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UNIFIED INTERPRETATION OF PROVISIONS OF IMO SAFETY, SECURITY, ENVIRONMENT-RELATED CONVENTIONS

Comments on document SSE 10/12/3

Submitted by IACS

SUMMARY

Executive summary:	This document provides comments on document SSE 10/12/3, providing information on the outcome of SSE 9 and MSC 107 on single essential propulsion components and their reliability.
Strategic direction, if applicable:	7
Output:	7.1
Action to be taken:	Paragraph 15
Related documents:	SSE 8/15/3 and SSE 10/12/3

Introduction

1 The document is submitted in accordance with the provisions of paragraph 6.12.5 of the *Organization and method of work of the Maritime Safety Committee and the Marine Environment Protection Committee and their subsidiary bodies* (MSC-MEPC.1/Circ.5/Rev.5); and comments on document SSE 10/12/3 (Secretariat), providing information on the outcome of SSE 9 and MSC 107 on single essential propulsion components and their reliability.

Discussion

2 Document SSE 8/15/3 (IACS) and the proposed interpretation therein is not related to electric propulsion in general since it is referring to an unconventional design and is not intended to provide a basis for a wider consideration of the reliability of electric propulsion compared to a mechanical propulsion line. It is addressing a very specific design solution for electric propulsion, where an electric motor is provided with two stator windings within the same stator iron core.

3 Further, document SSE 8/15/3 clarifies that electric motors provided with two stator windings within the same stator iron core are not tolerant to a single failure of a winding. IACS understands that design solutions can mitigate this, enabling electric propulsion with a single shaft and propeller that will maintain propulsion in case of a failure in one of the windings. The interpretation in document SSE 8/15/3 is formulated such that it does not rule out designs with single electric propulsion shaft lines but specifies that the design must be tolerant to a single failure of a winding. That document is not going into wider discussions on the reliability of a single electric propulsion shaft line in comparison with a single mechanical propulsion shaft line.

Electric propulsion in view of SOLAS regulations

4 The reliability of an electric motor for propulsion may be considered in comparison with the reliability of the components in a mechanical propulsion line. IACS opines that failure modes that are unexpected and unrepairable should be given special consideration and understands that this is the case for winding failures of electric machines. For conventional mechanical single propulsion lines, the reliability of the individual components in the propulsion line are given special attention. IACS members have detailed rules for these components in view of application as single essential propulsion line components. These are designed with high degrees of safety factors and the components are subject to extensive testing and verification to ensure an acceptable availability of propulsion. The reliabilities of the components have been proven through decades of in-service experience, providing a well-documented level of reliability. There are certain components, such as clutches, elastic couplings and pitch control mechanisms, that may have somewhat increased failure rates; however arrangements are required to enable restoration of propulsion within an acceptable timeframe by the crew.

5 Electric motors are designed to industry standards. In general, the rules of IACS members are referring to these standards. Current industry standards for electric motors are for general application and not specific for application as a single essential component for propulsion. It is noted that clause 12 of IEC 60092-501 provides a standard for electric propulsion motors. This standard is not addressing the risk of winding failure and is not considered to provide the required reliability as a single component for propulsion. Thus, the standard is considered in view of an electric propulsion arrangement with two independent electric propulsion motors.

6 Part D of SOLAS chapter II-1 provides regulations for the electrical power generation and distribution. The philosophy is based on component redundancy in lieu of high reliability of single components. Components with windings similar to electric motors, such as generators and transformers, are required to be redundant. A dual winding generator or dual winding transformer, where a winding failure would result in a loss of power generation or distribution, would not comply with SOLAS.

7 Consumer reliability for propulsion is covered by part C of SOLAS chapter II-1, in particular regulation 26.2. This means that SOLAS is not covering redundancy for a ship function, such as electric propulsion. However, following the principles in SOLAS, it is evident that the same considerations with respect to failure modes and redundancy should be applied to electric motors as other components in the electric power chain for electric propulsion.

8 This has also been the principle followed for ship designs with electric propulsion for the last decades. Ships have been designed with two or more independent electric propulsion motors.

9 IACS is of the understanding that designs with dual winding motors were initially utilized in order to provide for the power demand of the motor to be divided between two motor drives (frequency converters) due to limitations in power for motor drives. By the utilization of a dual winding motor, this would also provide for a design with redundancy for components in the power supply to the motor, in particular for the motor drives that have been of particular concern with respect to their reliability. Clause 4.1.4 of IEC 60092-501 provides a standard for an electric propulsion arrangement where a dual winding electric motor is utilized as a single component for propulsion, providing for redundancy in the supply to the motor. Such a standard is considered relevant to refer to by Administrations for non-conventional ships having a low risk with respect to loss of propulsion. The standard points out that "a winding damage will lead to the total loss of the propulsion motor, and in this case the single failure design criteria cannot be fulfilled". This standard is, accordingly, not considered relevant for SOLAS ships.

10 It is now observed that the design with a single electric motor with dual windings is also being applied for SOLAS ships. It appears that it may have been misunderstood that such a design with two windings provides for single failure tolerance for the electric motor as well, and is in line with the SOLAS principles. As explained in document SSE 8/15/3, these windings are not independent, as they share the same magnetic flux. A failure in one of the windings will require de-excitation of the motor (i.e. loss of propulsion) in order to "disconnect" the fault current. If the motor is not de-excited, this will result in a standing fault current, which, in any case, will result in failure of the other winding and potentially a fire. The purpose of document SSE 8/15/3 and the proposed interpretation is to highlight this and to ensure that ships are designed with sufficient reliability for propulsion.

The experience of IACS members pertaining to the reliability of electric machines

11 As ships with electric propulsion for the last decades have, in general, been designed with two or more independent electric propulsion motors, failure of an electric propulsion motor for these ships will not result in a total loss of propulsion and, accordingly, will not be included in any databases for loss of propulsion power or reflected in any incident statistics.

12 However, IACS members are informed about failures of ships' main components. Even though reliability statistics cannot be derived from this, the incidents which were experienced give IACS concern with respect to the designs addressed in document SSE 8/15/3. IACS is aware of two separate recent incidents happening within two months of the second quarter of 2023 that underscore the importance of addressing this safety concern. For both these incidents, a winding failure in a dual winding electric propulsion motor led to the complete loss of the propulsion motor. While the ships' safety was maintained, due to redundancy in propulsion units, it is crucial to note that if the ships had been designed with one dual winding propulsion motor, according to the design discussed in document SSE 8/15/3, these incidents would have resulted in a complete loss of propulsion power for these ships. These are very recent incidents experienced long after document SSE 8/15/3 was submitted to SSE 8 and underscores that the concerns raised therein are for real and need attention.

Proposal

13 Considering the supplementary explanation of the issue, IACS is of the view that the hazard with the designs discussed in document SSE 8/15/3 require immediate attention. It is imperative to address this risk promptly to ensure that the designs of propulsion arrangements for new ships adequately consider and mitigate this potential danger.

14 With the above in mind, IACS proposes that the Sub-Committee confirm the conclusion which was taken at SSE 9 to agree to the unified interpretation presented in document SSE 8/15/3 and recommend to MSC 109 the approval of the interpretation and dissemination by means of an MSC circular.

Action requested of the Sub-Committee

15 The Sub-Committee is invited to consider the foregoing, the proposals in paragraph 14, and take action, as appropriate.