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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

Roadmap for the revision of the Code of Safety for Nuclear Merchant Ships (resolution A.491(XII))

Submitted by the Kingdom of the Netherlands

SUMMARY

Executive summary:	This document identifies the potential use of nuclear energy in commercial shipping and proposes a roadmap including a timeline for the revision of the Code of Safety for Nuclear Merchant Ships (resolution A.491(XII)).
Strategic direction, if applicable:	3
Output:	3.8
Action to be taken:	28
Related documents:	MSC 108/INF.21; MSC 109/WP.9; MSC 110/18/16 and MSC 110/21

Introduction

1 At MSC 110, the Working Group on the Development of a Safety Regulatory Framework to Support the Reduction of GHG Emissions from Ships Using New Technologies and Alternative Fuels (the Group) prepared instructions to the SDC Sub-Committee (MSC 110/WP.9, annex 5), which were agreed by the Committee.

2 One of the instructions relates to the revision of the Code of Safety for Nuclear Merchant Ships (resolution A.491(XII) (Nuclear Code). The SDC Sub-Committee is requested to start this work at SDC 12, if possible, prepare a work plan and to report to MSC 111. Member States and international organizations were invited to submit relevant documents for consideration by SDC 12 (MSC 110/21, paragraphs 26 and 27).

3 This document intends to support the work of the SDC Sub-Committee and proposes a roadmap for the revision of the Nuclear Code, taking into account the technological developments and relevant initiatives.

Background

4 MSC 108/INF.21 (WNTI) included a comprehensive gap analysis, which provides a framework for the development of a revised Nuclear Code adopting a non-prescriptive technology neutral approach similar to that used by IAEA in their Safety Standards.

5 MSC 110/18/16 (Russian Federation) proposed a new output, to further extend the application of SOLAS chapter VIII and the Nuclear Code to non-self-propelled Floating Nuclear Power Plants (FNPPs) to regulate the safety of such units. The Committee did not agree to include the proposed output in the work programme. However, it was noted that a separate set of non-mandatory provisions addressing safety requirements for FNPPs could be developed at a later stage, taking into account that inter-agency work in cooperation with the IAEA might be necessary (MSC 110/21, paragraph 18.87).

6 MSC 110 requested the Secretariat to continue close cooperation with the IAEA Secretariat on issues related to commercial nuclear-powered ships, so that the experts from both organizations could cooperate, with a view to coordinating relevant actions and identifying regulatory needs (MSC 110/21, paragraph 20.13).

Use of nuclear energy

7 It is important to highlight that from a regulatory perspective, in accordance with the decision of the Committee, FNPP's are to be seen separately from the revision of the Nuclear Code (paragraph 5 above). However, from a technological perspective, there is a link between FNPPs and ships using nuclear energy for propulsion. It is expected that the application of nuclear reactors of non-self-propelled FNPPs will result in them being floating stationary at a fixed location, notably within the twelve nautical miles territorial waters of coastal States and will be developed prior to application of nuclear power for propulsion. It might be expected that FNPPs undertake a single voyage to another fixed location or even become self-propelled.

8 Based on the knowledge gained on nonself-propelled FNPPs, nuclear energy generated by a reactor can be utilized on board ships for propulsion (nuclear ships) or for the hybrid solution: use of nuclear energy on the high seas and propelled by conventional fuel or alternative fuels and technologies in territorial waters. The latter is important for setting the requirements for the entering of ports.

Nuclear power on board propelled ships

9 Vessels with nuclear power generation on board might use nuclear power for mission equipment, such as offshore drilling and heavy lift or propulsion. At the same time, alternative (conventional) means of powering propulsion might also be installed allowing, for example, port entry with a powered down nuclear reactor. It should be noted that, even when shut down, a nuclear reactor remains a basic nuclear installation and, as such, must comply with relevant applicable regulations. Furthermore, refueling results in a clearly different risk profile compared to normal operation.

10 In addition to the gaps and barriers mentioned in document MSC 110/WP.9, careful consideration should be given to the different risk profiles and associated regulations for all different stages of the nuclear reactor: refuelling, nuclear powered propulsion, nuclear operation with conventional propulsion and nuclear shut down with conventional propulsion. These different applications may require specific rules and guidelines in combination with different locations of use: international waters, passing through territorial waters and in ports.

Technological developments and initiatives – Nuclear and maritime

11 Onshore nuclear developments include Advanced Nuclear Reactors and Small Modular Reactors. The range of power output of Small Modular Reactors (SMRs) is wide and runs from 10 MWe to 300 MWe and are, therefore, potential solutions for maritime applications. Companies developing nuclear reactors of suitable sizes for maritime applications have gathered in various initiatives to promote nuclear power on board ships and floating units.

12 IAEA provides for the regulatory framework for nuclear reactors and is currently modifying its codes and guidelines to cover nuclear reactor technologies other than large size Light Water Reactors. It is important that these modifications to the IAEA (Safety) Standards (Fundamentals, Requirements and Guides) also include guidelines for maritime application and entail the additional demands for use on the high seas, such as the environmental conditions and the associated ship motions, remote operations and other risks including flooding.

13 In 2024 the IAEA launched its initiative "The Atomic Technologies Licensed for Applications at Sea (ATLAS)" aiming to establish a framework for the use of nuclear power in the maritime industry.* It is acknowledged that IAEA's approach towards safety, security and safeguards is essential for the maritime applications. For all these three areas the maritime conditions and environmental risks will need to be (re-)evaluated, as it would be the case for a land-based site, considering e.g. earthquakes. To ensure a suitable outcome for maritime and offshore applications, cooperation with the Organization is essential (see paragraph 6). Solutions suitable for land operations, such as recovery, reliance on external means of protection and environmental threats will need adaptations for maritime applications.

Challenges

14 Industry initiatives have also been undertaken to investigate nuclear concepts suitable for shipping and offshore contracting purposes. A challenge that appears in the feasibility studies is the alignment of regulatory instruments developed by the different bodies (e.g. IMO and IAEA). Some examples are identified where such alignment is required:

.1 Safety cases and operational conditions for ships and non-propelled units are different from land-based operations in view of the ship motions induced by environmental conditions, flooding and sinking hazards and availability of mitigation measures.

.2 Ownership and liability are different for maritime application compared to land-based applications. For maritime application, licensing, commissioning, maintenance and decommissioning operations may occur at different locations under different jurisdictions. Hence, especially for security and safeguards, extensive collaboration and understanding of nuclear and maritime matters are essential.

15 Mutual acceptance between States of a licensed reactor for propulsion on board a ship is a topic which deserves discussion in close cooperation between IMO and IAEA. For international shipping, harmonization has been achieved through international certification and survey requirements (e.g. Harmonized System of Survey and Certification (HSSC) (resolution A.1186(33)). So far, the licensing of nuclear installations is limited to mostly land based applications, or stationary FNPPs under the responsibility of a single State. Therefore, harmonization and international acceptance have not been considered relevant.

* Atomic Technologies Licensed for Applications at Sea (ATLAS) Project, Source: IAEA Year in Review 2024 | IAEA

Social trust and cost-benefit

16 The adoption of nuclear power on board floating units or ships requires social trust from Member States and their stakeholders. Whilst the interest on nuclear energy both onshore and offshore has grown in the recent years, questions regarding safety, security and safeguards are to be legitimately expected.

17 The Organization's approach towards nuclear power should address the societal concerns in order to gain trust. This would include requirements for entering the ports, crew familiarization and protection, response to incidents, decommissioning, waste management and non-proliferation, besides the robust selection and description of safety cases to be addressed. The distinction between the use of nuclear propulsion within approaches to port and use of nuclear power only away from port should be part of the considerations.

18 Nuclear propulsion and power generation on board ships or FNPPs will require an initial investment from the owners and manufacturers of nuclear energy power plants. The power plant should always be new build, large power and should be subject to requirements to consider and prepare for manufacturing, maintenance and end-of-life. Once the installation is designed and built, the running costs are predictable. With refuelling periods of 2 to 20 years, ship and offshore operations can be independent and autonomous. For ship owners and offshore contractors, the perspective of nuclear energy might be attractive in terms of total cost of ownership, and independent and extended service.

19 In order to lower the risk of a successful introduction of nuclear energy on ships and floating units, the Organization should consider the total picture of nuclear energy from cradle to cradle to the extent possible (or cradle to grave), and incorporate the societal trust as a driver to establish a clear and trustable code.

Proposals

20 In annex 5 of document MSC 110/WP.9, the SDC Sub-Committee is identified as the suitable body for carrying out the revision of SOLAS chapter VIII and the Nuclear Code. Given the complexity and the challenges of the regulatory framework (e.g. safety of the reactor, safety of the ship, security, risk for human environment) it is considered that additional IMO bodies need to be involved. It is proposed to assign SDC as the coordinating body and include the SSE, CCC and HTW Sub-Committees as associated bodies.

21 Close cooperation between the Organization and IAEA, preferably in cooperation with the ATLAS initiative, is essential for updating the Nuclear Code, as well as the early and substantial involvement and participation of the nuclear safety Regulatory Bodies and Maritime Administrations. It is proposed to establish a joint working group (JWG) between the Organization and IAEA for the effective revision of the Nuclear Code.

22 The two United Nations agencies, IMO and IAEA, should work jointly in the following manner:

.1 Relevant IAEA requirements should be taken into account when revising the Nuclear Code, identifying to what extent the IAEA requirements would be applicable and should be extended to maritime. This includes the Requirements for the Design of Nuclear Installations, as updated to include all types of reactor technologies and future innovations.

.2 Relevant maritime requirements and approaches should be taken into account by the IAEA when revising the Nuclear Code and supporting documents via the collaboration with the ATLAS initiative. Concepts as design extension conditions should be applied to, for instance, maritime related external hazards.

23 The possibility to include cross references in both IMO and IAEA regulations should be explored. For example, the IAEA Safety Guides could be referenced in the Nuclear Code as an acceptable standard to the Organization for compliance with the requirements. That would ensure that:

.1 there is no overlap or contradiction and future updates of IAEA requirements could be easily implemented, without necessarily revising each time the Nuclear Code; and,

.2 Administrations (including the national regulators for licensing the reactor) would have a harmonized instrument for the licensing of any type of reactor project.

24 Safety (including testing and prototyping), security and safeguards should be treated in an integrated way according to the IAEA approach, inclusive of cybersecurity.

25 The impact of nuclear maritime operations on requirements should address at least the following:

.1 competences, and training of crew and other persons involved;

.2 maintenance, waste and decommissioning (see paragraph 14);

.3 mutual acceptance of a licensed reactor for propulsion on board a ship in analogy with international ship certification (see paragraph 15);

.4 remote operation aspects;

.5 safety cases and design conditions specific for maritime application (see paragraph 14);

.6 crisis management;

.7 nuclear fuel (paragraph 10) and ship recycling; and,

.8 clarification of the responsibilities and the transfer of responsibilities of/between national authorities, ship master and the nuclear licensee.

26 Interested Member States having experience in operating, or hosting in their ports, nuclear-powered ships should be invited to share their feedback and lessons learned from safe operational experience. This would include both civil and military experiences as far as they may be shared.

27 Taking into account the above the following workplan is proposed:

SDC 12 (2026)	Start with an inventory of topics/challenges relating to the use of nuclear reactors for maritime applications (see paragraphs 14, 15, 16, 17, 23 and 24). Identify gaps and challenges in the relevant regulatory framework (e.g. design and safety of the reactor, safety of the ship, security, risk for human environment, operational profile) and identify the relevant regulatory body (see paragraphs 20 to 23). Establish a correspondence group to start with the review of the gap analysis in document MSC 108/INF.21 (WNTI) and identify additional topics which need to be included based on the inventory.
MSC 111 (2026)	Consider SDC 12 report and agree to establish JWG IAEA/IMO (see paragraph 20)
JWG IAEA/IMO (2026)	Identify which working packages in the ATLAS Project are relevant for the revision of the Nuclear Code and other challenges based on the inventory finalized at SDC 12 (see paragraphs 14, 24, 25). Ensure alignment in the definitions and the requirements in IMO and IAEA regulations (see paragraphs 22 and 23). Discuss the compatibility between certification of ships and licensing of a nuclear reactor installed on board ships (see paragraph 15) and other topics shown in paragraph 25. Clarify responsibility and jurisdiction issues. Align the tasks and timeline of ATLAS project with the revision of the Nuclear Code and SOLAS chapter VIII.
SDC 13 (2027)	Consider the report of the JWG IAEA/IMO to progress the revision of the Nuclear Code.

Action requested of the Sub-Committee

28 The Sub-Committee is invited to note the information in this document, consider the proposal in paragraphs 20 to 27 and take action as appropriate.

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