-1, the following SOLAS regulations may be applied.

II-2/5.2	Control of air supply and flammable liquid to the space
II-2/5.3	Fire protection materials
II-2/6	Smoke generation potential and toxicity
II-2/7.5.5.1	Smoke detection system

II-2/8.2	Protection of control stations
II-2/8.4	Draft stops
II-2/9	Containment of fire

MODUs and OCS facilities – in lieu of meeting the requirements in 46 CFR 108.131-147 and 108.404-413, the following regulations in the IMO MODU Code may be applied.

9.1	Structural fire protection
9.2	Protection of accommodation spaces, service spaces and control stations
9.7	Fire detection and alarm system

Offshore supply vessels – in lieu of meeting the requirements in 46 CFR 127.220, the following SOLAS regulations may be applied.

II-2/5.2	Control of air supply and flammable liquid to the space
II-2/5.3	Fire protection materials
II-2/6	Smoke generation potential and toxicity
II-2/7.5.5.1	Smoke detection system
II-2/8.2	Protection of control stations
II-2/8.4	Draft stops
II-2/9	Containment of fire

Oceanographic research vessels – in lieu of meeting the requirements in 46 CFR 190.07 and 193.05-1, the following SOLAS regulations may be applied.

II-2/5.2	Control of air supply and flammable liquid to the space
II-2/5.3	Fire protection materials
II-2/6	Smoke generation potential and toxicity
II-2/7.5.5.1	Smoke detection system
II-2/8.2	Protection of control stations
II-2/8.4	Draft stops
II-2/9	Containment of fire

3.7.2 SOLAS Vessels

Ref: SOLAS regulation II-2/9.7

All ventilation ducts must be constructed of noncombustible materials. However, short sections of combustible ductwork meeting the criteria for low flame spread materials may be used at the termination of a duct not exceeding 0.02 m^2 in cross sectional area, usually between the rigid sheet metal supply duct and a ceiling mounted diffuser. The total length of the combustible duct should not exceed 2 meters and the combustible duct should not be located within 600 mm of an opening through A or B-class divisions, including continuous B-class ceilings.

SOLAS requires automatically operated fire dampers in all ducts that exceed 0.075 m^2 (116 in^2) in cross sectional area and pass through A-class boundaries. Ducts that are between 0.075 m^2 and 0.02 m^2 (31 in^2) in area may pass through A-class boundaries without fire dampers if they are routed through 3 mm thick steel sleeves at least 450 mm in length on each side of the division. Ducts 0.02 m^2 or less in area may pass through A-class boundaries without fire dampers if they are routed through 3 mm thick steel sleeves at least 200 mm in length on each side of the division. For the application of these criteria, the ducts should not be subdivided into multiple smaller ducts at the penetration of a division to avoid the requirements for fire dampers and/or sleeves.

3.8 Atriums, Balconies and Multi-Level Spaces

3.8.1 Domestic vessels

Ref: 46 CFR 72.05-5 (m), 116.439-440

One of the basic principles of shipboard fire safety is subdivision of the vessel by horizontal and vertical fire barriers to limit the spread of fire. Where it is necessary to penetrate multiple decks for services such as stairtowers, elevators or pipe and cable trunks, the vertical shafts are enclosed in A-class construction at all levels to limit fire spread. Atriums and balconies pose a challenge to the traditional compartmentation approach since they connect multiple deck levels without being enclosed. To offset this, additional fire protection measures intended to achieve the same level of fire safety have been published in Subchapter K (see 46 CFR 116.439-440), which may also be applied to passenger vessels subject to Subchapter H.

A key consideration in the protection of multi-level spaces is whether any openings through the deck provide a large enough cross-sectional area to enable the occupants to be aware of fire occurrence on any of the interconnected levels, and evacuate to a safe area before they are endangered. The requirements for minimum opening size also provide a greater smoke dilution volume and prevent the vertical opening from acting like a flue.

Balconies

Balconies are partial decks between the bottom and top level of a single enclosed space. Balconies designed in accordance with 46 CFR 116.439 are restricted to installations where no more than two deck levels are spanned. If the design of the vessel is intended to have openings that pass through more than two deck levels, the atrium requirements in 46 CFR 116.440 apply.

46 CFR 116.439 does not apply to external passenger cabin balconies, however, the fire risk should be considered when specifying the materials of construction used for the balcony dividers, deck coverings and surface finishes (see section 3.8.2).

If the unobstructed open area between an interior balcony and the overall space is less than 93 m^2 (1,000 square feet), additional protection consisting of noncombustible draft curtains at least 450 mm (18 inches) deep are required at the bottom of the balcony with sprinkler heads

spaced 1.8 m (6 feet) apart, located on the side of the draft curtain away from the opening, in accordance with the NFPA 13 criteria for unenclosed floor openings. The draft curtains and sprinklers are intended to control or delay fire spread from the bottom level of the space to the balcony, allowing more time for the occupants to evacuate.

The regulations require two means of escape on each level of balconies. An open stairway between a balcony and the space below, is considered a convenience stair and is not acceptable as one of the required means of escape from that level.

The deck area of balconies may also affect consideration of main vertical zone length, and in some cases require the addition of automatic sprinkler protection (see 46 CFR 116.439(c) & (d)).

Atriums

Atriums are defined as enclosed multi-level public spaces with intermediate-level deck openings through more than two decks, which are not used as stairways or trunks for shipboard services.

The regulations permit open atriums if the minimum size of the deck opening is at least 20% of the total deck area of the space or 93 m^2 (1,000 square feet), whichever is less, and the minimum dimension of any side of the opening is at least 6.1 m (20 feet). If the deck opening is not square, the minimum size of the opening should be determined in consultation with the Coast Guard. The regulations also require that the size of the openings must not decrease on upper decks. This is to allow smoke and hot gases to freely rise to the top of the atrium.

Two means of escape must be available on each level of atriums, at least one of which must be a stairtower. If an open stairway is provided between levels, it is considered a convenience stair and is not acceptable as one of the required means of escape.

Subchapter K requires all atriums to have an automatic smoke extraction system that is capable of exhausting the entire volume of the atrium in 10 minutes or less, or an engineered smoke management system that complies with NFPA 92B. The smoke extraction system must also have manual control capability.

The entire main vertical zone containing an atrium must have automatic sprinklers installed in accordance with NFPA 13, and an approved smoke detection system, except that vessels without overnight accommodation do not require a smoke detection system.

3.8.2 SOLAS vessels

Ref: SOLAS regulations II-2/8.5, II-2/13.3.2.4.4

SOLAS defines atriums as public spaces within a single main vertical zone that span three or more open decks. Internal balconies are considered open spaces between only two deck levels. SOLAS does not have any criteria for the minimum size of openings between different levels of an atrium.

SOLAS requires two means of escape on each level of balconies and atriums, and at least one of the means of escape must be a stairtower. If an open stairway is provided between levels of a balcony or atrium, it is considered a convenience stair and is not acceptable as one of the required means of escape.

Atriums are required to have a smoke extraction system that is automatically actuated by the required smoke detection system, and must be capable of exhausting the entire volume of the atrium in 10 minutes or less. The smoke extraction system must also have manual control capability.

Many SOLAS passenger ships are fitted with external cabin balconies designed to be directly accessed from the passenger cabins. These spaces are not considered separate open deck spaces, but are considered a part of the cabin they serve. Because of this, a fire boundary is not required between the cabin and the balcony. Doors and windows located in the outboard cabin bulkheads facing the balconies may be constructed of non-approved materials, such as sliding glass doors.

Following the Star Princess fire in 2006, SOLAS was amended to require specific structural fire protection features on balconies to minimize the risk of fire spread from the balconies to the inside of the ship. Cabin balconies on all ships constructed after 1 July 2008 are required to comply with regulations II/2-4.4.4 (ignitability of primary deck coverings), II-2/5.3.2.2 (maximum calorific value), II-2/5.3.2.4 (low flame spread characteristics), II-2/6.2 (smoke and toxic products of paints, varnishes and other finishes) and II-2/6.3 (toxicity of primary deck coverings). In addition, any ceilings, linings or partial bulkheads used to screen or separate adjacent balconies are required to be constructed of noncombustible materials. Furniture and furnishings on cabin balconies must be of restricted fire risk as defined in regulation II-2/3.40.1, 3.40.2, 3.40.3, 3.40.6 and 3.40.7, unless a fixed pressure water spraying system and a fixed fire detection and fire alarm system complying with the FSS Code are installed.

The requirements for noncombustible ceilings, linings and partial bulkheads as well as furniture and furnishings of restricted fire risk also apply retroactively to existing ships after their first survey after 1 July 2008.

3.9 Fiberglass (FRP) Construction

3.9.1 Domestic Vessels

Ref: 46 CFR 177.410

Inspection Note: Previously uncertificated small passenger vessels that do not comply with 46 CFR 177.410(c) and (d) can be certificated if records exist showing they are constructed with fire retardant resin. If the type of resin used for construction cannot be documented, it is not normally feasible to take samples of the hull that satisfy the size and laminate schedule specified in the qualification tests.

Subchapter T permits the use of composite FRP materials for the construction of a vessel's hull, decks, bulkheads and superstructures. For general applications, fire retardant resins are required. Past testing done by the Coast Guard has shown that FRP materials constructed with fire retardant resins represent a fire hazard equivalent to wood.

General purpose (non fire retardant) resins are accepted for the construction of vessels carrying 12 or less passengers, not powered by gasoline engines. Additional requirements for vessels built with general purpose resins are listed in 46 CFR 177.410(c). One of the requirements specifies that machinery space boundaries must be lined with noncombustible panels or insulation approved to 46 CFR 164.009. Rigid aluminum or steel sheet metal panels of at least 0.8 mm thickness (22 USSG) may be used for this purpose, as well as any approved insulation batts or blankets approved under 164.009 or 164.109. Intumescent paints and foil vapor barriers do not satisfy this requirement.

Fire retardant resins must be tested to one of two acceptable test protocols listed in 46 CFR 177.410(b).

The first test method is MIL-R-21607, which is a small-scale test involving a sample size of 127 mm x 12.7 mm x 12.7 mm (5 in x .5 in x .5 in) that is exposed to a standard electrical heating coil. The approval test measures the average time to ignition and the average burning time from five specimens. The specimens are constructed to a specific laminate schedule using 40 plies of cloth and a cured resin content of 38 to 44 per cent. The laminate panels are conditioned by exposure to the weather for one year before being subjected to the ignition test.

The alternative test method is ASTM E-84, which is also the standard test used to approve interior finish materials under 46 CFR 164.012. This test is a much larger scale and requires a specimen size of 508 mm x 7320 mm (1.7 feet x 24 feet) that is mounted on a noncombustible substrate and placed on the ceiling of the test furnace. The E-84 test method option does not require a standard laminate schedule, only a minimum sample thickness of 3.2 mm and maximum thickness of 6.4 mm, along with a minimum resin content of 40% by weight. To be accepted as fire retardant, the measured flame spread of the specimen must be 100 or less. This test method does not require the specimen to be weathered for 12 months prior to testing.

3.9.2 SOLAS Vessels

SOLAS does not permit the use of combustible materials of construction. Composite materials that qualify as fire restricting materials are permitted by the High Speed Craft Code (see section 2.15).

3.10 Vehicle Spaces

Ref: 46 CFR 70.10-1, 114.400 & 415 (type 11 spaces)

3.10.1 Domestic vessels

Subchapter H refers to two types of vehicle spaces; spaces specially suitable for vehicles and vehicle decks. Spaces specially suitable for vehicles are enclosed vehicle spaces intended for the carriage of vehicles with their batteries connected and fuel in their tanks. Vehicle decks are considered open decks without full enclosure, but may have a partial overhead or canopy. For the purposes of assigning structural fire protection requirements, both types of vehicle spaces are considered type 11 spaces, unless the passengers have access to their vehicles during the voyage. In that case they are considered type 7 spaces. Vehicle decks that are completely open and have no overhead or partial overhangs may be considered type 13 spaces.

Subchapter K refers to vehicle spaces as… "spaces not on an open deck for the carriage of motor vehicles with fuel in their tanks, into and from which such vehicles can be driven and to which the passengers have access." Again, these spaces are classified as type 11 spaces or if the passengers have access to their vehicles during the voyage, they are type 7 spaces.

Vehicle decks are usually designed using the entire length of the vessel as one common space to allow the vehicles to be driven on and off the ship. The requirements for main vertical zone bulkheads are not applied to these spaces. Instead, the MVZ insulation criteria are applied to the horizontal decks above and below the space. For Subchapter H vessels, the higher insulation values in Table 72.05-10 (f) apply, and for Subchapter K vessels, the insulation values explained in 46 CFR 116.415(d) apply.

The arrangement of the means of escape onboard vehicle ferries must be in accordance with the applicable vessel regulations. Ferries are typically designed with one or more vehicle decks with accommodation spaces located above the vehicle decks to provide the passengers with a waiting area with shops and restaurants. Stairtowers are provided to travel between the various deck levels. Subchapter H requires that the discharge from each stairtower must give access to the embarkation deck, or if the embarkation deck does not extend to the area in question, the stairtower must give access to an open deck area where there is an exterior stairway that provides ready access to the embarkation deck. Subchapter K allows the option of either discharging to the embarkation stations or to areas of refuge.

The regulations thus require that the stairtowers must only discharge to low risk areas; embarkation stations (type 4 spaces), open decks (type 4 spaces since open deck areas are considered safety areas when used as a means of escape) or areas of refuge. Escape through these types of spaces is not expected to expose the passengers to a greater level of risk. Arrangements where the stairtowers discharge to an open vehicle deck, and the passengers walk across the vehicle area to the embarkation stations do not comply with the regulations, and increase the likelihood of the escape path being cut off by a fire on the vehicle deck. In such designs, a protected means of escape on the open deck is needed to separate the vehicle area from the escape path.

3.10.2 SOLAS Vessels

Ref: SOLAS regulation II-2/13.7, II-2/20

SOLAS considers three types of vehicle spaces, defined as follows:

Special category spaces – Enclosed vehicle spaces above and below the bulkhead deck into and from which vehicles can be driven and to which passengers have access (similar to "spaces specially suitable for vehicles" in the CFR);

Ro-ro spaces – Spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the ship in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded, normally in a horizontal direction; and

Vehicle spaces – Cargo spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion (usually cargo holds on cargo ships where the vehicles must be loaded with a crane).

These three types of vehicle spaces may be found on cargo ships or passenger ships. If a passenger ship has ro-ro spaces or special category spaces, it is designated as a ro-ro passenger ship and must comply with the additional means of escape criteria in regulation II-2/13.7. Moreover, a mandatory evacuation analysis is required during the design of the vessel to identify and eliminate areas of congestion that could impede egress. The process to be followed for the evacuation analysis may be found in MSC/Circ. 909.
The structural fire protection requirements for vehicle spaces on SOLAS passenger vessels are listed in regulations II-2/9.6.2 and 20.5. Basically, for passenger ships carrying more than 36 passengers, A-60 insulation is required on all bulkheads and decks, except where the vehicle space abuts a category (5) open deck area, category (9) sanitary space, or category (10) tank or void space. In these cases, only A-0 protection is required. The standard may also be reduced to A-0 for decks between fuel oil tanks located beneath vehicle spaces.

The structural fire protection requirements for ro-ro spaces and vehicle spaces on SOLAS cargo ships are listed in regulation II-2/Tables 9.5 and 9.6. Vehicle spaces and ro-ro spaces are considered type 11 spaces.

Ro-ro passenger ships are not required to be subdivided by main vertical zone bulkheads every 40 meters. Instead, main horizontal zones are provided by insulating the decks below and above the vehicle spaces. This allows the inclusion of multiple decks within the main vertical zone, provided the overall clear height of the space does not exceed 10 meters.

3.11 Passenger Vessel Space Categories

3.11.1 Domestic vessels

Ref: 46 CFR 72.05-10, 46 CFR 116.415

Subchapters H and K include tables that indicate the required fire endurance of the bulkheads and decks that separate different spaces. The intent of the tables is to provide a higher degree of protection for shipboard spaces that typically present a greater fire risk because of either a higher fire load or the normal presence of ignition sources. These tables form the basis for the subdivision of passenger vessels into discrete fire areas, and a number of policy interpretations and clarifications have been developed for their application.

General

If the use of a space could fit into two or more categories defined in the tables, the type of space with the highest boundary requirements should be used. If two adjacent spaces are not completely separated (e.g., two spaces separated by a partial height bulkhead or a space with a deck opening to the space below), the two spaces may be considered a common area if the size of the opening is at least 30% of the total area of the common boundary. If the size of the opening is less than 30%, they are considered separate areas and should be separated by fire rated barriers or equivalent doors. Note that this concept is not applicable to partial bulkheads used to subdivide a space for utility or artistic reasons. There is no requirement for minimum size openings between different areas in a common space.

The 30% opening criteria does not strictly apply to smaller incidental or accessory areas within larger areas. For example, a closet or bathroom within a stateroom does not need to be considered a separate fire area. Similarly, pantries and walk-in refrigerators in galleys do not generally require fire rated separations, if the pantry or refrigerator can be considered as contributing to the operation of the main space. Normally, such areas are evaluated on a case-by-case basis, considering the relative fire hazard and quantity of combustible materials that may be introduced.

Control Stations – (type 1 spaces)

Control stations are spaces that may house vital equipment, or that may need to remain occupied to coordinate emergency actions during a fire. These spaces are defined by 46 CFR 72.05-5 and 46 CFR 114.400 as spaces that contain emergency power sources, continuously manned spaces containing navigating and radio equipment, areas where fire extinguishing or detecting equipment is centralized, and propulsion machinery control rooms that are located outside the machinery space. Emergency generator rooms are not considered control stations but are classified as machinery spaces. The term “centralized” in regard to fire control equipment means that the space contains the primary system equipment such as a cylinder bank or control panel. For example, the main fire alarm panel in the wheelhouse or the main CO_2 cylinder storage room are considered control stations. Corridors where the fire alarm manual pull stations or the fire extinguishing system remote releases are located are not control stations.

Stairways, stairtowers and elevator shafts – (type 2 spaces)

Type 2 spaces are stairways and stairtowers used as a vertical means of escape. Elevator shafts are also considered type 2 spaces, and must be insulated to the same boundary requirements. This includes the use of self-closing A-class fire doors at each level, if the elevator shaft penetrates more than two decks. There are two acceptable arrangements for elevator doors. If the elevator cab doors are not fire rated, A-class elevator lobbies may be constructed at each level with self-closing A-class fire doors constructed in accordance with section 2.11.1 to satisfy the boundary requirements. Alternatively, UL listed 1-1/2 hour rated passenger elevator fire doors with listed hardware, including hangers, track, header, sill, closer, and retaining clips as indicated in the individual approval may be used without the need to construct separate A-class lobbies on each level.

Because elevators are considered type 2 spaces, the requirements of 46 CFR 72.05-55 and 46 CFR 116.423 for approved interior finishes and fire resistant furnishings apply to the construction of the elevator cab.

Low risk service spaces, toilets and storerooms – (type 8 spaces)

Low risk service spaces include washrooms, public toilets, isolated pantries with noncombustible furnishings, cleaning gear lockers with a deck area less than 5 m^2 having no storage provisions (other than for brooms, mops and soap), and small laundries containing only a tub, washing machine and a household type dryer.

On Subchapter K vessels, workshops that are not part of a machinery space are also considered type 8 spaces.

Bathrooms with a single toilet and sink with vanity, that do not have storage provisions for other materials may be considered part of the space in which they are located, and not separate type 8 spaces.

High risk service spaces – (type 9 spaces)

High risk service spaces include galleys, main pantries, storerooms containing flammable liquids, large laundries, cleaning gear lockers containing flammable liquids or having a deck area of 5 m^2 or more, paint and lamp lockers, baggage rooms and garbage disposal and stowage rooms. On Subchapter H vessels, workshops that are not part of a machinery space are considered type 9 spaces.

Incinerator rooms or garbage stowage rooms with an incinerator are considered type 12 spaces.

Galleys are spaces with installed cooking appliances with surfaces that may exceed 121° C (250° F), such as ovens, ranges, griddles and deep fryers, generally connected to a flue or exhaust hood. Rooms containing portable cooking equipment such as microwave ovens, heat lamps, steamers, popcorn makers, toaster ovens and solid alcohol fuel (Sterno)

are not considered galleys. Spaces with portable cooking appliances are normally considered type 6 spaces.

Tanks, voids and auxiliary machinery spaces – (type 12 spaces)

Type 12 spaces are low fire load areas such as tanks, voids and auxiliary machinery spaces with no appreciable storage, that house low risk machinery without flammable liquids such as pumps, electrical machinery, ventilation or air conditioning equipment, fan rooms, etc. Type 12 spaces that include the storage of combustible materials resulting in a fire load of 2.5 kg/m^2 or greater are considered type 10 spaces.

Spaces containing ventilation equipment, fans, hot water heaters and similar electrical equipment with an aggregate power requirement of 7.5 kW or less that are located within an accommodation area and serve only that area are not considered type 12 spaces and may be separated from adjoining areas by B-0 boundaries, provided they are not used for storage.

Open deck areas – (type 13 spaces)

Type 13 spaces are areas that are permanently open to the weather. To be considered as a type 13 space, the deck area must be permanently open to the weather on one or more sides. Deck areas that are beneath a canopy or overhang are considered open deck areas if all areas under the overhead are within 5 m from the nearest opening. Open deck areas that include embarkation stations, lowering and/or stowage locations for primary lifesaving appliances, areas of refuge and escape routes to such areas are considered safety areas which are type 4 spaces. Vessels constructed with long main vertical zones in accordance with NVIC 8-93 should comply with the bulkhead and deck requirements listed in enclosures (1) and (2) of NVIC 8-93 and not Subchapters H or K.

CHAPTER 4 - CONSTRUCTION AND ARRANGEMENT OF ALUMINUM VESSELS

4.1 Aluminum Construction

4.1.1 Domestic vessels

Ref: 46 CFR 32.57-5(e), 72.05-5(i), 92.07-5(e), 108.131(c), 114.400

The vessel regulations require the hull, superstructure, structural bulkheads, decks and deckhouses of all vessels to be constructed of steel or other equivalent material. Aluminum may be considered equivalent to steel if it is suitably insulated. The following sections provide guidance on how aluminum construction can be designed to show equivalency to steel without the need for fire testing. These guidelines may be applied to any type of domestic vessel except tankers, and high speed craft designed to the IMO High Speed Craft Code.

Typical shipboard fire scenarios are not capable of developing temperatures high enough to significantly weaken or melt steel bulkheads or decks. Because of this, uninsulated steel of the appropriate thickness is accepted for A-0 class divisions without any added structural insulation. If the division is required to be A-15, A-30 or A-60 class, it is necessary to apply approved insulation to limit the temperature rise on the unexposed side of the division for the required time period. Since the typical fire exposure is not expected to weaken the structural steel, approved structural insulation applied to one side of the division will provide protection for a fire on either side of the division.

Aluminum has a much lower melting point than steel, and will begin losing its structural strength at a temperature of approximately 232° C (450° F), which can be expected in a typical shipboard fire. It is therefore necessary to insulate aluminum divisions to protect the aluminum core from thermal damage. For an unrestricted application, insulation is required on both sides of the division to protect the aluminum core from a fire on either side. For conservatism, a maximum core plate temperature of 200° C (360° F) was established as the acceptance criteria for type approvals. If the division is required to be an A-15, A-30 or A-60 barrier, additional insulation is provided to further limit heat transmission through the assembly to restrict the average unexposed side temperature rise to 139° C (250° F).

The use of insulation to protect both sides of an aluminum division somewhat complicates the arrangement and amount of insulation needed. If an aluminum bulkhead is insulated on only one side, the thickness of insulation needed can be determined by a straightforward fire test where the insulated side of the bulkhead is exposed to the test fire. During the test fire exposure, the heat transferred to the core and its resultant temperature rise depend on the amount and type of insulation applied to the bulkhead, and the amount of heat that is lost to the atmosphere on the unexposed side of the core plate. If insulation is applied to both sides of the bulkhead, the heat loss from the aluminum core will be reduced by the insulation on the unexposed side. The added insulation on the unexposed side requires the application of additional insulation on the exposed side to compensate for the reduced heat loss on the unexposed side. If both sides of the core are insulated, the amount of insulation needed for a

particular rating must be adjusted because the insulation on the unexposed side reduces the effectiveness of the insulation on the exposed side and vice versa.

In the late 1960s, a research program was carried out by the Society of Naval Architects and Marine Engineers (SNAME) to develop a reference tool for designing A and B-class aluminum divisions. The results of the program are published in SNAME Technical and Research Bulletin 2-21, *Aluminum Fire Protection Guidelines*. The guidelines provide a calculation technique and a number of examples of various classes of aluminum bulkheads and decks. The guidelines are based on the use of stiffened aluminum plate of at least 5 mm thickness. Thicker plate may be used for actual construction, but if a plating thickness less than 5 mm is to be considered, additional fire tests are necessary due to the reduced heat capacity of the core. The test program was based on the use of structural fire protection materials tested to the Subchapter Q test methods. Materials tested to the FTP Code are tested to different standards and cannot be used in conjunction with Bulletin 2-21.

SNAME bulletin 2-21 provides the necessary equations for calculating the insulating effectiveness of different structural fire protection configurations. The research program showed that diverse results are obtained if the structural insulation is attached directly to the aluminum core plate, or if an air gap is provided between the two components. The guidelines provide a means for calculating the total insulating value Ft, and the core insulating value Fc. Ft is the same regardless of which side the fire occurs on. Fc is specific to each side of the division. The values used for Fc and Ft are correlated to the approved thickness of approved structural insulation (164.007) and bulkhead panels (164.008). There are also provisions for the added benefit of air gaps (minimum 25 mm) and approved noncombustible insulations of any thickness (164.009). The basic units of insulating value in the equations are defined as "S" and "P". S is the approved thickness of structural insulation necessary for an A- 60 rating. P is the approved thickness of bulkhead panels needed for a B-15 rating. The approved bulkhead panel thickness P is considered equal to .67 S.

The Fc values are the minimum amounts of insulation needed to achieve an A-0 or B-0 rating by maintaining the core temperature below 200° C (360° F). The SNAME test results showed that for B-class, a minimum Fc value of .45 S will provide 30 minutes of core protection and that for A-class, a value of .72 S will provide 60 minutes of protection for aluminum plates that are insulated on one side only. As explained above, if both sides of the division are insulated, the amount of insulation needed on one side must be increased to compensate for the reduced effectiveness of the insulation applied to the opposite side.

To illustrate how insulation on both sides affects the insulating effectiveness of the division, consider an aluminum bulkhead insulated with approved structural insulation attached directly to one side of the core. Equation 2 (page 7) of the SNAME Bulletin notes that the Fc value can be calculated as:

$$Fc = Fe - 0.1\ (Fu)^2$$

Where Fe is the insulating value of the fire exposed side of the bulkhead and Fu is the insulating value of the unexposed side. If one side of the bulkhead is insulated to .72 S, the Fc value for the insulated side of the bulkhead is calculated as follows:

$$Fc = .72\ S - 0.1\ (0)^2$$

$$Fc = .72\ S$$

The bulkhead is therefore qualified as an A-class division for a fire exposure on the insulated side. If the fire exposure is on the uninsulated side, the values of Fe and Fu are reversed, and Fc becomes:

$$Fc = 0\ S - 0.1\ (.72\ S)^2$$

$$Fc = -\ 0.05\ S$$

Since the calculated insulation value is less than zero, the bulkhead has no rating for a fire on the uninsulated side.

For an A-class rating on both sides, the bulkhead would require added insulation on both sides. If the bulkhead is insulated with a thickness of .72 S on both sides, the calculated Fc value for both sides becomes:

$$Fc = .72\ S - 0.1\ (.72\ S)^2$$

$$Fc = .72\ S - 0.05184\ S$$

$$Fc = .67\ S$$

It can be seen that the addition of insulation to the unexposed side of the bulkhead has reduced the effectiveness of the insulation on the exposed side to a level below that required for an A-class division. In order to use the design as an unrestricted A-class bulkhead, the Fc value from both sides needs to be at least .72 S. If the thickness of insulation on the exposed side is increased to .79 S, the new Fc becomes:

$$Fc = .79\ S - 0.1\ (.72S)^2$$

$$Fc = .79\ S - 0.05184\ S$$

$$Fc = .74\ S$$

The bulkhead is qualified as an A-class division for a fire on the side with the thicker insulation. However, for a fire exposure from the other side, the Fc value now becomes:

$$Fc = .72\ S - 0.1\ (.79\ S)^2$$

$$Fc = .72\ S - 0.06241\ S$$

$$Fc = .66\ S$$

The increased thickness of insulation has caused the resulting effectiveness of the unexposed side to drop below the required amount needed for A-class. To compensate, the insulation value on both sides is increased to .79 S. Since the insulating value is identical for both sides, the adjusted Fc becomes the same for both:

$$Fc = .79\ S - 0.1(.79\ S)^2$$

$$Fc = .79\ S - 0.06241\ S$$

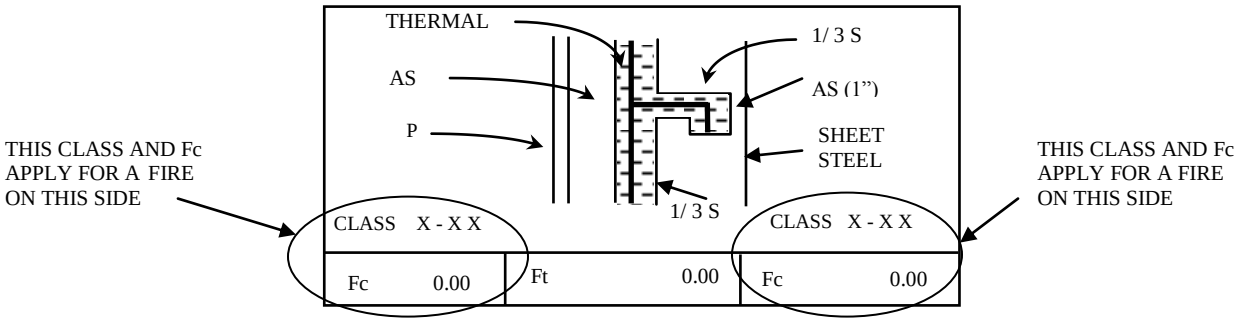
$$Fc = .73$$

The bulkhead now qualifies as an A-class division for a fire exposure on either side.

Ft is the total insulating effectiveness of the division and determines the amount of time the assembly is expected to limit the temperature rise on the unexposed side to 139 ° C (250° F). Ft is calculated by adding the Fc insulating values from the exposed and unexposed sides. The SNAME test program showed that an Ft value of .5 S provides 15 minutes of temperature rise limitation, .7 S provides 30 minutes and an Ft of 1.0 provides 60 minutes. Because of the amount of insulation necessary to protect the core plate to achieve an A or B-class rating (Fc), most arrangements will also have enough insulating effectiveness to limit temperature rise (Ft). For example, in the example above .79 S was required on each side of the bulkhead to satisfy an A-0 class rating for the core. The total insulating effectiveness Ft is .79 S + .79 S = 1.58 S, which exceeds the Ft of 1.0 needed for an A-60 rating.

Figure 4.1 is taken from SNAME Bulletin 2-21, Appendix C and shows typical aluminum bulkhead assemblies which are acceptable to meet Coast Guard requirements. For each illustration, the Fc value on the left is the A, B or C-class rating of the core for a fire exposure from the left side and the Fc value on the right is the rating for a fire exposure from the right side. The Ft value is the temperature rise limitation and is the same for a fire on either side of the division.

SNAME BULLETIN 2-21
TYPICAL ALUMINUM INSULATION DETAILS



Ft	TOTAL INSULATION VALUE OF ENTIRE DIVISION
Fc	EFFECTIVE INSULATION VALUE OF INSULATION PROTECTING THE ALUMINUM CORE
P	BULKHEAD PANEL THICKNESS APPROVED UNDER 164.008
S	STRUCTURAL INSULATION THICKNESS APPROVED UNDER 164.007
AS	AIR SPACE
THERMAL	NONCOMBUSTIBLE INSULATION APPROVED UNDER 164.009

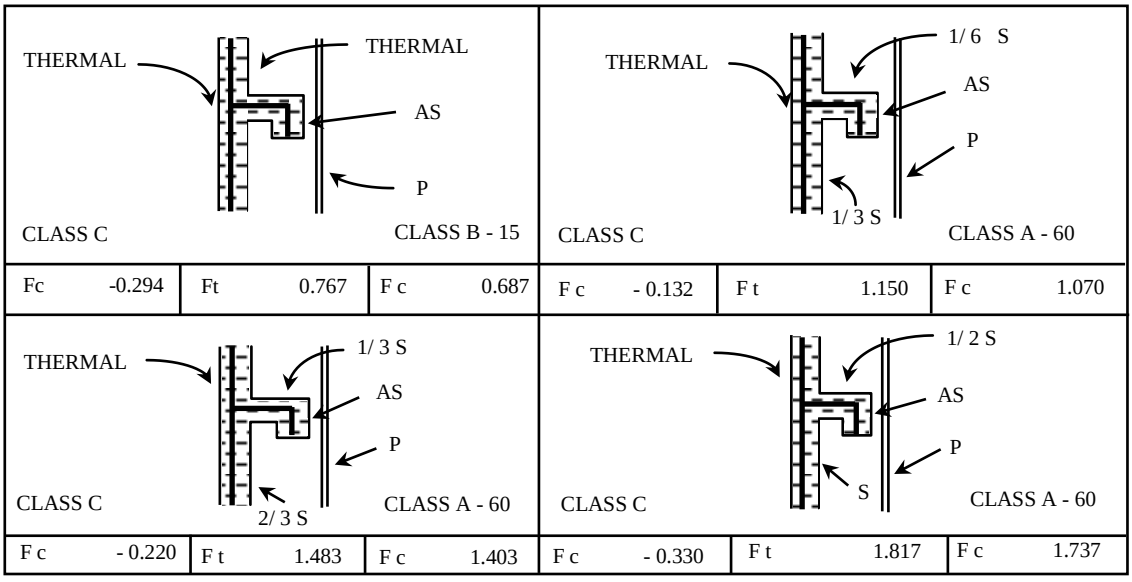


FIGURE 4.1

The traditional design approach for the protection of aluminum vessels relies on the regulations to specify which divisions must meet A or B-class criteria based on the occupancy of the space, and requires the same level of insulation on both sides of the fire barrier. SNAME Bulletin 2-21 also provides an alternative design approach, that is intended to reduce the overall amount of insulation required but provide an equivalent level of safety. A combustible loading survey is done of the vessel, and the resultant fire severity is determined for each space based on the actual fit-out and expected fire load in each room. The associated amount of insulation for each side of the fire barriers is then determined, and may be different for each side of the barrier.

SNAME Technical Bulletin 2-21 provides overall guidance on insulation procedures and should be consulted for the exact details. This section is intended to clarify the main elements of the calculation method. Some additional guidance is outlined below:

1. When insulation is not applied equally to both sides of a division, high hazard spaces such as machinery spaces adjacent to a tank or void should have the higher insulating value on the machinery space side. Control stations that are expected to be occupied during an emergency and are adjacent to accommodation spaces should have the higher insulating value on the accommodation space side, since it is likely the control station may remain occupied during a fire emergency.

2. Decks should be insulated from the underside. For most applications, downward heat transfer from a fire is limited. Past research has shown that 6 mm (1/4 inch) of most deck coverings is adequate and further calculations are not required. Carpet, carpet padding, and vinyl tile should not be used for this purpose unless these materials can be shown to provide adequate insulation through testing. Vinyl tiles that meet the IMO FTP Code, Annex 1, Part 5 may be accepted without testing. Approved insulation should be applied to the topside of a deck when the fire hazard from above is considered high, such as a vehicle deck where a fuel spill is likely.

3. Extremely low fire hazard spaces (combustible loading less than 2.5 kg/sq. m (0.5 lb/ft.sq.)) such as water tanks and voids need not be insulated, while fuel tanks should be insulated on the exterior if insulation is required.

4. The overhead, columns and sides of non-loadbearing canopies need not be insulated. However, consideration should be given to the affects the collapse of the structure may have on escape. Loadbearing structures and columns that support decks, life saving equipment, walkways and similar features should be insulated on all sides in accordance with the fire load of the affected area as follows:

Fire load (Kg/m^2)	Fc Value
Less than 2.5	0
2.5 to 9.95	.5 S
9.96 to 22.45	.9 S
22.45 to 34.95	1.2 S
34.96 and above	1.4 S

5. Shell plating and hull framing below the main deck should be insulated to A-0 criteria for a distance of at least 30 cm (12 inches) below the lightship waterline. Interior bulkheads that extend into bilge areas need only be insulated to the lowest deck level.

6. Insulation in machinery spaces should be covered by a vapor barrier, and should not extend into the bilges where it may become oil soaked.

7. Bulkheads and decks separating interior spaces from exterior weather areas should be insulated on the interior side, except where adjacent to vehicle decks and similar high hazard spaces. Exterior insulation should have a suitable weatherproof covering.

8. Penetrations should be arranged and protected so they do not impair the fire performance required of the division. All electrical penetrations should be fire tested. Piping penetrations should be fire tested or designed in accordance with accepted construction specifications.

4.1.2 SOLAS Vessels

Ref: SOLAS regulations II-2/11.3, II-2/11.4.

SOLAS requires that all bulkheads, decks, and related fire protection materials must be tested to the applicable test methods in the FTP Code, with each side of the division exposed to the test furnace. SNAME Technical and Research Bulletin 2-21 is not applicable to SOLAS ships.

Several interpretations are contained in MSC/Circ. 1120 in regard to aluminum construction, that are accepted on U.S. flag ships:

1. Aluminum decks should be tested with a deck covering in place, to verify that the 200° C temperature of the aluminum core is not exceeded. The specific deck covering used in the approval test does not need to be used for shipboard applications. Any approved deck covering is acceptable. If a bare aluminum deck is tested to Part 3, Annex 1 of the FTP Code with insulation installed on the bottom side and no deck covering on the top surface, the approval is limited to applications without deck coverings. Alternatively, if the temperature of the bare aluminum core can be maintained below 150° C during the test, then the Coast Guard will accept any approved deck covering.

2. When spaces of categories (1) to (10) in regulation II-2/9.2.2.3 or of categories (1) to (5) and (10) in regulation II-2/9.2.2.4 are located on top of aluminum decks, the deck does not need to be insulated from the upper side, provided the deck is protected by an approved deck covering.

3. Doors, windows and other division penetrations intended to be installed in aluminum divisions should correspond to prototype(s) tested on a bulkhead or deck made of aluminum, unless the Coast Guard is satisfied that the construction, as approved, does not impair the fire resistance of the division regardless of the division construction.

4.2 Very Low Fire Load (Type 5a) Spaces

4.2.1 Domestic vessels

Inspection Note: The presence of a trained crewmember, such as a deckhand, in the 5a space is necessary whenever the vessel is in operation to ensure that a person familiar with fire fighting and evacuation procedures is on duty. An inspection note to this effect should be placed in the vessel's COI. In addition, all conditions of approval for the restricted fire load should be noted. Any modifications to the vessel arrangement or fire load should be referred to the Marine Safety Center for approval.

In 1994, the Coast Guard developed an equivalency policy adapted from the alternative fire loading approach in SNAME Bulletin 2-21 for passenger spaces with extremely low combustible loading, originally published as PFM 1-94. These spaces are designated as Type 5a spaces and may be considered on either steel or aluminum vessels certificated under Subchapters T or K carrying 600 or less passengers, and having no overnight accommodations. The Type 5a space policy is intended to provide a consistent level of fire protection, while permitting weight savings in the required amounts of structural fire protection installed.

The Type 5A space policy is suitable only for large open public spaces with a uniformly distributed fire load, consisting of rows of fixed seating, conversational seating arrangements or dining tables and no areas where there is a concentrated fire load. This helps to ensure slow fire growth and minimize the peak heat release rate, preventing localized flashover. In addition, the type of interior finish materials, furniture, and furnishings is restricted as discussed below

To qualify for a Type 5a equivalency, the following conditions must be satisfied:

1. Fire load calculations in accordance with section 4.3 must be used to demonstrate that the combustible load in the space does not exceed 5 kg/m^2 (1 lb/ft^2), including 0.75 kg/m^2 (0.15 lb/ft^2) for passenger effects. Luggage storage rooms separated from the 5a space should be provided in cases where the 0.75 kg/m^2 (0.15 lb/ft^2) allowance is inadequate. Life jackets stored in closed, nonperforated, noncombustible containers and electrical cable insulation located behind nonperforated, noncombustible ceiling panels or bulkhead linings do not need to be included in the fire load calculations.

2. Any installed interior finishes or trim must be approved under 46 CFR 164.012 or 164.112.

3. Furniture and furnishings, draperies, curtains, rugs and carpets must be fire resistant in accordance with 46 CFR 116.423. Additionally, all upholstery, padding and cushions must be fire resistant. Case furniture must be constructed entirely of noncombustible materials, except that interior finish materials or paint approved under 164.012 or 164.112 may be applied to exposed horizontal surfaces.

4. Seating furniture meeting CAL TB 133 is acceptable in lieu of meeting UL 1056.

5. Any aluminum frame windows fitted in the bulkheads used to separate qualified refuge areas or lifeboat embarkation stations from type 5A spaces must be either Coast Guard approved A-0 windows, or provided with steel retaining clips. This also applies to windows on the deck below areas of refuge.

6. Aluminum decks within Type 5A spaces do not require top side A-class insulation.

7. An approved fire detection and manual fire alarm system must be installed in all areas. Smoke detectors must be fitted in all accommodation, control stations and service spaces.

8. A fire pump and fire main system complying with 46 CFR 181.300-320 for vessels greater than 19.8 m (65 feet) must be installed.

9. Any stanchions supporting normally occupied decks must be steel or insulated to A-class requirements.

10. The shell plating and framing below the main deck must be A-0 construction for a distance that extends at least 300 mm (12 inches) below the lightest load waterline.

11. Fuel tank boundaries may be uninsulated aluminum or steel construction provided: (1) the fuel tank boundaries are not adjacent to a potential source of ignition, or (2) the fuel tank boundaries are not adjacent to a space containing more than 2.5 kg/m^2 (0.5 lb/ft^2) fire load. Sight glasses, when permitted by Subchapter F, should be constructed in a manner to preserve the fire integrity of the bulkhead and shall comply with 58.50-10(a)(6).

12. Stairs and ladders located entirely within a type 5A space or stairs located entirely within a stair tower enclosure may be constructed of uninsulated aluminum or steel.

13. Voids and other spaces where the fire load does not exceed 2.5 kg/m^2 (0.5 lb/ft^2) and constructed of steel or aluminum do not require insulation.

14. 5A vessels may be allowed excursion permits if the proposed function is within the approved arrangement and fire load assumptions. If the excursion is a food event, the food is to be prepared ashore and brought aboard for serving (no cooking aboard).

15. In public areas, one A-II portable fire extinguisher must be provided for every 45 m^2 (500 ft^2) or fraction thereof.

Table 4.1 gives the requirements for the non-MVZ boundaries for 5A spaces. Boundaries that are MVZ's should be constructed and insulated in accordance with the applicable vessel regulations.

Table 4.1

Boundary requirements for Type 5A spaces

Type 5A space adjacent to:	Space type	Minimum Boundary Requirement
Control stations	1	C-class smoke tight
Stairway and elevator enclosures	2	C-class smoke tight
Corridors	3	C-class smoke tight
Areas of refuge, embarkation stations and external escape routes	4	See paragraph 4.2.1.1 below
Staterooms and all public spaces with noncombustible veneers and trim and fire resistant furnishings	5	B-0 bulkheads / A-0 decks
5A space	5A	C-class smoke tight
Staterooms of 500 square feet or less with combustible furnishings, and isolated storerooms (Type 6 public spaces not permitted)	6	B-15 bulkheads / A-0 decks
Public spaces over 500 square feet with Combustible furnishings	7	Not Permitted
Washrooms, toilet spaces and isolated pantries with noncombustible fittings	8	C-class
Galleys, main pantries, storerooms, luggage storage rooms,and workshops	9	A-15 – insulated on high fire load side only
Machinery spaces	10	A-15– insulated on high fire load side only
Cargo spaces / Vehicle spaces	11	Not permitted
Fuel and water tanks and voids	12	A-0*
Open decks - not vehicle spaces	13	C-class smoke tight

* May be reduced to C-class where the fire load of the adjacent spaces does not exceed 2.5 kg/m^2 (0.5 lb/ft^2)

4.2.1.1 Boundary requirements for 5A spaces adjacent to areas of refuge, embarkation stations and external escape routes

46 CFR 114.400 defines “areas of refuge” as areas that are separated from the effects of fire and flooding for the maximum amount of time required to complete disembarking of the vessel or one hour, whichever is less. This regulation also defines areas of refuge as “safety areas”. The requirements for the bulkheads and decks that separate various spaces are listed in tables 116.415(c) and 116.415(d). However, neither table lists areas of refuge or safety areas. The requirements for bulkheads and decks that separate areas of refuge from adjacent areas are therefore established on a vessel-by-vessel basis. The original type 5A space policy accepted non-fire-rated barriers for this purpose, based on consideration of the restricted fire

load. This policy was based upon narrowly focused research and the use of simplistic zone fire models. Moreover, these background studies were based on the evaluation of regularly shaped compartments fitted with uniformly distributed seating, and only considered a few types of common seating materials available at that time. The affects of variations in the location of door and window openings were also not considered.

Since the promulgation of the type 5A space policy in 1994, the Coast Guard has re-examined this issue using advanced computational fluid dynamics modeling, which has shown that while this approach may provide an acceptable level of safety in some cases, it is very sensitive to the type and distribution of seating materials and other combustibles, as well as the ventilation conditions in the space. The Coast Guard has, therefore reconsidered the blanket policy of accepting non-fire-rated barriers between areas of refuge, embarkation stations and external escape routes, and determined that a higher level of protection may be necessary to account for such variations. A-60 fire barriers should be provided between type 5A spaces and areas of refuge, embarkation stations and external escape routes, unless a performance-based engineering analysis is performed to substantiate a lesser amount of protection.

The performance-based analysis should demonstrate that localized or progressive failure of the vessel's structure will not occur, when exposed to a fire in the type 5A spaces, using the type and distribution of combustible materials and interior arrangements specific to the vessel. The analysis should also demonstrate that the areas of refuge and external escape routes to the embarkation stations will remain tenable throughout the refuge period from the effects of the design fire scenarios in the adjacent 5A spaces. The means of escape are arranged as a system that allows the passengers to escape from the fire-affected spaces to the areas of refuge, where they take shelter while the crew attempts to control the fire. If it becomes necessary to abandon ship, the passengers then travel from the refuge areas to the embarkation stations. The analysis should demonstrate that the entire escape path, including external areas, is capable of surviving the design basis fire exposure.

Key input parameters of the analysis, including the minimum design fire scenarios and required safety margins, and pass/failure criteria for the fire scenarios should be established for each project in consultation with the Coast Guard prior to performing the analysis.

A recognized performance-based fire protection engineering approach should be used for the analysis. Currently, three approaches are accepted by the Coast Guard: NVIC 3-01, *Guide to Establish Equivalency to Fire Safety Regulations for Small passenger Vessels*, the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*, Society of Fire Protection Engineers and National Fire Protection Association, 2000 and International Maritime Organization MSC/Circ. 1002 *Guidelines on Alternative Design and Arrangements for Fire Safety.*

The performance-based fire protection engineering analysis should address the following issues specific to the 5a spaces:

1. The fuel packages selected for the analysis and the design fire scenarios should be representative of the maximum fuel loading and type and distribution of combustibles expected during operation of the vessel.

2. The fire modeling should use the actual room geometry of the occupied space, including all sources of ventilation such as HVAC ducts, doors and windows.

3. The heating effects predicted by the fire models should then be used as input to heat transfer models to calculate the structural response.

4. The use of a conservative approach should be clearly demonstrated in all calculations.

5. The engineering analysis should consider the long-term control of the combustible materials and provide details of how future changes to outfitting, materials or interior arrangements will be accounted for in the vessel's safety management system.

4.2.2 SOLAS vessels

The domestic vessel Type 5A space policy is not applicable for use on SOLAS vessels. There are no provisions in SOLAS for the consideration of combustible loading in regard to the level of structural fire protection.

Accommodation spaces of minor fire risk are considered Type 6 spaces by SOLAS, and have lower structural fire protection boundary ratings than Type 7 spaces. The only additional requirement is the use of furniture and furnishings of restricted fire risk. See regulation II-2/9.

4.3 Fire load Calculations

Ref: 46 CFR 116.427, NVIC 8-93

Onboard domestic vessels, calculations may be used to document the fire load of low risk spaces (Type 5 and 5A spaces), and for vessel designs complying with NVIC 8-93. There is no equivalent program for use on SOLAS vessels.

Fire load is a relative measure of the amount of combustible materials available to burn in a space, and is calculated in terms of mass per unit area. For simplicity, all combustible materials are assumed to have an equivalent heat of combustion, thus it is not necessary to verify the heat release rate of different materials installed on the vessel.

There are two categories of combustibles that should be included in the calculations:

1. Combustible materials of construction permitted by the regulations such as decorative laminate interior finishes, trim and carpets; and

2. Combustible operational materials provided by the ship's owner such as furniture, decorations, bedding and restaurant and office supplies.

Personal items which are brought onboard by the passengers or crew do not need to be included in the fire load calculations.

The fire load limits established in Subchapter K, NVIC 8-93 and in section 4.2 of this NVIC are summarized below:

Type of space	Maximum permitted fire load
Type 5	15 kg/m^2 (3 lb/ft^2)
Type 5A	5 kg/m^2 (1 lb/ft^2)
Type 6 & 7*	37.5 kg/m^2 (7.5 lb/ft^2)
Long Main Vertical Zones in accordance with NVIC 8-93	15 kg/m^2 (3 lb/ft^2)

* Calculations are required only if the cognizant OCMI determines that the fire load of the space is near this limit. See 46 CFR 116.427.

The amount of combustible materials must be documented during the construction of the vessel though a submittal to the Marine Safety Center (MSC). The calculations will be reviewed and marked "Examined". Final approval is granted by the OCMI, who verifies the actual arrangement of the spaces. A copy of the "Examined" fire load calculations should be kept onboard the vessel to allow the inspectors to verify that the fire load has not significantly changed during normal operation. The fire load calculations should be submitted using the standard format provided in Figure 4.3.1.

Fire load calculations should include all combustible construction and operational materials in addition to all loose or free standing combustibles intended for use or stowage in the space. This includes furniture, furnishings, carpet and padding, rugs, combustible deck coverings, draperies, interior finish, veneers, trim, decorations, computer and office equipment, slot machines, electrical cable insulation, plastic piping, light diffusers, mattresses, bedding, plastic resin or FRP shower modules and countertops, daily cleaning/dining supplies, lifesaving equipment (except PFDs in closed metal lockers), office supplies, restaurant supplies, alcohol greater than 80 proof, gaming supplies and similar materials. Approved interior finish materials and fire resistant furnishings are combustible materials and should also be included in the fire load calculation.

Interior decorations should be included in the fire load calculations, and must also be included in the calculations for the total volume of combustible materials required by 46 CFR 72.05-15 and 46 CFR 116.422. Temporary decorations for seasonal events and parties need not be included in the calculations, subject to the discretion of the OCMI.

Solid wood doors opening to exterior spaces need not be included in the fire load calculation because they are considered part of the vessel structure. Furthermore, deck coverings approved under 46 CFR 164.006 need not be included in the fire load calculations because they are considered noncombustible materials.

Figure 4.3.1 Fire Load Calculation Format

Space designation				
Deck No.				
Type of space (5, 5a, 6, 7)				
Gross deck area				Square meters
Total weight				Kilograms
Fire load				Kg/m^2
Construction materials				
Material	Quantity A	Unit weight B	Total weight A x B	Mfr certification of % combustibles attached? (Y/N)
Floor and deck coverings				
Carpet				
Carpet padding				
Interior finish/veneers				
Trim and decorations				
Cable insulation				
Plastic piping				
Light diffusers				
Countertops/ shower modules				
Case furniture				
Other				
Operational materials				
Free standing furniture				
Draperies				
Computer and office equipment				
Gaming machines				
Bedding				
Cleaning supplies				
Bar and restaurant supplies				
Other				
Total weight				

For items that are constructed of both combustible and noncombustible materials, such as furniture, gaming tables, and slot machines that are constructed of metal and wood or plastic, the mass of the metal components may be excluded from the fire load calculation. Written certification from the builder of the vessel or the manufacturer of the item indicating the total mass of the item and the combustible mass of the item should be provided to the MSC.

Combustible materials located in concealed spaces behind linings should also be included in the fire load calculations, unless the concealed space is separated by:

1. A-class linings; or

2. B-class linings if the space has a fire load not exceeding 15 kg/m^2, or

3. C-class linings if the space has a fire load not exceeding 5 kg/m^2.

The fire load of multilevel spaces, such as balconies and atriums, should be calculated on a deck-by-deck basis using the gross deck area on each level. The gross deck area is considered the actual area of the balcony or the area of the periphery spaces around the atrium opening. The area of the opening is not included in the gross area calculation

4.4 High Speed Craft

The Coast Guard uses the IMO High Speed Craft Code (HSC Code) for the approval of both domestic and SOLAS high speed craft. The HSC Code uses a systematic approach for the fire safety of lightweight vessels operating on restricted routes where outside assistance and a place of safe refuge is available within 4 hours at normal operating speed, while traditional vessels constructed to the requirements of chapter II-2 of SOLAS have no operational restrictions and are expected to be self-sustaining with all necessary emergency equipment carried onboard.

The HSC Code is intended as a stand-alone document and must be applied in its entirety to ensure that all of the necessary safety trade-offs have been incorporated into the design and operation of the vessel. Use of the Code is not mandatory. Vessel owners may also use Subchapter K, Subchapter H, Subchapter T or SOLAS, as appropriate for the design of their vessels.

The HSC Code does not require noncombustible A-class and B-class divisions for the separation of different spaces. Instead, the vessel is subdivided into common hazard areas containing either machinery spaces, passenger spaces, control spaces or escape routes. These hazard areas are required to be separated by "fire-resisting divisions", which can be constructed of either noncombustible materials or fire-restricting materials. Fire restricting materials are combustible materials such as composite panels that have been tested in accordance with the fire test procedures specified in IMO Resolution MSC. 40(64) as amended by IMO Resolution MSC.90(71). The tests for fire restricting surface materials are performed according to the standard ISO 9705 room/corner test. All fire barriers and related insulating materials used to comply with the HSC Code must be tested to the criteria in the IMO FTP Code.

The required structural fire protection values for bulkheads and decks used to separate hazard areas are keyed to the amount of time needed to completely evacuate the vessel. A maximum 60 minute structural fire protection time is used as the basis for the overall evacuation system design. Calculations and a practical drill are used to demonstrate the evacuation can be completed within the maximum permitted time plus a safety margin. The

evacuation time must be shown to be no more than 1/3 of the structural fire protection time, minus 7 minutes for initial detection and extinguishing actions. Thus the maximum evacuation time is (60 minutes – 7 minutes) / 3 or 17.66 minutes. In cases where the evacuation can be completed in less time, the Code permits the structural fire protection time to be reduced proportionately, but not below 30 minutes.

Structural fire protection times are used to determine the required insulation value of the fire-resisting divisions that separate areas of different fire hazard. Boundaries of major fire hazard areas such as machinery spaces, galleys and some sales shops are required to have a 60 minute structural fire protection time. Boundaries of areas of moderate fire hazard, such as auxiliary machinery spaces, bond stores and crew berthing areas must have a 30 minute fire protection time. Areas of minor fire hazard, such as public spaces, corridors and stairways, and escape routes are not required to have a structural fire protection time, but are required to be separated by smoke-tight divisions.

Most high-speed craft are constructed of aluminum. The HSC Code therefore provides tables for the required structural fire protection times for each side of the decks and bulkheads separating different hazard areas. In some cases, different structural fire protection times are required for opposite sides of the division. The Code currently does not require insulation to be applied to the topside of decks in special category or ro-ro spaces. Recent amendments to the Code extend this exemption to any space protected by a fixed fire extinguishing system.

Furniture and furnishings in public spaces and crew accommodation areas are required to comply with the criteria listed in Chapter 7 of the HSC Code. Draperies and suspended textiles, upholstered furniture, bedding components and deck finishes are required to be tested to the appropriate fire tests in the FTP Code. Case furniture must be constructed entirely of noncombustible or fire restricting materials, except that a combustible veneer with a calorific value not exceeding 45 Mj/m^2 may be applied to exposed surfaces. Freestanding furniture must be constructed with frames of noncombustible or fire restricting materials. All furniture components that are required to be constructed of fire restricting materials must be tested to ISO 5660. See section 2.15 for further details.

CHAPTER 5 - CONSTRUCTION AND ARRANGEMENT OF MODUs AND FLOATING OFFSHORE INSTALLATIONS

5.1 General

The structural fire protection requirements for MODUs and offshore installations are provided in 46 CFR part 108 and 33 CFR parts 140-147, respectively. The requirements for offshore facilities are further broken down into one set of criteria for floating facilities and another for fixed facilities. The IMO MODU Code is not used by the Coast Guard for the review of U.S. flag facilities because it does not contain sufficiently detailed requirements in certain areas. However, the Alternate Compliance Program (ACP) has provisions for the review of MODUs that have been designed to the 1989 IMO MODU Code plus class society rules plus the U.S. ACP supplement requirements.

5.2 MODUs

The requirements in Subchapter I-A are based on the provisions of 46 CFR Subchapter I, *Rules and Regulations for Cargo and Miscellaneous Vessels,* with additional provisions appropriate for mobile offshore drilling units. Thus, the basic structural fire protection criteria for cargo vessels have been made applicable to MODUs. However, because of the different hazards found on MODUs, the Coast Guard has developed several interpretations of the regulations that are unique to this application:

Control stations – Control stations are considered spaces that contain emergency power sources, continuously manned spaces containing navigating and radio equipment, areas where fire extinguishing or detecting equipment is centralized and propulsion machinery control rooms that are located outside the machinery space. In addition, control stations also include spaces that may need to be occupied during a fire to manipulate vital industrial processes, such as ballast control stations. Areas where emergency or remote equipment shutdowns are located are not considered control spaces, since the controls only need to be accessed momentarily.

Fire rating of emergency generator enclosures – 46 CFR 108.139 requires emergency generators to be separated from adjacent areas by A-class boundaries. On MODUs, it is typical to provide diesel or gas turbine emergency generators that are factory assembled package units with steel weather enclosures that do not fully meet the criteria for A-class divisions. If the package units and associated cables are remotely located near the edge of the unit in a area where exposure to fire sources from below is unlikely, and are shielded or otherwise separated from a horizontal fire exposure on the same deck, A-class boundaries are not required. Details of such arrangements will be checked during plan review, and if necessary by the OCMI.

Storerooms – 46 CFR 108.137 requires storerooms to be separated from accommodation and control spaces by A-class boundaries. In this context, storerooms are considered storage areas where considerable amounts of combustible materials including flammable or combustible liquids may be kept. Within the accommodation areas on MODUs, it is common to have closets that may contain linens, mops, brooms and small amounts of household

cleaners. The Coast Guard has determined that for such spaces having a deck area of 5 m^2 or less and no storage of flammable liquids, the requirement for A-class boundaries may be reduced to B-15 class.

Fan rooms / machinery spaces – 46 CFR 108.137 requires machinery spaces to be separated from accommodation and control areas by A-class divisions. This regulation is intended to apply to main machinery spaces or other machinery spaces where flammable liquids, internal combustion engines or major electrical equipment are present. Spaces containing ventilation equipment, fans, hot water heaters and similar electrical equipment with an aggregate power requirement of 7.5 kW or less having no storage provisions that are located within an accommodation area and serve only that area present a lower fire risk and may be separated from adjoining areas by B-class bulkheads. If an accommodation area air handler room is separated from the corridors by B-class bulkheads, additional HVAC system restrictions may apply (see section 3.7.1).

Use of steel gratings – 46 CFR 108.133 requires the hull, superstructure, structural bulkheads, decks and deckhouses to be made of steel or equivalent materials. The definition of equivalent material means a material that by itself or with insulation added has structural and integrity properties equivalent to steel at the end of the applicable fire exposure. There are three levels of structural fire protection recognized in 46 CFR. These levels are "A-class" or 1 hour fire integrity, "B-class" or 30 minutes of fire integrity and "steel or equivalent material" which has no implied fire integrity other than the steel's inherent ability to remain undamaged during fire exposure. Main structural elements are required to be constructed of steel or equivalent material. This does not require any fire resistance rating for these structures. If a fire rated boundary is intended by the regulations, an A-class or B-class boundary will be specifically called for. Thus, in areas where no fire endurance rating is called for, the use of open steel gratings is acceptable unless the open gratings could allow a single fire from below to cut off both means of escape from an area. In this case, solid steel decking should be installed.

Use of FRP gratings and cable trays – Fiber reinforced plastic gratings and cable trays are acceptable for use on MODUs as explained in sections 2.17 and 2.18. Typical applications include walkways and elevated platforms, electrical switchgear rooms, generator rooms, machinery spaces and open deck areas. All FRP gratings and cable trays must meet low flame spread criteria. FRP gratings are also tested for their capability to sustain specified structural loads expected for the locations where they will be installed. Any FRP cable trays installed in accommodation, service and control areas must also meet low smoke generation criteria.

Accommodation modules and temporary quarters – Any temporary accommodations on offshore facilities must be constructed to the same criteria as permanent deckhouses listed in 46 CFR 108.143. This applies to all areas intended as living quarters, sleeping areas, mess areas, medical treatment areas, recreational areas, toilet and shower areas, offices and corridors serving these areas. This does not apply to incidental spaces in industrial areas. The exterior boundaries of the modules are required to be at least steel A-0 steel. If the quarters module will be located next to an emergency generator, the exterior boundaries are required to be A-60. Accommodation spaces with a deck area exceeding 27 m^2 (300 ft^2) are

required to have two means of escape. Windows are not credited as a means of escape, however, kickout panels of adequate size will be considered acceptable. Piping, machinery and electrical installations, if provided, should comply with Subchapters F and J. Because accommodation modules may be moved to different facilities, each module should be provided with a permanent nameplate indicating the exterior boundary rating of the module (A-0 or A-60). Eighth Coast Guard District Recommended Practice RP 98-01 should be consulted for structural details and plan review criteria.

Requirements for fire dampers in A-class divisions – Offshore facilities built to Subchapter I-A are required to have fire dampers in all ductwork that penetrates A-class divisions. Alternatively, the fire damper provisions of the IMO MODU Code may be applied to facilities that will not be certificated to SOLAS or the IMO MODU Code, if they have the additional fire protection measures required by regulations 9.1, 9.2 and 9.7 of the MODU Code (see section 3.7.1). The additional measures must be provided for the entire vessel, not just selected areas.

Regulation 9.2.12 requires that automatically operated fire dampers should be installed in all ducts that exceed 0.075 m^2 in cross sectional area and pass through any A-class boundaries. Ducts that are less than 0.075 m^2 but larger than 0.02 m^2 may pass through A-class boundaries without fire dampers if they are routed through 3 mm thick steel sleeves at least 450 mm in length on each side of the division. This requirement is considered applicable only to ducts of uniform dimension that pass through fire boundaries. A large duct may not be subdivided into multiple smaller ducts when passing through a fire boundary to avoid the requirement to install automatic fire dampers.

Aluminum helidecks – The regulations in 46 CFR 108.231 through 108.241 and 108.486 through 108.489 list the requirements for the use of helicopter decks on offshore facilities. These regulations are based on the use of steel helidecks and supporting structure. In response to industry requests for the use of lightweight materials, aluminum helidecks will be accepted if they are cantilevered off the side of a unit and are not located adjacent to any accommodation areas or living quarters. If the helicopter platform is located above a deckhouse, living quarters module or similar occupied structure:

1. the platform must be insulated to A-0 class if it is located 1 m or less above the top of the house;

2. there must be no openings in the deckhouse top and exterior bulkheads under the platform;

3. the deckhouse top and exterior bulkheads, including penetrations must be constructed as A-0 class divisions;

4. all windows located under the platform must be provided with steel shutters operable from inside the deckhouse; and

5. a drainage system constructed of steel must be provided to collect fuel spills and direct them to a safe location, independent of the deckhouse.

If the helicopter landing deck is exposed to a fire, a structural analysis must be performed to verify that the structural strength of the helideck has not been affected and that it is safe for continued use.

The following fire extinguishing equipment must also be provided for all aluminum helidecks:

1. An approved fixed foam fire extinguishing system consisting of monitors and/or hose stations must be installed for the protection of all aluminum platforms. The system must be designed in accordance with 46 CFR 108.487, except that the minimum foam solution discharge rate shall be calculated on the basis of the total surface area of the helicopter platform, but not less than:

Category	Helicopter overall length	Discharge rate foam solution (l/min.)
H1	up to but not including 15m	250
H2	from 15m up to but not including 24m	500
H3	from 24m up to but not including 35m	800

Sufficient foam concentrate must be provided to discharge the system at the required rate for at least five minutes. The height of the foam monitors, when not in use, must conform to the requirements for landing areas in 46 CFR 108.235, i.e., the monitors must not extend more than 150 mm (6 inches) above the deck if they are located on the landing area or within the safety net area.

2. At least one B-V dry chemical semi-portable extinguisher, one B-II minimum 20 lb carbon dioxide hand portable extinguisher, and one fire main hydrant with approved hose and nozzles must be located at each of the two required access points to the landing platform.

5.3 Floating Outer Continental Shelf (OCS) Facilities

Floating facilities are required to meet the requirements listed in 33 CFR 143.120. The structural fire protection requirements in 46 CFR 143.120(b) specify that the facility must comply with the MODU rules in Subchapter I-A. In some cases, additional regulations may apply, which are evaluated by the Marine Safety Center on a case-by-case basis.