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## Nuclear Ships

**Notice to all Shipowners, Operators, Masters, Officers, Maritime Administrations, Port Authorities and Recognised Organisations**

*This notice should be read with the Merchant Shipping (Nuclear Ships) Regulations 2021.*

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### Summary

This notice provides guidance on the application of the Merchant Shipping (Nuclear Ships) Regulations 2021 (SI 2021/XXX), which regulate UK commercial nuclear-powered ships and foreign commercial nuclear-powered ships visiting UK waters. The guidance covers the following aspects:

- Approvals and surveys
- Reactor Installation
- Safety Assessment
- Quality Assurance Programme
- Operating Manual
- Radiation safety
- Manning and Training
- Ports

## 1. Introduction

- 1.1 This notice provides guidance on the application of the Merchant Shipping (Nuclear Ships) Regulations 2021 (“the 2021 Regulations”), which implement Chapter VIII of the International Convention for the Safety of Life at Sea, 1974 (SOLAS), relating to commercial nuclear-powered ships. The 2021 Regulations also incorporate the provisions of IMO Resolution A.491, “Code of Safety for Nuclear Merchant Ships” (“the Nuclear Code”), which contains the basic requirements for the design, construction and operation of nuclear ships.
- 1.2 A nuclear-powered ship is constructed with a nuclear power plant to provide energy to the propulsion system which normally includes components such as a nuclear reactor, heat exchanger, steam generator feeding a steam turbine, and associated piping, pumps, and valves.



- 1.3 The nuclear reactor generates heat via the fission of nuclear fuel. This causes risks associated with radiation and other hazards arising from concentrated energy sources such as high pressure and high temperature.
- 1.4 The reactor installation means the total ship main propulsion system, including the nuclear steam supply system which generates the steam for propulsion.
- 1.5 The 2021 Regulations contain requirements for nuclear-powered vessels for the purposes of ensuring safety and environmental protection, with special attention to radiation hazards.
- 1.6 While the Nuclear Code is based upon established and accepted ship-building, marine and nuclear engineering principles, it is recognised that the Code should be reviewed as necessary to ensure it captures technological progress. The Nuclear Code is currently restricted to conventional types of ships propelled by nuclear propulsion plants with pressurised light water type reactors.
- 1.7 To date, the MCA has not engaged directly with commercial nuclear-powered ships as there are no ships using nuclear-powered propulsion operating under the UK Flag and there are very few nuclear-powered vessels currently operating in the global commercial fleet.
- 1.8 However, it is recognised that nuclear propulsion could be part of the solution against climate change and proposals may be made in the future to use this technology in order to achieve the necessary reduction of greenhouse gas emissions from shipping.
- 1.9 Although it is not possible at the present time to provide extensive guidance on this subject, the MCA will provide clarification on a case-by-case basis. The MCA will also endeavour to provide additional guidance when further experience of nuclear-powered ships is acquired.

## **2. Approvals and surveys**

- 2.1 The nuclear reactor installation for a United Kingdom nuclear ship must be approved by the MCA before construction of the ship commences (see section 3 in this MGN).
- 2.1 A safety assessment must also be prepared and approved by the MCA prior to construction, together with preliminary plans and a complete description of the quality assurance programme (see regulation 7 of the 2021 Regulations and sections 4 and 5 in this MGN).
- 2.2 Surveys of the ship must be carried out during the construction phase, and trial phase, mainly for quality assurance purposes but also to verify that the ship is built in conformity with the requirements of the 2021 Regulations, which include the requirements of the Nuclear Code, and with any added recommendations. Surveys must be carried out in accordance with regulation 19 of the 2021 Regulations, which incorporates the requirements of Chapter 8 of the Nuclear Code.
- 2.3 The ship must be subjected to a pre-commissioning test programme (regulation 19(4) of the 2021 Regulations), which is a series of tests to be carried out prior to the initial survey of the ship.
- 2.4 When satisfied with the test results and the updated documentation provided on behalf of the ship, the MCA or the delegated Certifying Authority may authorise the commissioning and issue a Nuclear Passenger Ship Safety Certificate or a Nuclear Cargo Ship Safety Certificate, if satisfied at the date of the survey that the ship complies with the applicable requirements of the 2021 Regulations. The certificate must be kept on board the ship and be ready for inspection at all times. As such, the approval takes into account the technical



requirements in the Nuclear Code, and with special consideration of the technological advancement in nuclear power generation and nuclear safety.

- 2.5 The results of surveys and tests should be recorded and copies of all reports should be provided to the MCA and kept on board for examination by the authorities concerned.
- 2.6 The nuclear component of a nuclear-powered vessel should be surveyed during the operational phase as required by paragraphs 8.4 and 8.5 in Chapter 8 of the Nuclear Code, which supplement the periodical surveys required by Chapter I and Chapter VIII of SOLAS (see regulation 19(7) to (9) of the 2021 Regulations). All surveys of nuclear ships are subject to the general requirements in paragraphs 8.1.6 to 8.1.8 in Chapter 8 of the Nuclear Code (see regulation 19(1) of the 2021 Regulations).
- 2.7 Continuous surveys can be undertaken in accordance with paragraph 8.4.3 of the Nuclear Code in place of the periodical surveys required by paragraphs 8.4.3.1 to 8.4.3.4 of the Nuclear Code (surveys of the nuclear steam supply system and supporting hull structure), and this should be arranged with the MCA (see regulation 19(8) of the 2021 Regulations). Additional surveys will also have to be carried where there are particular circumstances, such as an accident involving the nuclear ship or during repair work (see regulation 19(9) of the 2021 Regulations).
- 2.8 When evaluating the proposal, the MCA may engage the experience and resources of Certifying Authorities, UK Departments or Agencies specialised in nuclear safety.

### **3. Approval of reactor installation**

- 3.1 The MCA should be approached in the early stages of the design to receive detailed information for the purposes of the approval of a reactor installation onboard a UK nuclear-powered vessel (regulation 10 of the 2021 Regulations).
- 3.2 The reactor installation is the total ship main propulsion system, including the nuclear steam supply system which generates the steam for propulsion. It has the same meaning as “nuclear propulsion plant”, which term is used in the Nuclear Code.
- 3.3 The reactor installation should be designed having regard to the special conditions of service on board the nuclear ship both in normal and exceptional circumstances of navigation.
- 3.4 The design, construction and standards of inspection and assembly of the reactor installation of a UK nuclear-powered vessel must comply with the requirements in the 2021 Regulations, the Nuclear Code and be subject to the approval of the MCA in light of the limitations which will be imposed on surveys by the presence of radiation.
- 3.5 It should be noted that the Nuclear Code is based on pressurised light water type reactors. Other type of reactors will require special considerations and may be approved by the MCA on a case-by-case basis.

### **4. Safety Assessment**

- 4.1 The design team should engage with the MCA in the early stages of the design to agree the basis of the approval of the safety assessment of a UK nuclear-powered vessel.
- 4.2 Prior to construction, the safety assessment (along with the preliminary plans – see section 2 above) must be submitted to the MCA for review. The MCA may provide further recommendations if needed.



- 4.3 Construction must start only after the safety assessment has received the approval of the MCA.
- 4.4 The safety assessment should contain sufficient information to enable the MCA to perform the evaluation. This should be submitted to the MCA for approval before the construction of a UK nuclear-powered vessel.
- 4.5 The safety assessment and the voyage plan of a foreign nuclear-powered vessel must be notified to the MCA at least 12 months before the arrival of the vessel in United Kingdom waters.
- 4.6 A UK nuclear ship should notify the safety assessment to the government of a visiting country before the arrival of the vessel in the port and should check the particular requirements of that country well in advance.
- 4.7 The basis of the safety assessment should be in line with the principle of risk acceptance and radiation safety in Chapter 1.4 and Chapter 6.1 of the Nuclear Code.
- 4.8 The safety assessment should be a systematic analysis of the safety of the nuclear ship as required by the 2021 Regulations, with particular attention to the matters in Annex 3 of the Nuclear Code. This should cover the design, construction, operation and decommissioning of the ship and its nuclear power plant to provide assurance that there are no unreasonable radiation or other hazards, at sea or in port, to the crew, passengers or public, or to the waterways or food or water resources.
- 4.9 The safety assessment should include a complete description of the quality assurance programme (see section 5).



## **5. Quality Assurance Programme**

- 5.1 A nuclear-powered ship should be designed, constructed, tested, inspected, operated and decommissioned under a Quality Assurance Programme (QAP) (regulation 27 of the 2021 Regulations).
- 5.2 At all stages in the ship's life cycle, there should be a single organisation responsible for the management and control of the overall QAP.
- 5.3 As a precondition to MCA approval for the construction of a nuclear ship, a QAP should be developed by the responsible organisation to the satisfaction of the MCA in line with the requirements of the 2021 Regulations, the Nuclear Code and the commitments made in the safety assessment.
- 5.4 The establishment and implementation of the QAP in relation to the nuclear steam supply system and its interface with the rest of the vessel should follow the basic requirements outlined in appendix 5 to the Nuclear Code and in the IAEA Safety Series No.50-C-QA (as amended).
- 5.5 In the event of a change of responsible organisation, the transfer of responsibility should be made so as to prevent interference with the implementation of the QAP.
- 5.6 The basic responsibility for achieving quality in performing a particular task during the design, manufacturing, commissioning, operation and decommissioning of a nuclear ship, rests with those to whom the task is assigned and not with those seeking to ensure by means of verification that such quality has been achieved.

## **6. Operating Manual**

- 6.1 A fully detailed operating manual should be prepared and continuously updated for the information and guidance of the operating personnel in their duties on all the matters relating to the operation of the nuclear power plant with a particular attention to safety (regulation 14 of the 2021 Regulations).
- 6.2 A nuclear-powered vessel must keep on board a copy of the operating manual approved by the flag administration of the vessel.

## **7. Radiation safety**

- 7.1 The requirements for radiological protection and radioactive waste management are contained in regulation 8(f) (in relation to the design and construction of a nuclear ships) and in regulation 11 (in relation to the operation of a nuclear ship and the protection of persons) of the 2021 Regulations. These provisions make cross-references to particular paragraphs in Chapter 6 of the Nuclear Code and should be consulted carefully.
- 7.2 Arrangements should be made for the prompt recording of information concerning the emergency or accidental release of radioactive substances in excess of recommended limits. This information must be provided immediately to anyone who may be impacted, such as crew, the owner or operator, the flag administration, the responsible organisation, and the authorities of any coastal state likely to be affected (see paragraphs 6.4.12 and 7.4.2 in the Nuclear Code).



## 8. Manning and Training

- 8.1 The minimum number of crew members carried on a nuclear ship to operate the nuclear power plant, as well as their qualifications, must comply with the requirements of the Operating Manual approved by the MCA to ensure that the ship and its nuclear power plant can be safely operated and maintained.
- 8.2 The MCA acknowledge that the operation of the nuclear power plant on board a vessel requires special qualifications and training which are not currently addressed in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). Therefore, the approval of qualifications and training requirements will be considered on a case-by-case basis, taking into consideration the requirements of paragraph 7.6 in Chapter 7 of the Nuclear Code, and, where appropriate, any available training standard related to the specific nuclear technology under consideration.
- 8.3 The MCA may approve special training courses and training providers when further experience of nuclear-powered ships is acquired.
- 8.4 Personnel will have to complete a special training course and examination to the satisfaction of the MCA. The completion of such a course, and passing an appropriate examination, will be reflected in the certificate of qualification. The course curriculum must include, as a minimum:
- 8.4.1 The master and qualified officers should hold certificates commensurate with their duties. They should have successfully completed a special training course approved by the MCA, the curriculum of which includes as a minimum:
- the basic principles of nuclear energy and its application to ships;
  - the particulars of the structure and performance of a nuclear ship;
  - knowledge of the possible consequences of navigational accidents to the ship and to the environment;
  - basic principles of radiation hazards and radiological protection;
  - action to prevent or alleviate postulated emergency situations.
- 8.4.2 Engineer officers should successfully complete:
- the principles of nuclear engineering and nuclear reactor theory;
  - a course in radiation physics, including radiological effects on health and the environment, principles of radiological protection and radiation monitoring;
  - design and operating principles of the nuclear steam supply system (NSSS), its monitoring, control and protection systems;
  - engineered radiation safety features of the ship and of the nuclear power plant (NPP);
  - particulars of the ship's hull structure;
  - detailed study of a NSSS of the type fitted on the ship for which the officer is being trained and study of the Safety Assessment, Operating Manual and operating instructions for the NPP equipment;
  - practical training in start up, shutdown and control of the NSSS, in normal and simulated emergency conditions, including maintenance, checking and survey procedures;
  - principles for the safe operation of NPP including maintenance inspections, surveys, core refuelling and waste management;
  - study of national and international safety requirements applicable to nuclear ships and their NPP.
- the certificate of qualification for engineer officers should record the completion of the special training course and



the chief engineer and qualified engineer officers should hold certificates commensurate with their duties and should be subject to retraining and re-examination for each type of NSSS they may be required to operate;

- all NSSS operators should have successfully completed a special training course approved by the MCA and should hold an appropriate operator's certificate. The degree of detail of course content should be commensurate with the duties of the operator;
- all members of the ship's crew who would undertake specific or general tasks in the event of a radiation accident, should be trained in radiation protection to a level commensurate with the duties they would be expected to perform. This training should be periodically updated and repeated at a frequency sufficient to ensure a continued awareness and understanding of the radiation protection requirements.

8.4.3 The personnel responsible for radiation protection should:

- be trained in radiological protection and dosimetry to a level satisfactory to the MCA;
- have successfully completed a detailed training course approved by the MCA and possess a qualification certificate indicating the types of NSSS and radiation protection equipment for which they have been trained;
- a ship's doctor, if carried, or other medically trained crew member, should have received adequate training in treating the effects of radiation exposure.

8.4.4 Other crew members involved in the operation of the NPP should be given theoretical courses and practical training commensurate with their official duties in the operation of the NPP and their muster list duties, as well as instructions on the use of personal health protection equipment. This training may be given in a training centre or onboard ship by qualified engineer officers. The qualifications of the crew members referred to in this subsection should be to the satisfaction of the MCA.

8.4.5 Crew members not involved in the operation of the NPP should be acquainted with the established procedures for entering controlled areas of the ship and with their muster list duties. They should also be familiar with the measures necessary to ensure their personal protection in the event of accidents resulting in high radiation.

8.4.6 All persons on board, including non-crew members, should have received instruction on health physics and radiation protection procedures before entering the controlled areas of the ship.

8.4.7 The practical training in NSSS control should be carried out on special simulators, or on ship or land-based facilities having NPP installations of the type the trainee will operate. Trainees should, without assistance, perform a sufficient number of reactor start ups and shutdowns to demonstrate to the satisfaction of the MCA their competence to suitably control reactor operation under all PPCs.

8.4.8 Appropriate officers and NSSS operators should be regularly retrained, to update their qualifications in theory and in the safe operation of the NPP. The frequency and level of re-qualification training should be to the satisfaction of the MCA.

8.4.9 The qualifications and skills of crew members, in performing their assigned duties, should be exercised and improved by carrying out ship emergency and radiation alarm drills to the satisfaction of the MCA. The radiation alarm drills should simulate the probable damage and consequences of postulated accidents involving the NPP.





## 9. Ports

- 9.1 A nuclear-powered ship may be subject to special control before entering a UK port, and during the visit, to verify the presence on board of a valid nuclear ship safety certificate, and to ensure there are no unreasonable radiation or other hazards at sea or in port, to the crew, passengers or public, or to the waterways or food or water resources.
- 9.2 Duties of ports will be set out in a revised version of the Port Marine Safety Code and the Guide to Good Practice on Port Marine Operations, taking into consideration the safety of the port and emergency response before allowing the entry of a nuclear-powered ship.
- 9.3 The Port Marine Safety Code has been developed to improve safety in the port marine environment and to enable organisations to manage their marine operations to nationally agreed standards. It provides a measure by which organisations can be accountable for discharging their statutory powers and duties to run harbours or facilities safely and effectively. It also provides a standard against which the policies, procedures and performance of organisations can be measured.

## 10. More Information

- 10.1 For more information contact [infoline@mcga.gov.uk](mailto:infoline@mcga.gov.uk) quoting the team: Future Propulsion and Fuel Safety within the Ships Standards department of the MCA.

### More Information

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Published: Insert December 2020  
Please note that all addresses and  
telephone numbers are correct at time of publishing

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