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CERTIFICATION OF SHIPBUILDING PRODUCTS IN ACCOMMODATION AREAS

Onboard passenger ships

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The International Maritime Organization, IMO, is the world's largest and most important maritime organization. A number of different organizations and sub-committees are working underneath the IMO, all of which review and regulate maritime safety requirements. One of the most important aspects concerning maritime safety and seaworthiness is the right kind of construction and fire protection of materials.

These requirements are strictly regulated by the committees under the IMO but the role and responsibility of classification societies is also enormous, as they are the ones supervising the compliance of these regulations as of the construction phase. However, these rules and guidelines are not found in one single book, and additionally the requirements of flag states, Europe, and classification societies vary from each another.

As these are everyday matters for people working within shipbuilding, the purpose of this thesis was to study the rules of the European Union, classification societies, IMO and flag states regarding the rules and certification requirements for shipbuilding materials. The intention was to clarify the requirements in such manners that no interpretation mistakes would be possible to make. The work was done from the perspective of an interior designer, excluding technical products such as air conditioning machineries, electrical cables and piping's. The work is not intended to specify any unusual requirements. The work also includes an appendix of a valid material certificate. It is meant to clarify the information provided on a certificate.

Because of all the different laws, rules, regulations and guidelines provided by several different authorities, it was challenging to write the thesis in such a way that the subject would be somehow limited but kept sensible. The structure and content of the text was also difficult to write in an explicit manner. The fact that these rules are continuously amended makes the job more challenging, and forces one to be constantly vigilant with the new amendments.

The main objective was achieved by clarifying the testing procedures and required certificates for various products. Whenever there is a reason for wanting to find out exactly why a specific requirement is as stated, the information can be found in this thesis.

KEYWORDS:

IMO, SOLAS Fire Test Procedure, Shipbuilding

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LAIVANRAKENNUSTUOTTEIDEN SERTIFIOINTI YLEISILLÄ ALUEILLA

- Matkustajalaivoilla

Kansainvälinen merenkulkujärjestö (IMO) on maailmanlaajuisesti suurin ja merkittävin merenkulkua määrittelevä organisaatio. IMO:n alaisuudessa toimii useita eri järjestöjä ja alakomiteoita, jotka tarkastelevat ja säätelevät merenkulun turvallisuusvaatimuksia. Yksi meriturvallisuuden- ja kelpoisuuden kannalta oleellinen asia on oikeanlaiset rakennus- ja palosuojelumateriaalit.

IMO:n alaisuudessa toimivat komiteat säätelevät erittäin tarkasti näitä vaatimuksia mutta myös luokituslaitosten vastuu on suuri, sillä he valvovat laivan rakennusvaiheessa että näitä sääntöjä noudatetaan. Näitä sääntöjä ja ohjeita ei löydy yhdestä ainoasta teoksesta, ja tämän lisäksi lippuvaltiot, Euroopan Unioni sekä luokituslaitokset asettavat omat sääntönsä.

Koska nämä ovat jokapäiväisiä asioita laivanrakennuksen parissa työskenteleville henkilöille, on tarkoituksena tutkia Euroopan Unionin, luokituslaitosten, IMO:n sekä lippuvaltioiden sääntöjä koskien laivanrakennusmateriaalien sertifiointivaatimuksia. Työn tavoitteena on selventää vaatimuksia siten, että suunnittelijalle ei jäisi mitään tulkinnanvaraiseksi. Työ suoritetaan sisustussuunnittelijan näkökulmasta jolloin asiat kuten ilmastointikoneistot, sähkökaapelit tai putkistot eivät sisälly työhön. Tarkoituksena ei ole eritellä kaikkia erityisvaatimuksia. Työ sisältää liitteen voimassaolevasta sertifikaatista, jonka tarkoituksena on täsmentää sertifikaatista löytyviä tietoja.

Koska erinäisiä lakeja, sääntöjä, säädöksiä ja ohjeita löytyy todella paljon, oli haastavaa rajata opinnäytetyön aihealue järkevästi. Tekstin rakenne ja sisältö olivat myös hankalia tehdä järkevään ja yksiselitteiseen muotoon. Sääntöjen jatkuva muuttuminen haastaa laivanrakentajaa ja pakottaa pysymään valppaana uusien muutosten kanssa.

Tavoite saavutettiin selventämällä eri tuotteiden testausmenetelmät ja vaatimukset niin, että laivasuunnittelija osaa työn avulla määrittää vaatimukset materiaaleille. Tämän lisäksi työstä on mahdollista lukea syyt miksi juuri kyseinen tuote tai materiaali vaatii tämän tietyn hyväksynnän.

ASIASANAT:

IMO, SOLAS, Fire Test Procedure, Laivanrakennus

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LIST OF ABBREVIATIONS

Administration	Govern of which a vessel is registered under
IMO	International Maritime Organization
FSS CODE	International Code for Fire Safety Systems
FTP CODE	International Code for Application of Fire Test Procedures
MarED	Co-ordination group for the notified bodies
Member state	Country of the European Union
MSC	Maritime Safety Committee
SOLAS	International Convention for the Safety of Life at Sea
USCG	United States Coast Guard

1 INTRODUCTION

1.1 Goals and limitations of the thesis

The main purpose of this thesis work is to gather and simplify the existing requirements regarding certification of shipbuilding materials, excluding high-speed craft requirements. The work will concentrate on requirements for spaces within accommodation areas of passenger ships.

There is plenty of information about regulations concerning material certification and the procedures for manufacturers of applying a certificate and they are mostly very explicit. The issue is that they are spread out in various codes, regulations and other documents.
Since the information can already be found, this work will eventually be a composition of the minimum requirements, written in such manners, that the risk of interpretation errors would be minimized.

This work will briefly introduce the primary reasons for material certification by explaining about fire safety and the toxic hazards of smoke production in connection with a fire.

One chapter will be dedicated to introducing the one single most important convention and other relevant codes concerning fire safety and narrating a short history of them, as well as the most important contents. These conventions and codes are serving as the foundation for this work.

The intention is not to educate the reader about manufacturing processes or the exact procedures for acquiring a certificate. But this work will summarily go through the most important information and criterions about the procedures concerning material testing and the allowed exemptions in order to familiarize the reader with the basic knowledge of how a material has been tested in order to acquire a certificate.

A certain amount of knowledge within the shipbuilding industry is required to comprehend the text, since some basic technical terms and abbreviations used within shipbuilding will be constantly used. Considering the main purpose, the target is though to write in such simple manners, that a person new to shipbuilding will be able to understand clearly the minimum requirements for different spaces and products.

The work will mostly be based on International Code for Application of Fire Test Procedures 2010 and International Code of Fire Safety Systems due to the reason that fire testing is the most common testing method for products to be approved by.

This work will be done to Foreship Ltd. due to the reason that there has been some uncertainty concerning material certification in the past.

1.2 Company introduction - Foreship Ltd.

Foreship Ltd. is an employee owned naval engineering company, founded in 2002 by Marcus Höglund, Markus Aarnio and Petri Hakulinen, with the first project being a conversion of a luxury yacht (Foreship 2019a).

Since the launch in 2002, the company has made a significant growth from year to year in both revenue as well as the number of employees having almost 400 projects in 2018 with nearly 100 employees. The company operates today offices in Turku, Helsinki, Rauma, Mariehamn, Tallinn, Fort Lauderdale and Seattle and is one of the leading naval architect & marine engineering companies globally.

The company is involved in a numerous amount of newbuilding's, as well as conversion projects. The extensive list of references includes everything from domestic shipping companies such as Eckerö Shipping to all the major cruise companies such as Royal Caribbean Cruise Line. Even an interior design of a floating villa can be found as a reference. (Foreship 2019b).

1.3 Purpose of material certification

1.3.1 Fire safety

A fire onboard a ship is one of the most dangerous scenarios of them all. Simply put, a ship is essentially a huge steel box, which traps fire within, and will keep burning as long as there are flammable materials around. Additionally, a ship carries several tonnes of various fuels, oils and other flammable substances in order to make headway. Especially cargo ships have an increased amount of these, as they may be their cargo.

Additionally, there is a numerous amount of ignition risks, since there are a large amount of machineries and electrical appliances onboard. These are a very dangerous combination, which has lead to several great fire disasters at sea over time. They have also lead to a lot of excellent treaties and codes being born, as well as legislatur precautionary amendments.

Even though the International Maritime Organization (IMO) is continuously trying to improve all aspects concerning marine safety, the fact is that it actually requires a real-life incident for any major improvements to take place in the regulations.

The first statutory requirements regarding onboard fire safety were adopted as part of the 1914 International Convention for the Safety of Life at Sea (SOLAS). Prior to this, only national requirements were existing. (IMO 2019a).

The 1974 SOLAS convention was adopted with a significant amendment. Chapter II, which concerns construction requirements, was subdivided into "Chapter II-1" and "Chapter II-2". Chapter II-2 about Construction – Fire protection, fire detection and fire extinction was now introduced for the first time. (IMO 2019a).

With the introduction of chapter II-2, requirements for non-combustible materials, fixed sprinkler and fire detection systems became statutory for all new ships (IMO 2019a).

In 1990 a car and passenger ferry, M/S Scandinavian Star, operating between Norway and Denmark was caught on fire and is yet the most recent well-known fire disaster in maritime history with 158 casualties. Speculations of whether the fire truly was an accident or not are still ongoing, but the fact remains that it lead to a great amount of amendments to fire safety requirements and in 1992 they were adopted as a response to the tragic incident. The disaster also forced the sub-committee of fire protection to revise the chapter to be more explicit. The regulations had been very indefinitely determined in such ways as “to the satisfaction of the Administration”. (IMO 2019a).

In 1996, chapter II-2 was amended for the first time since the incident, and a completely new code was introduced as well; International Code for Application of Fire Test Procedures (FTP Code). The FTP Code was mandatory in order to ensure an international conformity regarding material testing and certification. (IMO 2019a).

Year 2002 was yet again a significant year concerning fire safety when the 2000 amendments came into force. International Fire Safety Systems Code (FSS Code), was published and made mandatory. (IMO 2019a).

1.3.2 Smoke and toxicity

Not only is an uncontrolled fire as such a life-threatening matter but the smoke it produces may be even more hazardous because of all the chemicals and particles that are breathable and are released during a fire.

Where a substance or materia containing carbon is caught on fire, it releases smoke as a product of an incomplete burning and releases carbon monoxide, carbon dioxide and particulate matter. Carbon monoxide and dioxide are per se non-toxic gases, but they do displace oxygen meaning that in great amounts they will make the air unbreathable. Particulate matters which are also released, are very small particulars which can only be seen using a microscope. They are so small that they can be inhaled directly into the lungs where they will cause serious health issues. (Department of Health 2016).

The substances and chemicals produced by a fire varies greatly depending on the burning substance. Smoke is always a hazard to health when trapped inside and therefore the FSS Code sets requirements for Emergency Escape Breathing Devices (EEBD). EEBD is an oxygen supply device that is only meant to be used as an escaping device. (FSS Code, 5).

The theoretical goal is to eliminate all possibilities of a fire accident to happen. The realistic scenario is however that fire accidents can never be completely excluded. That is why the regulations for fire safety are constantly amended to ensure the most secure outcome of a possible fire accident. Not only is it crucial that materials are non-combustible where required, but also that materials do not build a great amount of smoke and toxic when burned.

A great progress has already happened in the maritime industry regarding fire safety and suppression of fire as well as the technical advancement of products.

1.3.3 Fire load

Despite the fact that shipbuilding materials are strictly regulated, combustible materials are permitted to be used as well. Surface materials and decorations such as skirtings, mouldings etc. may be of combustible material given that they comply with the rules of SOLAS chapter II-2.

Fire load is a concept describing how much energy a material releases as it burns. Every substance has a calorific value of MJ/kg which are used in performing fire load calculations. Fire load calculations are compulsory determined by SOLAS for assuring that a space does not contain an excessive amount of combustible material. SOLAS chapter II-2, reg. 5.3.2.2 defines the maximum fire load value for a single material not to exceed 45 MJ/m^2. The total fire load of an entire space should not exceed a volume that is equivalent to 2.5mm veneer. (SOLAS 2004, 182). A fire load value calculated with 2.5mm veneer having a density of 720 kg/m^3 and a calorific value of 18 MJ/kg corresponds 33.3 MJ/m^2. All materials on walls and ceilings that are part of structural construction and are combustible must be taken into a fire load calculation. Exceptions are cablings, pipings, lightings and furnitures which are not fixed. (Willberg 2009, 12).

Not only must the calorific values be taken into consideration in a fire load calculation, but the combustible materials must also comply with SOLAS chapter II-2 regulations 5.3.2.4 and 6. These require the materials to be tested according to parts 2 and 5 of the FTP Code. Part 2 of the FTP Code requires the material to not release an excessive amount of smoke and toxic substances. Part 5 requires the exposed surfaces to be of low flame-spread quality. (SOLAS 2004, 181-183).

Fire load calculations are also determining factor in the designing phase of fire extinguishing systems. A space with a higher fire load value is in need of a more heavier fire extinguishing system than a space with only non-flammable materials. (Willberg 2009, 8-9).

2 REGULATING CODES, CONVENTIONS AND AUTHORITIES

2.1 SOLAS

SOLAS is a treaty under the IMO, which sets the minimum requirements regarding safety, not only for shipbuilding, but for maritime operations as well. The SOLAS treaty includes everything from the required amount of lifejackets onboard to insulation standards for bulkheads. (Räisänen 2010, 17-2).

SOLAS was originally founded in 1914 in response to the tragic sinking of the RMS Titanic, which resulted in the drowning of approximately 1520 people. The first convention was rapidly approved the same year, followed by a second convention in 1929, a third in 1948 and a fourth convention in 1960. There are still a great amount of ships sailing under the SOLAS 1960 regulations, since the keel-laying date is the determining factor of which regulations the ship must comply with. (Räisänen 2010, 17-2). In case any refurbishments are done to the ship, they must by carried out according to the regulations valid at the time being.
Up to this date, the 1974 convention of SOLAS is the current valid version which is to be referred to. However due to the numerous amendments made since, "SOLAS 1974 as amended" is the appropriate way of referring. Several consolidated editions have been published, with the newest one being SOLAS Consolidated Edition 2014. The most recently added chapter was made mandatory on January 1st 2017. (IMO 2019b).

The regulations are very roughly split into two categories; passenger ships and cargo ships. A ship that transports more than 12 passengers is classified as a passenger ship, all other ships are considered as cargo ships. Passenger ships are more strictly regulated than cargo ships, but the passenger ships are even further subdivided into ships carrying more or less than 36 passengers. (Räisäinen 2010, 17-2).

The SOLAS treaty contains 14 chapters, all regarding various crucial safety matters concerning everything from the construction phase to specific matters concerning nuclear ships (IMO 2019b). Amendments to the SOLAS convention are made by the Maritime Safety Committee (MSC) operating under IMO. MSC investigates previous accidents and researches all matters concerning maritime safety. The committee gathers in several sessions per year, where safety related matters are reviewed. Resolutions made by the committee are found on the IMO website in a numerical order. (IMO 2019c).

The title of a resolution contains the number of the resolution itself, followed by the session of which the resolution was adopted in. "RESOLUTION MSC.361(92) (Adopted on 21 June 2013)" describes resolution 361 being adopted on 21st of June 2013 in the committees 92nd overall session.

The most significant chapter of SOLAS for this thesis is Chapter II-2 - Fire protection, fire detection and fire extinction. This chapter contains the most important regulations concerning fire safety requirements of materials. This chapter has been amended and revised several times during the past century. SOLAS does not explicitly state any details about material certification, but simply sets the requirements where a product must be for example "Non-

combustible". Practically a shipbuilder takes into account the possible certification requirements in the designing phase and the material buyer makes material orders accordingly. This can though lead to a situation where a supplier may try to sell products with useless certificates for the main purpose leading to much more higher expenses, but with the help of the FTP Code, the buyer may verify the different kinds of certificates needed. The FTP and FSS Codes are both originated from chapter II-2 but since they both cover very broad areas, separate codes are more practical. (IMO 2019a). The following chapters will introduce these codes.

2.2 FTP CODE

The FTP Code is a resolution adopted by the MSC, containing the valid standards for material testing in order to comply with the correct material regulations. The FTP Code is therefore a crucial document for shipbuilders and the most important handbook for material manufacturers. It contains all specific guidelines for testing laboratories with every piece of information from the exact material testing procedures to the minimum accepted values in order to retrieve valid certificates. (2010 FTP Code, 1-7).

The FTP Code was originally adopted on 5th December 1996 by resolution MSC.61(67) and was made mandatory from 1st July 1998. It obligated all ships constructed on or after that date to comply with the regulations described in the 1998 FTP Code. (FTP Code, 1).

The current version, 2010 FTP Code, was adopted on 3rd December 2010 by resolution MSC.307(88) and made mandatory on 1st July 2012. It is still valid up to this date meaning that all ships constructed on or after that date are to comply with this version. Resolution MSC.307(88) of the 2010 FTP Code is the version used in this thesis. (IMO 2012).

2010 FTP Code contains an introduction part where definitions and standards are defined and the following annexes (2010 FTP Code, 2-4):

- Annex 1 Fire test procedures
- Annex 2 Products which may be installed without testing and/or approval
- Annex 3 Fire protection materials and required approval test methods
- Annex 4 Interpretation of SOLAS chapter II-2, regulations 5.3 and 6.2 (MSC/Circ.1120)

Annex 1 is subdivided into 10 parts concerning different testing procedures. Part 6 of the code is blank and parts 10 & 11 are amendments to the 2010 Code. (2010 FTP Code, 1.) These parts concerning high-speed crafts are excluded from this work.

Because the regulations are continuously revised, new amended versions of the codes may be published.

2.3 FSS CODE

International Code for Fire Safety Systems, FSS Code, was adopted by the MSC in 2000 and made mandatory in 2002 simultaneously to the revision of SOLAS chapter II-2. The main

intention was to separate the technical regulations from SOLAS to an independent code. The main requirements for fire fighting systems are still specified in chapter II-2 of SOLAS but the engineering specifications are found in the FSS Code. (IMO 2019a.)

The FSS Code, does not contain any information about material certification, but it contains all information of standards and guidelines regarding fire fighting equipment. It is one of the most single codes for a ship designer concerning fire safety onboard.

FSS Code includes 16 chapters, of which each and every one contains specific instructions regarding engineering specification for fire fighting equipment. The different chapters contains information and specifications from protective personal equipment for shipboard fire fighters to engineering specifications about fixed fire extinguishing and alarm system. (FSS Code 2015, iii-iv.)

Not only are equipment for fire fighting essential in a fire emergency, but the FSS Code has also specific guidelines about the arrangement of means of escape, low-location lighting and fire detection systems (FSS Code 2015, iii-iv).

In addition to the chapters concerning different fire fighting equipment, all resolutions and circulars regarding the chapters are included in the FSS Code.

Since the theoretical assumption is that fire accidents can never be completely eliminated, the need for proper fire extinguishing systems are becoming more and more crucial. Ships are getting bigger and the crew is getting smaller. Since the crew is limited and they are acting as fire fighters onboard the FSS Code is provided to ensure a safe working environment.

2.4 Classification societies

Classification societies are non-governmental, independent organizations recognized by SOLAS. They supervise and inspect that all ships comply with the relevant rules. There are approximately 50 organizations globally acting in the marine classification sector. The International Association of Classification Society (IACS) is a group of 10 societies which classifies nearly 94 percent of all ships globally. (IACS 2004, 2).

The largest and most well-known class societies are:

- Det Norske Veritas-Germanischer Lloyd (DNV-GL)
- Bureau Veritas (BV)
- Lloyds Register (LR)
- Registro Italiano Navale (RINA)
- American Bureau of Shipping (ABS)

In case where a shipowner is building a new ship, a suitable classification society must be chosen with their respective rules. The rules and standards of may vary greatly between societies. All minimum international requirements must be met, but a more strict set of rules may also be applied. The class society will supervise that all regulations, beginning from the building phase, are being followed and make notifications when necessary. In order to acquire

a valid class, the ship must eventually comply with all international and class regulations. A ship must always be classed to be permitted for shipping operations. (IACS 2004, 6).

3 PRODUCTS REQUIRING CERTIFICATION

3.1 Insulation material

Insulation materials must comply with SOLAS chapter II-2 regulation 5 and be of non-combustible material. Exemptions are allowed in cargo spaces, mail rooms, baggage rooms and refrigerated compartments of service spaces. (SOLAS 2004, 180).

Vapor barriers, cold service system pipe fitting insulation and adhesives which are used in attachment of insulation are not required to be of non-combustible material. They must however be kept to a minimum and all exposed surfaces must have a low flame-spread quality according to Part 5. (SOLAS 2004, 180-181).

3.2 Ceiling and linings

All linings, draught stops, ceilings and grounds shall be constructed of non-combustible material. Partial bulkheads and decks must also comply with this rule. Cargo spaces, mail rooms, baggage rooms, saunas and refrigerated compartments of service spaces are excluded. (SOLAS 2004, 181).

3.3 Exposed surfaces

Exposed surfaces of linings and ceilings in accommodation areas, corridors, stairways, service spaces and control stations must be approved of possessing low flame-spread quality in accordance with Part 5 of the FTP Code. Surfaces and grounds in spaces which are not easily accessible must also have the same quality. (SOLAS 2004, 182).

Where exposed surfaces are either painted, varnished or finished with another substance, must they be approved according to Part 2 of the FTP Code (SOLAS 2004, 183).

3.4 Primary deck coverings

All primary decks coverings within accommodation spaces, service spaces and control stations must be approved according to Part 2 of the FTP Code (SOLAS 2004, 183).

3.5 Low-location lighting

Means of escape shall be marked according to SOLAS chapter II-2 regulation 13.3.2.5.1 by either a low-location lighting or photoluminescent strip at a height not more than 300mm above the deck. (SOLAS 2004, 249).

Testing of low-location lighting must be carried out using white theatrical smoke with different Optical Densities, OD;

- Corridors a minimum of 0.5 m^{-1}
- Public spaces a minimum of 0.1 m^{-1}
- Stairways are without any smoke

A minimum of 60 persons should be used for testing of ages between 16 to 75. At least 80% of the test group should be able to reach the designated exit location, and in case the movement speed is below 0.7 m/s, the test will be considered as failed. (FSS Code 2015, 235).

3.6 Fire extinguishers

Chapter 4 of the FSS Code contains valid requirements of the standards regarding portable fire extinguishers and Resolution A.951(23) contains more technical specifications.

Fire extinguishers must be manufactured either according to a national standard or to the satisfactory of ISO 7165:1999. They must be constructed in manners which allow a simple and quick use of the extinguisher. All parts affected by the internal pressure must be, according to the international standard, tested up to a pressure of 5.5 MPa or 2.7 times the working pressure. (FSS Code, 98).

Every portable fire extinguisher must have the following information labeled (FSS Code, 99):

- name of manufacturer
- types of fire and rating for which the extinguisher is suitable
- type and quantity of substance (foam/water etc.)
- approval details
- instructions for usage and recharging
- making year
- operating temperature range
- test pressure

3.7 Fixed fire extinguishing systems

Gas fire-extinguishing systems must have discharge pipes, fittings and nozzles within the protected space to be constructed of materials with a melting temperature over 925°C (FSS Code 2015, 8).

Fixed foam fire-extinguishing system components within the protected space must be able to withstand ambient temperature changes, vibration, shock, humidity, clogging and corrosion. They must also be able to withstand a temperature of 925°C and the nozzles shall be removable for maintenance. (FSS Code 2015).

Automatic sprinkler system shall be of corrosion resistant material. Systems located in saunas shall have sprinkler heads with an operational temperature of up to 140°C. In accommodation

areas the sprinklers shall automatically start to operate within a temperature range of 68°C to 79°C. (FSS Code 2015, 12).

3.8 Fixed fire detection and alarm systems

Fire detectors must be operated by either heat, smoke or any other product of combustion. All smoke detectors located within stairways, corridors and escape routes shall be certified to operate when the smoke density ranges between 2 and 12.5% obscuration per meter. The testing shall comply with standards EN 54:2001 and IEC 60092-504. (FSS Code 2015, 23).

Heat detectors must be certified to operate at a temperature range between 54°C and 78°C in cases where the temperature rise is less than 1°C per minute. In cases where the temperature rise is more than 1°C, the detectors shall operate to a satisfaction of the administration. (FSS Code, 23).

In drying rooms or similar spaces the operational temperature of heat detectors is allowed to be up to 130°C and 140°C in saunas. Heat detectors shall be tested according to standards EN 54:2001 and IEC 60092-504. (FSS Code 2015, 23).

Control panels for fire detection systems must be tested according to standards EN 54-2:1997, EN 54-4:1997 and IEC 60092-504:2001 (FSS Code 2015, 24).

3.9 Miscellaneous products

The installation of electrical appliances and the operational requirements are regulated in SOLAS chapter II-2 part D and by classification societies. These regulations are excluded from this thesis.
Electrical lights installed on linings, ceilings or bulkheads does not require any specific certificate for maritime purpose. The consideration of national requirements must however be taken into account. As an example within the EU, all electrical appliances must be CE-marked. Additionally in any case where a light is installed on a product being part of a fire-rated division, the light must be either certified similar as the ceiling, lining or bulkhead. This way it is being considered as a part of the division. Alternatively a box must be built around the light with the corresponding fire rating.

Waste containers must always be of non-combustible materials according to the FTP Code (SOLAS 2004, 169).

Wooden linings, ceilings and benches are permitted only in saunas. The ceiling above the oven must however be lined with non-combustible material according to the FTP Code. (SOLAS 2004, 199).

Traditional wooden floorings are allowed to be used in small quantities for example on stages or dancing floors. The wooden flooring must be treated with a certified varnish and laid on a primary deck covering certified according to the FTP Code. (LR Interpretation 2004).

4 MATERIAL CERTIFICATION

In any case where a material has passed the relevant tests, it must acquire a valid certificate approved by a recognized organization (RO) acknowledged by the administration, before it is permitted to be installed onboard. Every RO of each government can be found the public IMO website (IMO 2019d). Within the European Union (EU) these organizations are called notified bodies.

A notified body is an organization, company, society or an entity of some kind, that has been authorized by a member state. Notified bodies assess if products may be allowed on the market within the EU. (European Commission 2019).

A classification society may also be accredited by a member state to act as a notified body and the largest class societies are also recognized by most governments. IMO provides a comprehensive online database of all recognized organizations by each government. (List of notified bodies under directive: 2014/90/EU Marine Equipment). The manufacturer is allowed to choose which RO or notified body they want their product to be approved by.

The manufacturer of a product or material is allowed to choose the RO or notified body found best suitable to perform the assessment.

Where a product holds a valid certificate, the approving RO or notified body must be clearly stated. Within the EU each notified body has a four-digit identification code which is used. For example the only notified body operating in Finland is Eurofins Expert Services that has the identification code 0809. Their administration approved testing laboratory is VTT. (MarED 2019a).

Theoretically not a single material is allowed to be installed onboard without a valid certificate. In practice exceptions are made in instances where validity period has expired and a new certificate has been applied for.

The certificate of approval is a document that describes among other things the main characteristics of the product, clarifies the approved application and use, as well as shows the method(s) used for testing. An example of a product certificate is presented in Appendix 1. The testing laboratory must also issue a separate test report.

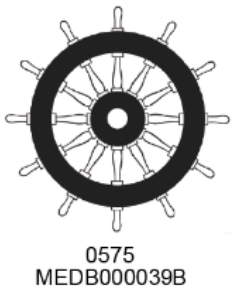
4.1 The Wheelmark

A product complying with the EU directives and approved by a notified body, shall retrieve The Wheelmark. The Wheelmark represents that the product is approved for the EU market and is therefore permitted to be installed onboard ships sailing under a member state. All products on the EU market and products installed onboard European flagged ships must have a valid wheelmarked certificate. (Directive 2014/90/EU, L257/154).

The standard appearance of The Wheelmark is described in Annex 1 of the EU Marine Equipment Directive (MED) and it shall be visibly attached to the product. In case the attachment of the mark on the product is not possible (e.g. insulation materials), the packaging

shall be marked as well as the documents concerning the product. (Directive 2014/90/EU, L257/155).

Picture 1 is the standard form of The Wheelmark. The notified body identification number, 0575 (DNV-GL AS) must also be stated as well as the MED-certificate number. The number of the notified body shall be attached by body itself or alternatively by the manufacturer according to instructions proved the body. (Directive 2014/90/EU, L257/155).



Picture 1. The Wheelmark on product certificate (Safety Hi-Tech 2019).

4.2 MarED

The collaboration group consisting of all the notified bodies approved by the administrations within the EU is called MarED. MarED supervises and carries out conformity assessments of marine equipment in accordance with the MARINE EQUIPMENT DIRECTIVE 2014/90/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 July 2014. (MarED 2019a).

Directive 2014/90/EU was made valid on 18 September 2016 and repealed thereby the previous Council Directive 96/98/EC. The current directive contains all relevant information and guidelines of how a conformity assessment shall be carried out, what the criteria's are and how the manufacturers shall act in order for an approval of their products. (Directive 2014/90/EU, L257/146).

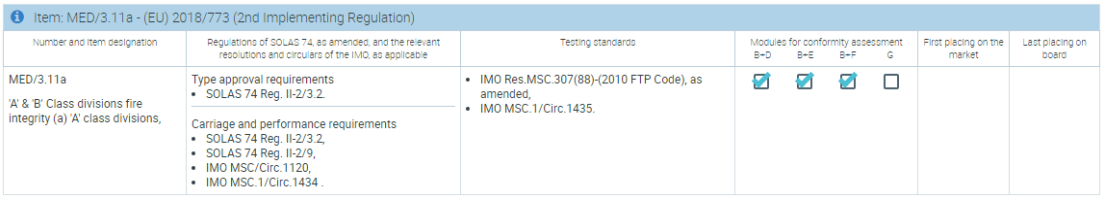
All ships operating under the flag of a member state, shall be subject to the regulations in this directive. In any case where a non-EU ship is flagged into a member state, the member state shall ensure that the ships equipment complies with the regulations by performing inspections onboard where necessary. (Directive 2014/90/EU, L257/152-153).

For a valid Marine Equipment Directive-certificate (MED-certificate) a product must be assessed according to a certain combination of different modules described in the directive. A MED-certificate indicates that the product complies with the standards of the Marine Equipment Directive. (DNV-GL 2019). The different modules for MED-certificates are B, D, E, F and G. Module B is the European Commission (EC) type-examination which is always required. Modules D, E and F are regarding the manufacturing process and Module G is conformity assessment based on unit verification. (Directive 2019/90/EU, L257/171-180).

In all matters where type examination of the product must be performed (Module B), either D, E or F module must be performed as well. These are normally products produced in large quantities. Where small amounts or one individual product is produced at a time, a more comprehensive examination of the entire product is to be carried out according to Module G. (Directive 2019/90/EU, L257/158).

All products concerned by the Marine Equipment Directive are found in the MED item list. Different product categories are identified by a specific MED number. For example fire protection products are categorized under MED/3.XX. Picture 2 shows an example of item MED/3.11a which is for A class divisions. The regulations and testing procedures are shown in

the following columns. The MED item list also contains valid information of the applicable modules required for different products. A product must get an approval of both modules for



Item: MED/3.11a - (EU) 2018/773 (2nd Implementing Regulation)

Number and item designation	Regulations of SOLAS 74, as amended, and the relevant resolutions and circulars of the IMO, as applicable	Testing standards	Modules for conformity assessment B+D	B+E	B+F	G	First placing on the market	Last placing on board
MED/3.11a 'A' & 'B' Class divisions fire integrity (a) 'A' class divisions,	Type approval requirements • SOLAS 74 Reg. II-2/3.2. Carriage and performance requirements • SOLAS 74 Reg. II-2/3.2, • SOLAS 74 Reg. II-2/9, • IMO MSC/Circ.1120, • IMO MSC.1/Circ.1434 .	• IMO Res.MSC.307(88)-(2010 FTP Code), as amended, • IMO MSC.1/Circ.1435.	☑	☑	☑	☐		

Picture 2. Regulation and testing standards according to MED item list (MarED 2019b).

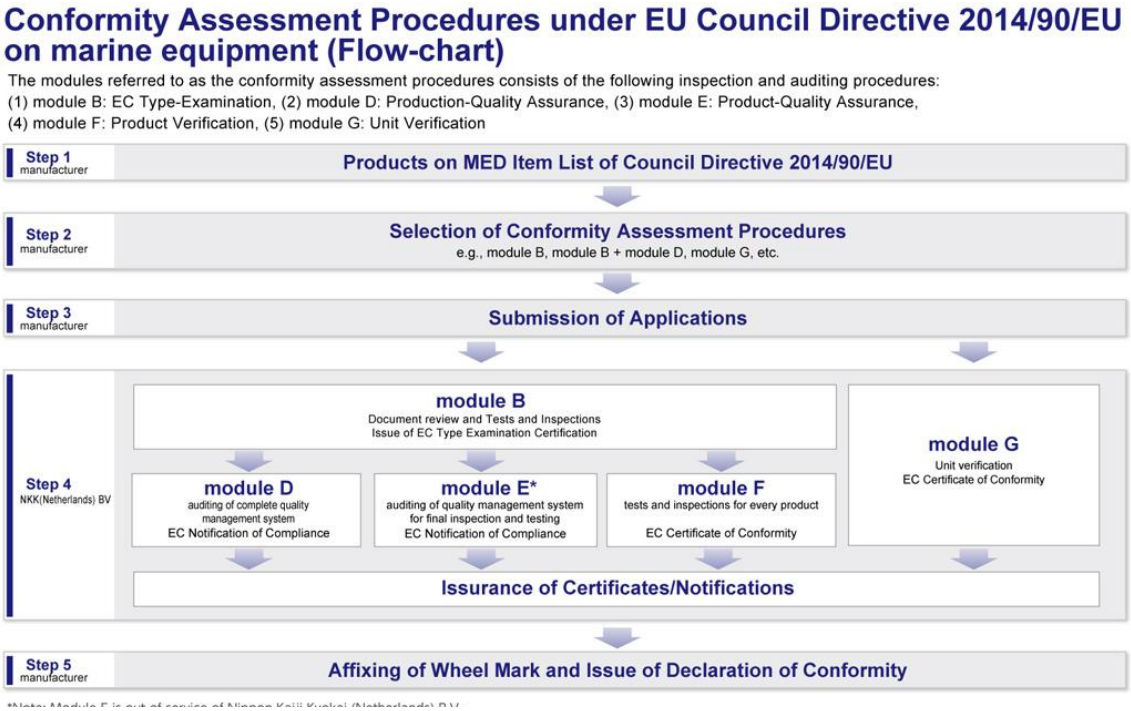
obtaining a valid MED-certificate. (MarED 2019b).

The main purpose of MarED and MED-certification is to ease the certification process within the EU. A classification society must accept a valid MED-certificate regardless of the issuing authority, but outside the EU, classification societies only approve certificates issued by themselves. Therefore it is common for manufacturers to seek approval of several different class societies.

A number of governments outside the EU does however recognize MED-certificates valid, providing that the organization issuing the certificate is recognized by the government. For example Bahamas is one state that approves MED-certificates issued by a recognized organization (The Bahamas Maritime Authority 2015).

The MarED public website contains unrestricted information to anyone, and has a comprehensive database including all notified body, rules and regulations as well as all approved products and their MED-certificate(s).

Picture 3 illustrates the procedures for applying a MED-certificate.



Picture 3. Steps for manufacturers applying a MED-certificate (ClassNK 2019).

4.3 Mutual recognition agreement (MRA)

In 2004 the United States of America (USA) and the European Commission (EC) signed the Mutual Recognition Agreement (MRA) as the outcome of a 5 year long negotiation. The purpose of this agreement is to ease the manufacturers workload of acquiring approval for its products on different market areas. This agreement is referred to as US - EC MRA. (United States Coast Guard 2019).

Followed by the US - EC MRA, negotiations between the US and countries of European Free Trade Association (EFTA) began. The MRA between the US and EFTA countries, US - EFTA MRA, was made valid in 2006. (United States Coast Guard 2019).

The agreements does not directly give the right of a manufacturer to place a product approved by the United States Coast Guard (USCG) on the European or EFTA market or vice versa. Approved products have the same approval criteria's for both markets. Several of the requirements are according to testing standards specified by the FTP Code. The agreements comprehends 43 products in the following three different categories (United States Coast Guard 2019):

- Life-saving equipment
- Fire protection equipment
- Navigational equipment

The different products approved under the MRA are listed in Annex 2 of the US - EC MRA and US - EFTA MRA. An example of products covered by the US – EC MRA is presented in picture 4. The first column describes the product type. The second column contains valid international regulations and guidelines. The third column presents valid MED approving standards and the final column the corresponding US standards. (US - EC MRA, Annex 2).

Fire protection

Product item identification	Applicable international instruments for construction, performance and testing requirements	EU technical regulations, item number in accordance with Directive 2014/90/EU	US technical regulations and approval guidance
Primary decks covering	- IMO Res. MSC.36(63)- (1994 HSC Code) 7 - IMO Res. MSC.97(73)- (2000 HSC Code) 7 - IMO Res. MSC.307(88) (2010 FTP Code), as amended	MED/3.1	- 46 CFR 164.106
'A' & 'B' Class divisions fire integrity (a) 'A' class divisions,	- IMO Res. MSC.307(88) (2010 FTP Code), as amended - IMO MSC/Circ.1120 - IMO MSC.1/Circ.1434 - IMO MSC.1/Circ.1435	MED/3.11 (a)	- 46 CFR 164.105 - 46 CFR 164.107
'A' & 'B' Class divisions fire integrity (b) 'B' class divisions. Note: Restricted 'B' Class divisions are not covered by this agreement.	- IMO Res. MSC.307(88) (2010 FTP Code), as amended	MED/3.11 (b)	- 46 CFR 164.108 - 46 CFR 164.110
Non- combustible materials	- IMO Res. MSC.36(63)- (1994 HSC Code) 7 - IMO Res. MSC.97(73)- (2000 HSC Code) 7 - IMO Res. MSC.307(88) (2010 FTP Code), as amended	MED/3.13	- 46 CFR 164.109
Fire doors Limited to fire doors without windows or with total window area no more than 645 cm2 in each door leaf. Approval limited to maximum door size tested. Doors must be used with a fire tested frame design. Note: Restricted 'B' Class doors are not covered by this agreement.	- IMO Res. MSC.307(88) (2010 FTP Code), as amended - IMO MSC.1/Circ.1319 - IMO MSC.1/Circ.1511	MED/3.16	- 46 CFR 164.136

Picture 4. Annex 2 explaining products and requirements (US/EC/Annex II/en 6).

5 PROCEDURES FOR FIRE TESTING

Annex 1 in the 2010 FTP Code describes the fire test procedures which are to be carried out during material testing and is therefore the most important chapter for material manufacturers as well as testing laboratories. In accordance with article 8 of the 2010 FTP Code, the administration may grant a certificate tested according to the 1998 version of the FTP Code. The tests must have been carried out within one year of the 2010 version being valid. The administration may also renew the certificate without retesting providing that the test report is not older than 15 years and no modifications are made to the product. (2010 FTP Code, 10).

The instructions for testing methods described in Annex 1 of the FTP Code, are to be carried out by a third-party laboratory. The laboratory shall be approved by the administration. For a testing laboratory to be officially authorized for testing, the administration must ensure that it (2010 FTP Code, 6):

- performs the required types of tests as a business segment
- possesses the correct instruments, personnel and facilities for the required tests
- has no relation whatsoever with the product being tested.

All approved laboratories approved by administrations are informed in the annual circular published by IMO.

In case where a product is granted a certificate of one or more category described in this chapter, must it be referenced to the appropriate part. For example a carpet approved by Part 2 – Smoke and toxicity test and Part 5 – Test for surface flammability, must be referred as "IMO 2010 FTP Code parts 2 and 5" (2010 FTP Code, 12).

Even though the rules are strict concerning material certification some parts allow exemptions to be made. As a thumb rule, materials which are undoubtedly non-combustible, produces no hazardous smoke and has a low flame-spread quality, may be used without any further testing. Annex 2 of the 2010 FTP Code describes the exemptions and in the product is assumed to comply with Annex 2, must it be referred to. For example "IMO 2010 FTP Code parts 2 and Annex 2" refers the product to comply with Part 2 – Smoke and toxicity test and exempted from testing according to Annex 2. (2010 FTP Code, 197-198).

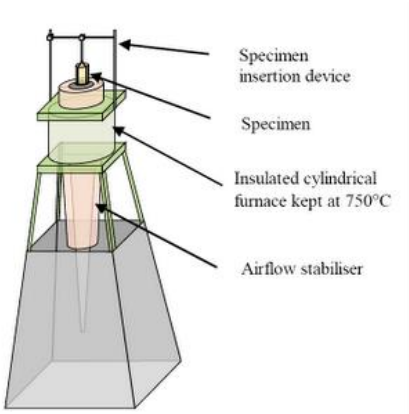
The following subchapters will explain the basics of different testing procedures.

5.1 Non-combustibility test

Where a material is required by SOLAS to be classified as "Non-combustible", it shall be approved and tested according to the guidelines in this chapter and possess the relevant certificate. The main reason for usage of non-combustible materials is to restrict the total amount of flammable materials.

The testing procedure shall be carried out in accordance with the ISO 1182 - Non-combustibility standard, which comprehends the exact procedures for testing such as the minimum size of the specimen. (2010 FTP Code, 13).

In compliance with the ISO 1182 standard, the test must be carried out by placing the specimen inside a cylindrical furnace which is heated up to a temperature of 750 °C. The specimen does not need to be exposed more than 30 minutes. During the exposure time, the temperatures of both the furnace and specimen shall be documented. After the testing, the total mass loss of the specimen shall be calculated. (Research Institutes of Sweden 2019a). Picture 5 illustrates the standard testing equipment in accordance with ISO 1182.



Picture 5. Illustrative picture of the testing furnace (Flameretardants 2019).

In case the product being tested consists of one single material (homogenous), five specimens shall be tested and in case the product is non-homogenous, ten specimens shall be tested (2010 FTP Code, 16). In order for the product to be approved and receive a valid certificate, the following criteria's must be fulfilled (2010 FTP Code, 13):

- the average furnace temperature does not exceed 30 °C
- the average specimen temperature does not exceed 30 °C
- the average duration of sustained flaming does not exceed 10s
- the average mass loss of the specimen does not exceed 50 %.

If a material passes all the criteria given above, it is considered to be a non-combustible material.

A product which is certified according to Part 1, being classified as non-combustible, is also presumed to comply with the requirements described in Part 2, and is therefore not required to be separately tested (2010 FTP Code, 197).

In case a material can without a doubt be classified as non-combustible, no testing or certificate is required. Products which may commonly be considered as non-combustible are steel and metal products, glass, concrete, ceramic materials and stone products. (2010 FTP Code, 197).

The product must consist entirely of non-combustible materials as the examples above, in order for them to be used without certificates (2010 FTP Code, 197).

5.2 Smoke and toxicity test

When a material is required to withstand high temperatures, without producing a great amount of smoke or toxic fumes, it must be certified accordingly. The material must comply with the testing standards described in Part 2 of Annex 1 from the 2010 FTP Code. Since a limited amount of combustible products are allowed, must they be of such materials that they

do not release a large amount of smoke. The smoke may also not contain a large amount of toxic substances.

SOLAS Chapter II-2 Part B Regulation 6 contains information about products and materials to fall under this category (SOLAS 2004, 183).

The basis for testing methods will be carried out according to the ISO 5659-2 - Smoke production standard. Minor modifications are however allowed to be made when necessary, in order to ensure accurate measurements of toxic gases. (2010 FTP Code, 21).

Picture 6. Apparatus for smoke and toxicity testing (Research Institutes of Sweden 2019c).

Testing must be carried out on three specimens. The specimens are tested individually by placing them inside the chamber shown in picture 6. They will be tested at the following conditions (2010 FTP Code, 30):

- irradiance of 25 kW/m^2 in the presence of pilot flame
- irradiance of 25 kW/m^2 in the absence of pilot flame
- irradiance of 50 kW/m^2 in the absence of pilot flame

In case where the maximum specific optical density of smoke (Ds max) differs more than 50% of the average value of the three specimens, additional three specimens must be tested and the value of six specimens shall be calculated. (2010 FTP Code, 30).

The values for calculating Ds max is described in Part 2 paragraph 9 of appendix 1 and the value must be logged for each test. A graph shall be produced for each specimen to determine the transmission of light against time. The minimum transmission of light (Tmin) is converted with Equation 1 to Ds max where (2010 FTP Code, 30):

- 132 = factor derived from V/AL
- V = volume of the testing chamber
- A = exposed area of the specimen
- L = length of the light path

$$Ds\,\max = 132\ log_{10}\left(\frac{100}{Tmin}\right)$$

Equation 1. Equation for calculating Ds max (2010 FTP Code, 30).

The samples of toxic measurements must be taken from the geometrical center of the chamber at the time of maximum optical smoke density (2010 FTP Code, 21).

An average value, Dm, of the maximum specific optical density of smoke must be calculated, and in order to be approved, the maximum accepted values are (2010 FTP Code, 21):

- 200 for surface materials of bulkheads, linings or ceilings
- 400 for primary deck coverings
- 500 for floor coverings
- 400 plastic pipes

For toxicity testing, values given below must not be exceeded (2010 FTP Code, 22).

- Carbon monoxide (CO) 1.450 ppm
- Hydrocarbon (HC) 600 ppm
- Hydrogen fluoride 600 ppm
- Nitrogen oxide (NO_x) 350 ppm
- Hydrogen bromide (HBr) 600 ppm
- Hydrogen cyanide (HCN) 140 ppm
- Sulfur dioxide (SO_2) 120 ppm (200 ppm for floor coverings)

Non-combustible materials are generally approved by the requirements of Part 2 and are therefore excluded from testing (2010 FTP Code, 197).

Surface materials and primary deck coverings which do not exceed the maximum values of:

- total heat release, Q_t, 0.2 MJ
- peak heat release rate, Q_p, 1 kW

are generally approved without any further testing (2010 FTP Code, 197).

5.3 Test for A, B and F class divisions

Where products (e.g. decks, bulkheads, ceilings, linings) are required to be of “A” or “B” class, they shall be approved according to requirements described in this part. “F” class division is excluded in this work, since it is not widely used in the maritime industry.

A-class divisions are formed by decks and bulkheads which are (IADClexicon 2019a):

- constructed of steel or other equivalent material
- suitably stiffened
- constructed in manners to prevent smoke and flame passage up to the end of the one-hour fire standard test shown in Equation 2, where:
  T = temperature (°C)
  t = time (min)

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

Equation 2. Standard time-temperature curve equation (2010 FTP Code, 6).

A-class boundaries are further sub-categorized into four classes; A-60, A-30, A-15 and A-0. The numerical value given in each class describes the amount of time in minutes, the average recorded temperature of the unexposed side must not exceed 140°C. The temperature rise must not either exceed 180°C at any individual thermocouple within the time period. (2010 FTP Code, 36).

B-class divisions are bulkheads, decks, ceilings or linings which are constructed in manners to prevent the passage of flame and smoke up to the end of the first half-hour of a fire standard test (IADClexicon 2019b). B-class boundaries are also subdivided into two categories; B-15 and B-0. Similar to A-class divisions, the numerical value describes a certain amount of time. The average recorded temperature of the unexposed side must not exceed 140°C and the temperature rise of a single thermocouple must not exceed 225°C during the time. (2010 FTP Code, 36).

Several thermocouples are placed on the tested object, and figures 7, 8, 9 in Appendix 1 of Part 3 shows the correct placement of thermocouples during different testing methods (2010 FTP Code, 65-67).

Whenever non-combustible materials are used in A- or B-class divisions, they shall comply with Part 1 and where combustible veneers are allowed to be used, they shall comply with Part 5 of the code (FTP Code, 38).

Class A-0 steel bulkhead may be installed without further testing, in case the following minimum values are fulfilled (2010 FTP Code, 197-198):

- 4mm plating thickness
- 60x60x5mm stiffeners, spaced 600mm

Class A-0 steel deck may be installed without further testing, in case the following minimum values are fulfilled (2010 FTP Code, 197-198):

- 4mm plating thickness
- 95x65x7mm stiffeners, spaced 600mm

5.4 Test for fire door control systems

Whenever a control system of a fire door is required to be operable in case of a fire, the requirements shall comply with the regulations in this part.

Before a laboratory performs the tests, they shall be supplied with the relevant drawings of the testing arrangement, including a complete part list. In case the system consists of insulation material, Part 1 of the FTP Code must be considered as well and Part 5 is relevant to any possible adhesives. (2010 FTP Code, 93-94).

At the beginning of the test, the average internal temperature must be 20 ± 10°C and within a margin of 5°C of the surrounding temperature. The door must also be at an opened position, whereas it shall present the capability of closing the door. The control system must also stay powered throughout the whole testing period. (2010 FTP Code, 97).

The average temperature within the furnace shall be increased and stabilized to 200 ± 50°C within 5 minutes of the start. This temperature must be maintained throughout the first 60 minutes of the testing period during which the opening and closing mechanisms are to be tested every 5 minutes. After the first hour, the average temperature shall be increased in accordance with the standard time-temperature curve (picture 5), to a value of 925°C. The door control system must be isolated from the power supply up to a temperature of 300°C and must be able to keep the door shut up to a temperature of at least 945°C. (2010 FTP Code, 97-98).

In order for an approved test, the (2010 FTP Code, 98):

- control system shall not fail during the first 60 minutes
- door shall stay closed from the first 60 minutes to the end of the testing period

5.5 Test for surface flammability

Where a surface is required by SOLAS to be of "low flame-spread" material and primary deck covering not to be easily ignitable they shall comply with regulations described in this part. Low flame-spread means that the material is of such quality that it sufficiently enough prevents the flame from spreading as per determined in the FTP Code. (Babicz 2015, 360).

The testing shall be performed according to the ISO 5658-2 - Flame spread standard where the testing specimen shall be of size 795x155mm (Research Institutes of Sweden 2019b).

For products where the normal thickness is under 50mm, the entire thickness of the product must be used. In cases where it is more than 50mm, material is to be cut away from the unexposed side to achieve a total thickness of 47-50mm. (2010 FTP Code, 128).

Testing must be carried out on three specimens. Floor coverings are attached by an adhesive to the substrate and primary deck coverings are applied to a 3mm steel plate and be of the same quality as the actual application. (2010 FTP Code, 107). If a floor covering consists of multiple layers, all individual layers shall comply with this part. The administration may require a test for each layer or a test for a combination of different layers. (2010 FTP Code, 128).

Each specimen shall be prepared according to paragraphs 8.1.1 and 8.1.7 in Appendix 1, Part 5 of the FTP Code and testing of each specimen may be terminated in case (2010 FTP Code, 109):

- the specimen does not ignite during a time period of 10 minutes of exposure
- the flaming has ended over 3 minutes ago or a time period of 10 minutes exposure

In case a test fails for some reason, the data from the specific test must be rejected and a new test must be performed (2010 FTP Code, 109).

To achieve a valid certificate and to be classified according to Part 5, the product must with its average testing values comply with the table shown in Picture 7.

	Bulkhead, wall and ceiling linings	Floor coverings	Primary deck coverings
CFE (kW/m^2)	≥ 20.0	≥ 7.0	≥ 7.0
Qsb (MJ/m^2)	≥ 1.5	≥ 0.25	≥ 0.25
Qt (MJ)	≤ 0.7	≤ 2.0	≤ 2.0
Qp (kW)	≤ 4.0	≤ 10.0	≤ 10.0
Burning droplets	Not produced	No more than 10 burning drops	Not produced

Where:

CFE	=	Critical flux at extinguishment
Qsb	=	Heat for sustained burning
Qt	=	Total heat release
Qp	=	Peak heat release rate

Picture 7. Acceptance values for tests (2010 FTP Code, 101).

Non-combustible products are generally approved for Part 5, however the possible attachment method must be taken into consideration for e.g. glues (2010 FTP Code, 198).

Primary deck coverings approved as not easily ignitable as required in Part 5 are generally approved to comply with the rules for floor coverings (2010 FTP Code, 198).

5.6 Test for vertically supported textiles and films

The regulations in this part are applied to all draperies, curtains and similar supported textile materials which are required to be of non-flame propagating quality.

The specimens must represent as much as possible the final product and a total of 10 specimens shall be cut. The size must be 220x170mm for each piece. In case the material varies on opposite sides, both shall be tested with 10 specimens. (2010 FTP Code, 143).

A propane gas burner will be used for testing and the correct method and order of testing procedures are described in Part 7 Appendix 1 Chapter 6. (2010 FTP Code, 143-144).

The test will achieve a failed outcome if the product shows any of the qualities below (2010 FTP Code, 135):

- after-flaming of more than 5 seconds for any of the specimens
- burn through to any of the edges of any specimen
- the cotton wool ignites below any of the specimen
- an average char length more than 150mm
- a surface flash propagating over 100mm from the original ignition point

5.7 Test for upholstered furniture

The requirements of this part must comply to all upholstered furniture required to be ignition and propagation flame resistant. Testing will be performed according to a smouldering cigarette test and flame ignition source test and must be carried out on specimens of the final product. (2010 FTP Code, 152).

Two smouldering cigarette tests are to be performed. A cigarette shall be lighted and placed on the specimen. If there is no sign of progressive smouldering or flaming during a time period of 60 minutes, another test will be carried out by placing the cigarette not closer than 50mm of the previous position. In case no smouldering or flaming is still noticed, the test is approved. In case progressive smouldering or flaming is recorded during either test, the product has failed. (2010 FTP Code, 158).

Two propane flame tests will also be carried out on the product. The burner tube must initially be stabilized for 2 minutes when lighted, and then placed on the product. The burner tube will be held 20 ±1 seconds on the product after which it will be removed. If any progressive smouldering or flaming is not recorded, another test will be performed on a different spot and in case smouldering or flaming still does not occur, the test has been approved. In other cases the product will have failed the testing standards. (2010 FTP Code, 158-159).

5.8 Test for bedding components

Whenever any bedding components are required to be certified, they shall comply with the regulations in this part. Testing must be carried out on specimens taken from a final product and only a change of coloring is permitted without new testing requirement. (2010 FTP Code, 164).

The testing procedures shall be carried out on items such as (2010 FTP Code, 165):

- blankets and quilts
- bedspreads
- pillows
- mattresses, including light mattresses

However items such as (2010 FTP Code, 165):

- bed sheets
- pillow cases
- box springs
- valances
- bed curtains

may be excluded from testing.

Four specimens of full nominal thickness mattress shall be prepared with the dimension 450x350mm. Testing of mattresses with removable covers, eight specimens must be made; four without the cover and four with the cover. (2010 FTP Code, 166).

Pillows must be tested in full size with four specimens (2010 FTP Code, 166).

Other products must be tested with four specimens, and they shall be cut from each product having dimensions of 450x350mm. Where loose filling occurs, the edges must be sewn together. (2010 FTP Code, 166).

Similar to Part 8, tests are carried out in accordance with smouldering cigarette test and propane flame test. A cotton-wool pad is placed on top of the smouldering cigarette during testing. The progressive smouldering and flaming behavior is observed throughout testing and two separate tests are carried out by both testing methods. (2010 FTP Code, 169).

Criteria's for determining progressive smouldering are described in paragraphs 10.1 and 10.2. In case where the product shows no sign of smouldering, it is considered to be of not easily ignitable material and classified according to Part 9. (2010 FTP Code, 170-171).

6 CONCLUSION

The main purpose of this thesis was to gather and simplify the existing requirements spread out in various codes and publications. The work was carried out by studying international requirements as well as the most commonly used regulations. The work had to be limited somewhere and was therefore focused on the visible parts of accommodation areas onboard passenger ships.

It would without a doubt be much easier for designer if all matters concerning material certification would be found in one place. Practically considering this would be impossible since there is not one organization setting the requirements.

Of all the codes, texts and regulations studied, the FSS Code is by far the most straightforward one. The code contains of the first chapters where the different applicable products are mentioned but the fact that all resolutions and circulars concerning these are a part of the code, makes it very straightforward. Therefore it would be extremely preferable if all codes and rules that are amended at some point, would have the actual amendments as appendixes.

The basic understanding of searching for valid requirements was under control at the start of the work. During the working phase though a certain norm about truly understanding the paragraphs and the referencing standard was comprehended.

Several new agreements and directives were also discovered and the big picture concerning the procedures became much clearer. Theoretically a designer does not even have to know anything about the procedures for testing and certification, but it does help in understanding the criteria's for the requirements.

As mentioned previously, this work could have easily been much wider, but the basis of this work can be applied for other areas of the ship in regards of IMO regulations, MarED etc.

Because this thesis is a composition of requirements, it will only be valid for a limited time. IMO, classification societies and administrations all possess the authority to amend and revise their regulations, making this work also subject to all amendments. This fact was already known by the beginning of the thesis, and internally within the company, the rules and regulations will be revised when deemed necessary. The construction, content and the layout may also be revised internally when enough feedback has been gathered.

This being said, the work is still far from over because this is a never-ending work that continuously has to be kept up-to-date in order for the correct regulations to be applied.

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PRODUCT CERTIFICATE

VTT EXPERT SERVICES LTD

CERTIFICATE NUMBER

CERTIFICATE NO VTT-C-11344-15-15

1 (2)

EC TYPE-EXAMINATION CERTIFICATE

according to Marine Equipment Directive (Module B)

APPROVED MODULE. MODULE B = TYPE EXAMINATION

THE WHEELMARK

ID OF NOTIFIED BODY (EUROFINS EXPERT)

NOTIFIED BODY 0809

OFFICIAL NAME OF PRODUCT APPROVED

This is to certify that the examined products with type designations

A-60 Steel Deck, Paroc Marine Wired Mat 100 or Paroc Marine Mat 100, 40/40 mm

meet the requirements imposed in IMO 2010 FTP Code, Annex 1 Part 3 (IMO Resolution MSC.307(88) Annex 1 Part 3) on

TESTING PROCEDURES APPLIED, PART 3 = TEST FOR A, B AND F CLASS DIVISIONS

Class A-60 Deck

and the provisions of Marine Equipment Directive 96/98/EC, as amended, last amendment 2013/52/EU, that apply to

EU DIRECTIVE WHICH THE PRODUCT COMPLIES WITH

fire integrity of A-60 Class division.

USCG CERTIFICATE NUMBER ACCORDING TO US-EC MRA

These products have been assigned a U.S. Coast Guard Module B number (**164.107 / EC0809**) to note type approval to Module B only as it pertains to obtaining U.S. Coast Guard approval as allowed by the "Agreement between the European Community and the United States of America on Mutual Recognition of Certificates of Conformity for Marine Equipment" signed February 27th, 2004.

Manufacturer of the product is

Paroc Group Oy

The Certificate is valid until May 10, 2020 unless cancelled or revoked, provided the conditions in this certificate are complied with and the equipment remains satisfactory in service.

Espoo May 11, 2015

Tiina Ala-Outinen
Business Manager

Ritva Paalanen
Lead Assessor

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FINAS

VTT EXPERT SERVICES LTD

CERTIFICATE NO VTT-C-11344-15-15 2 (2)

Manufacturer	Paroc Group Oy P.O.Box 240, Energiakuja 3 FI-00181 HELSINKI Finland.
Equipment	Annex A.1 Item No A. 1/3.11, "A" and "B" Class divisions, fire integrity.
Products	Class A-60 Steel Deck insulated with Paroc Marine Wired Mat 100 or Paroc Marine Mat 100, 40/40 mm.
Product description	"A" Class steel deck insulated from below with a stone wool mat having a nominal density of 100 kg/m^3. The surface of the insulation can be covered with a steel wire net (Paroc Marine Wired Mat 100) or can be without the net (Paroc Marine Mat 100). The thickness of the insulation is 40 mm. The insulation is fastened by using steel pins and steel washers or with bent pins without washers. The maximum distance of pins is 300 mm.
Technical document	Drawing no 12041 (03.03.2012) of manufacturer.
Test reports	Test Report No. 2012CS01621/1, 2/05/2012, RINA, Italy Test Report VTT-S-1081-15, 19 March 2015, VTT Expert Services Ltd. Finland
Test methods	(IMO Resolution MSC.307(88) Annex 1 Part 3 Fire Resistance Test Procedures for "A", "B" and "F" Class Divisions))
Notes	This certificate replaces the previous EC Type-Examination Certificates (B-module) VTT-C-5986-15-10. This certificate will not be valid if the manufacturer makes any changes or modifications to the approved equipment, which have not been notified to, and agreed with the notified body named on this certificate. Should the specified regulations or standards be amended during the validity of this certificate, the product is to be reapproved prior to it being placed on board vessels to which the amended regulations or standards apply. The Mark of Conformity may only be affixed to the above type approved equipment and a Manufacturer's Declaration of Conformity issued when the production-control phase module (D, E or F) of Annex B of the Directive is fully complied with and controlled by a written inspection agreement with a notified body.

PRODUCT ITEM NUMBER ACCORDING TO MED LIST

END OF CERTIFICATE

VTT EXPERT SERVICES OY VTT EXPERT SERVICES LTD