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DEVELOPMENT OF GUIDELINES FOR USE OF FIBRE REINFORCED PLASTIC WITHIN SHIP STRUCTURES

Consideration of fibre reinforced plastic within the regulatory framework

Submitted by the United Kingdom

SUMMARY

Executive summary:	This document provides arguments for consideration with regard to the use of fibre reinforced plastics (FRP) materials in the structure of SOLAS vessels
Strategic direction:	5.2
High-level action:	5.2.1
Planned output:	5.2.1.32
Action to be taken:	Paragraph 28
Related documents:	MSC 87/24/9, MSC 87/26 (paragraphs 24.14 and 24.31); FP 55/2 (paragraph 5); SOLAS chapter II-2; 2010 FTP Code; MSC/Circ.732 and MSC/Circ.1002

Introduction

1 The United Kingdom submitted a document to MSC 87 for a new work programme item (MSC 87/24/9) proposing the "Development of guidelines for use of Fibre Reinforced Plastic (FRP) within ship structures".

2 MSC 87 considered the matter and agreed to include the item in the biennial agendas of the FP and DE Sub-Committees as an unplanned output with a target completion year of 2013, assigning the DE Sub-Committee as the coordinating body.

3 The United Kingdom considers that there are two possible ways forward for this agenda item and requests that this Sub-Committee gives consideration to the most appropriate way forward for this agenda item.

Current regulatory framework

4 SOLAS regulation II-2/11 specifies the requirements for a ship's hull, superstructures, structural bulkheads, decks and deckhouses to be constructed of steel or other equivalent material, where "equivalent material" is any non-combustible material as defined in SOLAS regulation II-2/3.43.

5 To demonstrate non-combustible characteristics of a material, the FTP Code, Annex 1, Part 1 non-combustibility test is applied. The 2010 FTP Code allows for the testing of non-homogeneous materials (such as FRP), however when FRPs are exposed to heat, they produce combustible gases which fuel the fire and may lead to failure of the non-combustibility test.

6 In order to use FRP within a ship's structure and therefore deviate from the non-combustibility requirement, SOLAS regulation II-2/17 on alternative design and arrangements (regulation 17) needs to be followed requiring a risk-based design approach in order to deviate from the prescriptive requirements of SOLAS.

Option 1 – Development of guidelines for the application of SOLAS regulation II-2/17 for evaluating FRP structures

Summary of Option 1

7 Under option 1, in order to ensure that the use of FRP can be easily evaluated, guidelines for the application of SOLAS regulation II-2/17 specifically for FRP structures should be developed.

Background for Option 1 development

8 The application of SOLAS regulation II-2/17 can be a lengthy and complex procedure that does not necessarily ensure a positive result for the proposed arrangement under evaluation. When SOLAS regulation II-2/17 is used for evaluating FRP structures, it is usually ship specific and cannot be readily used for other ships. The risk and costs associated with conducting a SOLAS regulation II-2/17 evaluation for the use of FRP in ship's structures reportedly deters owners and yards from utilizing FRP.

9 The new SOLAS chapter II-2 which includes the aforementioned alternative design arrangements under SOLAS regulation II-2/17 was adopted by MSC 73. Since this adoption in the year 2000, no alternative design arrangements utilizing FRP within ship structures have been submitted by a Member State to the Organization.

10 The United Kingdom considers that SOLAS regulation II-2/17 may currently be contributing to the barrier to the use of FRP in ships' structures rather than providing a solution. Providing this additional guidance specifically for FRP may assist when undertaking a SOLAS regulation II-2/17 evaluation in order to use FRP within ship structures.

Details of option 1

11 A more structured approach to the specific use of FRP in ships' structures may make the risk-based evaluation more approachable. Standardization of certain aspects within SOLAS regulation II-2/17 and the associated MSC/Circ.1002 approach may remove unnecessary evaluation, allowing for a more structured evaluation which targets the areas appropriate to FRP and disregards areas that may not be applicable.

12 The proposed guidelines could be used to address key factors relating to the specific area of FRP use in ships' structures without diluting the content of MSC/Circ.1002.

13 For example, standardizing the following areas of the SOLAS regulation II-2/17 evaluation from within the MSC/Circ.1002 approach could be provided to suit a generic FRP application:

- Fire hazards for known spaces;
- Performance criteria and safety margins;
- Engineering judgements; and
- Calculation procedures.

Benefits of Option 1

14 This standardization could allow Administrations to recognize the format of the SOLAS regulation II-2/17 evaluation enabling them to review the results more effectively and with more confidence. It could also make the results from different evaluations easily comparable for identification of similar attributes or identifying trends in design that can help further development in this area.

15 SOLAS regulation II-2/17 evaluation allows for a balance of active and passive fire control systems in order to provide a solution under the risk-based analysis. Under the prescriptive requirements of SOLAS these are separate areas that cannot be assessed through a risk analysis in order to integrate the individual requirements.

16 Standard alternate design and arrangement evaluations used for similar vessel types, with for example the same FRP superstructure, could enable owners to utilize evaluations undertaken for a series of similar ships, reducing the burden of repeat, bespoke evaluations for individual ships.

Option 2 – Development of FRP as a material type within the regulatory framework

Summary of Option 2

17 Under this option it is considered that FRP should not be regarded as a novel concept addressed as a ship specific alternative design and arrangement under SOLAS regulation II-2/17, but instead may be regulated for as a material type within the regulatory framework of SOLAS and the FTP Code.

Background for Option 2 development

18 MSC/Circ.732, adopted at MSC 66, is an interim guideline for demonstrating the equivalence of composite materials to steel. The methodology for determining the structural properties and critical temperature at which an FRP structure fails has significant merits. However this circular also requires that the material is non-combustible in the first instance and this has led to no known equivalences being reported to the Organization since these Guidelines were approved in 1996.

19 It is the United Kingdom's view that the potential barrier to the general acceptance and use of FRP in ships' structures lies with the inability to demonstrate equivalence to steel and the appropriateness of the associated risk-based design evaluation that is required under SOLAS regulation II-2/17 to provide equivalence to the relevant regulations.

20 If the regulations were to make provision for a standard test within the FTP Code which demonstrates equivalence to steel, or to have FRP as a material type like aluminium alloy in SOLAS regulation II-2/11.3, then the non-combustible requirement would be either proven or an equivalence to steel provided through standard and repeatable test procedures without the need for ship specific risk-based design evaluation.

Details of option 2

21 Aluminium is specified as an equivalent material to steel in SOLAS regulation II-2/11.3 and the FTP Code provides specific tests for the approval of aluminium structures. This controlled use of aluminium alloys in the vessels structure allows for aluminium structures to meet the regulation's purpose statement without the need to conduct a SOLAS regulation II-2/17 evaluation to demonstrate the material properties are equivalent to steel.

22 If FRP was to be considered as a material under SOLAS regulation II-2/11, then the regulatory framework surrounding its use could become prescriptive, controlled by the FTP Code which would provide a quantifiable approach for the use of FRP within ships' structures.

23 The use of the critical temperature philosophy outlined in MSC/Circ.732 could form the base for further work in determining the appropriate allowable temperature rise on the surface of an FRP structure in line with the 200°C allowable rise for aluminium alloys. It is the United Kingdom's view that this temperature rise is key to understanding FRP as a load bearing structure within a vessel which must be able to sustain fire damage and remain structurally sound.

Benefits of option 2

24 Standardizing the demonstration of equivalence of FRP to steel in this way may allow for FRP to be used in ships' structures without a risk-based design evaluation being undertaken for individual installations allowing shipyards to develop ships' structures in FRP and owners to explore the many benefits offered by FRP structures.

25 The United Kingdom proposes that the use of FRP as an equivalent material to steel may be included in SOLAS and/or the FTP Code where prescriptive FTP Code testing methods or acceptance criteria developed specifically for FRP could be used.

26 A testing standard against which FRP structures may be approved may also be used in conjunction with a SOLAS regulation II-2/17 evaluation. The quantifiable performance data of the FRP structure may enable the evaluation to focus on aspects outside of the performance of an FRP bulkhead that has already achieved type approval against fixed parameters.

Summary

27 The United Kingdom considers that there are two possible ways forward for the development of work in this area.

Option 1 – Development of guidelines for the application of SOLAS regulation II-2/17 for evaluating FRP structures; or

Option 2 – Development of FRP as a material type within the regulatory framework.

Action requested of the Sub-Committee

28 The Sub-Committee is requested to consider the two options outlined in this document and summarized in paragraph 27 as the possible way forward for this agenda item and decide as appropriate.