INTERNATIONAL MARITIME ORGANIZATION

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SUB-COMMITTEE ON SHIP DESIGN AND CONSTRUCTION
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Agenda item 9

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DEVELOPMENT OF A SAFETY REGULATORY FRAMEWORK TO SUPPORT THE REDUCTION OF GHG EMISSIONS FROM SHIPS USING NEW TECHNOLOGIES AND ALTERNATIVE FUELS

Potential of nuclear power for shipping

Submitted by the European Commission

SUMMARY

Executive summary:	This document provides information about a study addressing the potential of nuclear power for shipping.
Strategic direction, if applicable:	3
Output:	3.8
Action to be taken:	Paragraph 11
Related documents:	MSC 108/INF.21; MSC 109/WP.9, MSC 109/WP.9/Add.1; MSC 110/6/4 and MSC 110/21

Introduction

1 In the context of the development of a safety regulatory framework to support the reduction of GHG emissions from ships using new technologies and alternative fuels, MSC 110 assigned the tasks listed in annex 5 to document MSC 110/WP.9 to the SDC Sub-Committee. SDC 12, in particular, is requested to start the work on the assigned tasks, starting with the drafting of a work plan, including the update of the Code of Safety for Nuclear Merchant Ships and SOLAS chapter VIII, and the establishment of a correspondence group, if deemed necessary.

2 In this context, the MSC 110 agreed to invite interested Member States and international organizations to submit relevant documents for consideration at SDC 12.

3 This document provides information about a study carried out by the European Maritime Safety Agency (EMSA)* and awarded to a consortium led by the American Bureau of Shipping (ABS), and including Texas A&M University and ARCSILEA. The information

* Potential use of nuclear power for shipping - EMSA - European Maritime Safety Agency

provided is of general, educational and in some instances, specific technical nature, which may be useful for the Sub-Committee's work on this topic.

Main elements of the study

4 The structure of the report, beyond the introduction, is the following:

.1 Use of Nuclear Power in the Shipping Sector;

.2 Safety and environmental regulations, standards and guidelines; and

.3 Risk Assessment Using Nuclear Power in Merchant Vessels.

Some highlights on the content of the above-mentioned chapters can be found in the paragraphs below.

Use of nuclear power in the shipping sector

5 The chapter of the study on the use of nuclear power in the shipping sector, explores the fundamental aspects of nuclear power plants, including the properties of nuclear fuel and radioactive materials, nuclear criticality, reactor components, and capacity. It covers further various classifications of nuclear power plants based on reaction type (fast and thermal neutron reactors), moderator material (light water, graphite, heavy water), and coolant material (pressurized water, boiling water, gas-cooled, liquid metal, molten salt, supercritical water, and supercritical CO_2 reactors). The chapter also addresses the suitability of different reactor types for merchant marine applications, considering factors like fuel availability and the unique challenges faced by the maritime industry.

6 Furthermore, the subject chapter discusses the sustainability advantages of nuclear propulsion, highlighting its near-zero well-to-wake (WTW) emissions and zero greenhouse gas (GHG) tank-to-wake emissions during operation, which positions it as one of the potential pathways for decarbonizing the shipping sector. It also provides a techno-economic analysis, examining capital expenditures (CAPEX) and operational expenditures (OPEX) for nuclear-powered vessels. The study indicates that while initial CAPEX might be higher, nuclear-powered vessels could achieve lower OPEX over time due to stable fuel costs and longer refuelling intervals, particularly when compared to very low sulphur fuel oil (VLSFO)-fuelled vessels as carbon costs and fuel expenses increase.

Safety and environmental regulations, standards and guidelines

7 A comprehensive overview of the regulatory landscape governing nuclear power in the shipping industry, both internationally and within EU Member States is provided in another chapter. Roles of key international organizations are detailed, such as the International Atomic Energy Agency (IAEA), in establishing safety and environmental standards. The chapter also addresses critical aspects of civil liability, insurance, and the relevant conventions, such as the Brussels Convention and the Vienna Convention, which define the legal framework for nuclear damage.

8 Additionally, it examines EU legislation applicable to EU Member States, including the "Fit-for-55 package". It further explores national regulations in countries like Canada, France, Japan, Republic of Korea, the United Kingdom, the United States, and others, further detailing an overview of different positions by other Nations regarding nuclear applications. The chapter concludes by identifying existing national and international guidelines from bodies like ASME, ASTM International, NFPA, NEI, WNTI, ANS, WANO, WNA, and NEMO, and performs a gap

analysis highlighting areas requiring further regulatory development for nuclear-powered merchant vessels.

Risk assessment using nuclear power in merchant vessels

9 On a chapter dedicated to safety, the methodologies and findings of risk assessments conducted for integrating nuclear power into merchant vessels are detailed. The chapter discusses general nuclear power safety principles, and the need for both qualitative and quantitative risk assessments throughout a plant's lifecycle, from design to decommissioning. This chapter emphasizes the importance of a high-level preliminary Hazard Identification (HAZID) study to identify early-stage risks associated with nuclear power integration for vessel propulsion and power generation.

10 The HAZID studies analysed three specific vessel types: a cruise ship with a Lead-cooled Fast Reactor (LFR), a Bulk Carrier with a Very High-Temperature Reactor/High-Temperature Gas-cooled Reactor (VHTR/HTGR), and a container ship with a VHTR/HTGR. These preliminary assessments identified hazards such as radiation leaks, flooding, vessel sinking, capsizing, collision, grounding, manning and training requirements, technology licensing, compliance with non-proliferation treaties, external risks (e.g. piracy), shipyard capabilities, and the impact of marine load variations on reactors. The findings from these HAZID studies provided recommendations for preventive and mitigation safeguards, aiming to achieve safer designs and contribute to the development of specific regulatory requirements, thereby ensuring effective risk reduction. It has, however, to be remarked that this hazards analysis is preliminary to screen major hazards and has to be considered in combination with several other well-established risk assessment methodologies available for this specific sector.

Action requested by the Sub-Committee

11 The Sub-Committee is invited to note the information provided in this document.