RUSSIAN MARITIME REGISTER OF SHIPPING

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RULES

FOR THE CLASSIFICATION AND CONSTRUCTION OF NUCLEAR SHIPS AND NUCLEAR SUPPORT VESSELS

PART IX

RADIATION SAFETY

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RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF NUCLEAR SHIPS AND NUCLEAR SUPPORT VESSELS

Rules for the Classification and Construction of Nuclear Ships and Nuclear Support Vessels developed by Russian Maritime Register of Shipping (RS, the Register) have been approved in accordance with the established approval procedure and come into force on 1 October 2022.

The present edition is based on the 2022 edition of the Rules for the Classification and Construction of Nuclear Ships and Floating Facilities and on the 2017 edition of the Rules for the Classification and Construction of Nuclear Support Vessels, taking into account Circular Letters No. 110-312-1-1695c dated 04.02.2022 and No. 110-312-1-1702c dated 14.02.2022, amendments and additions developed immediately before publication.

The Rules set down specific requirements for the nuclear ships, nuclear support vessels and supplement the Rules for the Classification and Construction of Sea-Going Ships and the Rules for the Equipment of Sea-Going Ships of Russian Maritime Register of Shipping.

The Rules are published in the following parts:

Part I "Classification";

Part II "Safety Standards";

Part III "Hull";

Part IV "Stability. Subdivision";

Part V "Fire Protection";

Part VI "Nuclear Steam Supply Systems";

Part VII "Special Systems";

Part VIII "Electrical and Automation Equipment";

Part IX "Radiation Safety";

Part X "Physical Security".

REVISION HISTORY

(purely editorial amendments are not included in the Revision History)

For this version, there are no amendments to be included in the Revision History.

1 GENERAL

1.1 Facilities for protection against radioactive radiation and emissions of radioactive materials, RM systems, equipment of new fuel assemblies, irradiated fuel assemblies and radioactive waste storage facilities shall be subject to technical supervision by the Register.

1.2 Technical documentation on the RS equipment and systems subject to technical supervision by the Register is specified in Section 3, Part I "Classification".

1.3 Definitions and explanations relating to adopted abbreviations and terms are given in Part I "Classification".

2 RADIOLOGICAL PROTECTION

2.1 The controlled and supervised areas shall be enclosed on board the nuclear ship and nuclear support vessel[1] according to actual and potential radiation hazards. Warning sign shall be placed near the entrance to the controlled area and supervised area, where necessary.

To prevent contamination transfer into unrestricted area decontamination station shall be positioned between the controlled area and adjacent compartments, and shall be used as an entrance to the controlled area. Decontamination station shall be provided with the clothes changing facilities, dose control facilities for people and overalls and washing equipment. Access to the supervised area spaces shall be allowed through special purpose sanitary space in case of radioactive contamination.

2.2 The controlled area spaces shall be subdivided into categories as regards probability and level of radioactive contamination.

Air vacuum in the spaces (or groups of spaces), air humidity, temperature and number of air changes shall be provided by the ship's special ventilation system and shall be consistent with the national sanitary rules in force.

2.3 No machinery of the ship systems as well as fittings serving the systems may be located in the controlled area. Where such machinery and equipment shall be placed outside the machinery spaces for serving the remote-controlled area spaces, a special compartment shall be enclosed outside the controlled area. The compartment shall have a separate entrance from the upper deck and shall be provided with independent fittings.

2.4 The controlled area spaces where radioactive contaminations may occur, radioactive media and waste storage facilities shall be arranged within the collision protection in a single block, if possible to facilitate maintenance of machinery and equipment inside as well as transportation of equipment, materials and radioactive waste.

2.5 The minimum equipment necessary shall be installed in the controlled area spaces. The arrangement of equipment, pipes, cable runs shall not prevent proper decontamination of hull structures and equipment itself. The number of transit pipes, cables and other services through these spaces and their length shall be kept to a minimum, and they shall be laid in sealed corridors, linings or conduits.

Penetrations of these routes and pipelines in bulkheads enclosing the controlled area shall be sealed.

2.6 Machinery and equipment not suitable for decontamination shall be easily replaceable. Arrangement for covering these machinery and equipment during operation or general decontamination of spaces shall be envisaged.

2.7 Controlled area spaces where decontamination solutions and washing water may stagnate shall be of simple configuration without recesses and projecting parts, if possible. Bulkhead stiffeners shall be fitted from the side of less likely contaminated spaces. Comers of hull structures shall be rounded. Surfaces and welded joints shall have roughness of not lower than Ra 3.2.

2.8 Foundations, machinery and equipment attachments in the controlled area spaces where radioactive contaminations occur shall be designed to ensure access to all surfaces of foundations/their attachments for decontamination.

Foundation spaces inaccessible for decontamination shall be sealed.

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[1] Hereinafter referred to as "the NS vessels".

2.9 The controlled area spaces shall be equipped with system for collecting radioactive material leakages from the place of their possible formation and discharging to the special tank for collecting radioactive material leakages, equipped with water presence signaling devices of lower and upper levels.

2.10 Controlled area spaces shall have emergency escape route to the open deck.

2.11 Where the lift is available in the controlled area, an exit to the lift trunk shall be provided on each deck.

2.12 All controlled area spaces where radioactive contamination may occur under normal operation shall be located inside the shielding barrier.

2.13 To ensure RS along with the shielding barriers (refer to 2.2, Part II "Safety Standards"), SSS, storage facilities for irradiated fuel assemblies, SRW, LRW and gaseous radioactive waste and other possible radioactive sources (pipes, machinery, equipment, etc.) shall be provided with biological shielding.

Biological shielding for spaces and individual equipment shall be calculated on the basis of the maximum radiation level possible for the particular space or equipment, using the magnitudes specified in the national sanitary rules and state radiation safety standards.

To reduce radiation exposure, along with biological shielding time of exposure, distance to radiation source as well as personal protective equipment shall be used.

2.14 Radiation protection shall be provided in any part of the ship.

2.15 The design of the biological shielding shall provide a possibility to perform the survey of the equipment and docking repair operations with the reactor stopped.

2.16 Biological shielding shall be provided for spaces containing the LRW tanks, new fuels assemblies, irradiated fuel assemblies and SRW storage facilities. The LRW tanks, new fuel assemblies, irradiated fuel assemblies and SRW storage facilities shall be located in the special controlled area spaces, accommodation and service spaces shall be segregated from the controlled area by process spaces. Double bottom tanks located below irradiated fuel assemblies, LRW and SRW storage facilities are not allowed to be used for potable and washing water storage. The said tanks can be used for storage of ballast water or fuel. The storage facilities and tanks shall be surrounded by cofferdams.

2.17 The LRW tank cofferdams shall be provided with an independent heating system. Where steam heating is used, condensate collection and storage shall be separated from vessel's general systems to the tank of collecting radioactive material leakages. The design of heating, collection and storage systems shall exclude the medium release into the ship's spaces and environment. Corrosion-resistant materials shall be used for the manufacture of the heating system. Heating elements installation inside the tanks is not allowed.

2.18 Systems shall be provided to supply fresh air to pressure suits and helmets. Air shall be supplied via two independent ventilation units including the stand-by one. The redundant ventilation unit shall be capable of automatic activation in case of failure in the main ventilation unit.

2.19 The NS vessels intended for reactor cores loading/unloading or only for irradiated fuel assemblies and new fuel assemblies reception, storage and discharge shall be fitted with trim and cross-flooding systems and fittings to maintain equilibrium of the vessel during handling operations.

2.20 The NS vessels intended for reactor cores reloading, new fuel assemblies, irradiated fuel assemblies and radioactive waste transportation and storage shall have the main handling operations control room.

The main handling operations control room shall be provided with the following:

.1 visual and audible water level indication in the irradiated fuel assemblies storages and tanks;

.2 thermal control instruments for irradiated fuel assemblies storages and heat-exchange equipment;

.3 position indicators for pipe fittings of special systems;

.4 means for operation signalling of electric pumps and heat exchangers of special systems and monitoring of their parameters;

.5 means for water presence signalling in the bilge wells of the special bilge system in the controlled area spaces;

.6 RM information means for vessel spaces, open decks, ventilation exhaust outlets of the controlled area ventilation system and places of possible uncontrolled release of radioactive gases or aerosols;

.7 alarms operating in case of emergency in the new fuel assemblies and irradiated fuel assemblies storage spaces;

.8 alarm signals for personnel evacuation from the dangerous area;

.9 information means for controlled area ventilation operation and vacuum in the spaces with indication of fan operation and valve positions;

.10 means for two-way communication with the ship machinery space, valve control station, new fuel assembly preparation room and main work places in the controlled area, including positions from where cargo cranes operating with new fuel assemblies and irradiated fuel assemblies;

.11 means for two-way communication with the station from where repairs of the served ship are controlled;

.12 telemonitoring system for the controlled area spaces where potentially hazardous works are performed as well as for new fuel assemblies and irradiated fuel assemblies storage spaces.

All control, monitoring and signalling equipment in the main handling operations control room shall be combined on special panels which, in addition to the main electrical power supply, shall be fed from emergency sources of electrical power to be automatically connected.

2.21 The pipes in the sealed spaces to discharge water from the bilge wells shall be fitted with shutdown devices with position indicators, the information being displayed on a control panel in the main handling operations control room.

2.22 The controlled area spaces where aerosols might arise shall have closing devices capable to provide their tightness. The closing devices shall be fitted with "open-closed" position indicators, the information being displayed on a control panel in the main handling operations control room. Every opening shall be numbered.

2.23 Cargo handling gear in the controlled area spaces shall be of an enclosed design and meet the requirements of the Rules for the Cargo Handling Gear of Sea-Going Ships[1].

When performing crane operations with new fuel assemblies and irradiated fuel assemblies, cargo handling gear designed for nuclear material shall be used. The cargo handling gear shall ensure safe movement of cargo within speeds, accelerations, and vertical and horizontal movements as per its design.

Access to the cabin shall be from a space outside the controlled area.

2.24 On the NS vessels provision shall be made for reception of pure process media (water, steam, gases) from the outside and their discharge to the served ship or to the shore.

2.25 Integrity and leak tightness testing shall be designed for systems and facilities without putting the ship out of service.

2.26 In order to remove radioactive contamination, provision shall be made for decontamination facilities of all the controlled area spaces, equipment installed therein as well as of the ship's hull, including its outer surfaces. Structure material as well as coatings and paintings of the controlled area spaces and equipment where radioactive contamination of SC1 and SC2 occurs shall allow multiple decontamination.

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[1] Hereinafter referred to as "the Rules for the Cargo Handling Gear".

2.27 Compartments intended for handling contaminated radioactive substances, fluids, machinery and materials according to the design shall be equipped with local exhaust ventilation in the vicinity of workplaces.

2.28 Layout of the equipment, fittings and valves, laying of pipelines cable routes shall be arranged within the controlled area with regard to their accessibility for maintenance, repair, inspection, decontamination and survey as well as application of protective coatings and covering.

2.29 The structure of ladders, flooring and catwalks shall be such as to enable decontamination.

The scuppers within the controlled area spaces shall be fitted with shut-off valves and allow the water to be completely drained from spaces. Decks within compartments shall be deflected/inclined towards the scuppers.

2.30 The controlled area spaces shall be subdivided into categories as regards probability and level of radioactive contamination.

Air vacuum in the spaces (or groups of spaces), air humidity, temperature and number of air changes shall be provided by the vessel's special ventilation system and shall be consistent with the national sanitary rules in force.

2.31 Where air flows from one space to another, the flow shall be from areas of lower potential airborne contamination to areas of higher potential airborne contamination.

2.32 Air discharged from the controlled area spaces shall be continuously monitored and shall pass through efficient filters.

The controlled area ventilation system shall be designed so as to prevent contamination of the space where people can stay, and accumulation of radioactive substances. Radioactivity of the special ventilation system emissions shall not exceed the rates specified in the national sanitary rules and safety radiation standards.

3 RADIATION MONITORING

3.1 The special-purpose RM system complying with the requirements of Part XI "Electrical Equipment" and Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships[1] and the requirements of this Section shall be provided to record levels of air and surface radiation, contamination and radioactivity of liquids on board the ship.

3.2 The RM systems and/or means shall be designed for radiation process and radiation dose monitoring on board the ship for all states.

The RM system shall provide the following:

.1 monitoring of leak tightness of the fuel element claddings;

.2 monitoring of the primary coolant radioactivity;

.3 monitoring of the secondary and tertiary fluids' radioactivity;

.4 monitoring of fluids' radioactivity in the LRW storage facilities;

.5 monitoring of leakages from the primary to secondary and tertiary circuits and to the spaces;

.6 measurement of intensity of alpha-, beta- and neutron radiation, volumetric activity of gases and aerosols in corresponding spaces of th controlled area;

.7 radiometric analysis of radioactive samples;

.8 indication on high ionizing radiation, contamination and fluid radioactivity;

.9 indication on open access doors to the controlled area spaces and open emergency escape doors;

.10 output of signal for isolating the faulty SG.

3.3 The ionizing radiation detecting units shall be redundant within the controlled area spaces.

Degree of protection shall be not lower than IP57 for the radiation control system sensors and IP23 for the rest of the equipment.

3.4 Recording system shall record and store the following parameters:

.1 radiation doses for people involved in operations within the controlled area and supervised area, where necessary;

.2 ionizing radiation levels on board the ship;

.3 radioactive contamination levels within the attended areas on board the ship;

.4 amounts and activity of radioactive waste being stored on board the ship;

.5 activity of waste being discharged to shore facilities/special-purpose vessels;

.6 volumetric radioactivity of the primary coolant;

.7 data on pre-emergency situation change in radiation situation in case of an accident.

3.5 Data on radiation levels within the controlled and supervised areas, air radioactivity within the containment as well as concentrations of radioactive gas and aerosols being released into environment shall be displayed on the RM system console. The console shall be equipped with indicators for monitoring any increase in radiation level.

3.6 The ship shall be equipped with sufficient portable means of radiation dose monitoring for operation under normal and emergency conditions. This equipment shall include dosimeters for alpha-, beta- and neutron radiation, air sample activity and contamination meters.

3.7 In addition to devices specified in 3.6 and 3.7, the ship may be equipped with laboratory instruments for analyzing radioactive samples that are not subject to supervision by the Register, when automated RM system is used for other purposes.

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[1] Hereinafter referred to as "the Rules for the Classification".

4 HANDLING RADIOACTIVE WASTE. GENERAL

4.1 The design for ship shall envisage safety of crew and passengers and environmentally friendly collection, storage and treatment of radioactive waste before this radioactive waste is further discharged from the ship.

4.2 The SSS design of the nuclear ship shall ensure the minimum formation of radioactive waste.

4.3 The design for the nuclear ship shall include appropriate arrangements for monitoring and handling of SRW, LRW and gaseous radioactive waste being formed during normal operation to minimize its harmful effects on the crew members, passengers, environment and ship.

4.4 When designing and operating the radioactive waste treatment and storage arrangements, the following shall be taken into account:

.1 permissible radioactive levels;

.2 requirement for biological shielding and usage of cooling system;

.3 possible corrosive effects of some radioactive gases and liquids on materials of the containers, pipelines, equipment and fittings;

.4 requirement for radioactive leakage detection;

.5 possible formation of radioactive gases and measures to be taken to reduce effects and prevent combustible gas explosions.

4.5 Capacity of radioactive waste storage facilities shall comply with operating conditions for the ship.

4.6 The design shall ensure preventive measures for radioactive waste discharge from storage facilities into environment and spaces of the ship.

4.7 Storage and transportation facilities as well as pipelines for radioactive waste discharge from the ship shall be designed to prevent any discharge of radioactive substances into environment and other compartments of the ship.

4.8 Technical documentation shall contain criteria for design, manufacture, operation and testing intended for radioactive waste treatment and storage equipment. These criteria shall ensure subdivision of waste by their composition and volumetric radioactivity.

4.9 Radioactive materials shall be arranged within the shielding barrier.

4.10 The amount of radioactive gas being released into the atmosphere under SC1, SC2 and SC3 shall not result in radiation dose for the personnel.

4.11 Containers and pipelines with fittings shall be made of corrosion-resistant materials and alloys intended for multiple decontamination. These materials shall be approved by the Register.

4.12 Pipelines of radioactive fluid transfer systems shall be made of seamless electropolished pipes. Pipelines shall be connected by welding in compliance with the normative documents approved by the Register. Flange or union connections are allowed only where pipelines are connected to the equipment (filters, pumps, separators, tanks).

4.13 Pumps, pipelines and fittings shall have biological shielding, where necessary.

4.14 The foundations and fasteners of the RS system equipment shall prevent its displacement in case of variation in ship's position up to and including capsizing.

4.15 The interior surface of the RS system containers exposed to radioactive fluid and not to be painted shall have roughness not more than R_a = 6,3 μm.

4.16 The distance between piping and systems shall be as such to provide their proper maintenance and survey.

5 SRW HANDLING

5.1 The spent ion-exchange resins and filters as well as different parts (dirty tools, overalls, laboratory kits, etc.) shall be considered as SRW.

5.2 SRW shall be stored and transported in the containers.

The SRW storage shall provide for possible concentration/formation of gases and liquids.

5.3 SRW shall be stored in special storage facilities of stationary type (safe cabinets) and non-stationary type (containers), which shall be located in specially designed spaces.

A special-purpose fixed or transport container shall be provided for storage of changeable or temporarily removable large-sized equipment, if it is required by the core repair or re-loading technology. The container shall be equipped with devices for fixing the transferred equipment inside the container, and heat dissipation and power supply means shall be provided, where necessary.

5.4 The storage space shall have a trunk for loading and unloading containers by outside cargo handling gear or a properly equipped lift. The cargo platform (cabin) of the lift shall be designed so as to prevent the containers or individual loads from sliding when the vessel is rolling, loads from dropping into the trunk or creating obstacles for lift platform movement.

Provision shall be made for access into the lift trunk for its decontamination and repairs.

The requirements of the Rules for the Cargo Handling Gear are fully applicable to the lifts.

The storage space shall be fitted with a cargo handling gear for moving the containers inside the space.

5.5 Stationary storage facilities (safe cabinets) shall be located to minimize the ship list effect on the SRW handling operations, and their doors, when opened, shall not obstruct the passages in the space. The doors or other closing appliances of the spaces shall be fixed in the open position and locked when closed. It is recommended that the doors be fitted in such a way as to be an additional protective shield when works with open storage facilities are in process. Use of guillotine or folding-down doors is not allowed.

It is recommended that higher activity solid waste be stored separately from lower activity waste.

Where the SRW types are segregated according to their activity level, different biological shielding of the storage facilities is allowed. The dosage rate on the storage facilities outer surfaces shall not exceed the values required by the applicable sanitary rules and regulations.

5.5 Each container or box for the SRW storage shall bear identification number affixed to the outer surface. Entrance door of the waste storage space shall be fitted with a position indicator, information being displayed in the main handling operations control room.

5.7 The storage facilities and equipment shall be designed to make decontamination possible.

5.8 The SRW storage facilities and spaces where they are located and where such waste might produce aerosols or radioactive gases, shall have closing appliances capable of providing their tightness. The ventilation system of such storages and spaces, where it is a part of the special ventilation system (refer to Section 7, Part VII "Special Systems"), shall be fitted with aerosol filters.

5.9 Portable containers shall be used for the SRW collection, temporary storage and transfer to the shore or other vessels. The containers shall have reliable fittings for their gripping and carriage, the size of the containers shall allow for their transportation along the routes to be used in the course of handling operations. The container covers shall be securely locked, their design and strength shall provide their integrity under storage conditions.

The containers shall be painted with a warning coating and marked with the standard radioactivity symbol.

Provision shall be made for safe securing of the containers to prevent arbitrary movement and damage of the containers themselves and equipment of the spaces.

Where provision is made for storing the containers on open decks of the ship, any possibility of moisture penetration inside the containers or radioactive particle escape out of them shall be structurally prevented. This refers both to the container structure and structural design of their storage places on board (shelters for the case of bad weather, etc.).

6 LRW HANDLING

6.1 LRW STORAGE FACILITIES

6.1.1 Special built-in tanks (containers) located in the controlled area spaces shall be provided for the LRW reception and storage specially intended for this purpose.

The LRW collection and storage containers shall be designed as free-standing, of welded structure, made of corrosion-resistant materials and the tank bottom slope to the water collector shall provide water discharge under any operating heel or trim of the ship. Their framing, strengthening in support locations, etc. shall be made on the outside.

The roughness of containers interior surface exposed to radioactive fluid and not subject to painting, shall not exceed R_a = 6,3 μm. Supports (foundations) shall enable access for inspection and repairs of tank bottom.

6.1.2 The following shall be taken into account for designing the LRW storage facilities: waste shall be subdivided by their activity and, where necessary, with regard to physical and chemical properties. LRW shall be subdivided into low- and medium-radioactivity waste in compliance with the applicable Sanitary Radiation Safety Rules.

Communication between the medium- and low-radioactive water storage tanks is not allowed.

6.1.3 Tanks for storage of medium-radioactive water shall be made of corrosion-resistant materials suitable for multiple decontamination and washing. At least two such tanks shall be provided on the ship.

Such tanks shall have the necessary biological shielding. Where concrete is used for this purpose, the outer surfaces of the shielding shall be lined with a material allowing its decontamination or replacement.

6.1.4 Tanks for low-radioactive water storage may be made of ordinary constructional materials with subsequent application of anti-corrosive coatings; ship structures and spaces may be used as biological shielding. The efficiency of their protective properties, however, shall be checked by filling the tanks up to the upper level with liquid waste, having the maximum volumetric radioactivity permitted by the national sanitary rules for low radioactive waters.

6.1.5 Liquid radioactive storage facilities shall have:

.1 at least two manholes giving access inside the tanks for cleaning, inspection and repairs;

.2 system for supply inside the tanks and distribution of decontaminating solutions and steam for their heating;

.3 system for washing and discharge of decontaminating solutions and washing water;

.4 collecting wells (water collectors) provided at the bottom of the tanks to minimize non-removable residue of LRW and fitted with the efficient drainage arrangements;

.5 remote level gauging of LRW and audible alarms of the upper and lower levels with information led to the main handling operations control room and valve control station (for the NS vessels);

.6 sampling device;

.7 tank ventilation system (air pipes);

.8 system for the LRW overflow from the tanks;

.9 devices to prevent inadmissible pressure increase in the tanks, where operationally necessary;

.10 systems and/or means of removing sediments upon emptying the tanks and regular removal of contamination in the LRW containers.

Drainage pipe shut-down valves shall be installed either on the tanks directly or (in case biological shielding is provided) on the branch pipes of adequate strength.

The tanks shall be protected from spontaneous emptying in case of filling or other pipes damage because of process water ejection due to a "syphon" effect.

6.1.6 Valves shall be installed directly on the tanks in readily accessible places; they shall be of bellows type with branch connections to be welded, and shall be remote controlled. Stainless steel trays shall be provided in the fitting installation area or barriers shall be fitted on the deck (platform) plating to collect leaks in case of bellows damage.

Where valves are locally controlled, they shall have biological shielding.

The valves shall be provided with local position indicators and signal devices with extreme position indicators in the main handling operations control room and valve control station.

6.1.7 Tanks permanently or periodically operating under internal pressure shall be subjected after manufacture and then after installation on board the ship and connection of pipes to a hydraulic test according to the requirements of Part X "Boilers, Heat Exchangers and Pressure Vessels" of the Rules for the Classification.

The tanks operating under hydrostatic pressure shall be subjected after manufacture and then after installation on board and connection of pipes to hydraulic tests as required by Part II "Hull" of the Rules for the Classification. The structural strength of the LRW tanks shall be provided, in case of their filling-up to the top of air or overflow pipes, with a safety factor equal to 1,5.

6.1.8 The LRW storage tanks shall be fitted with air pipes made of corrosion-resistant materials. The air pipes from the medium-radioactive LRW tanks shall be led from the top part of the tanks to the space where they are located or to a higher category space (in terms of the existing or anticipated radioactive contamination), if any. The air pipes from the low-radioactive LRW tanks shall be led to the ventilation mast through the special ventilation system. Where special ventilation system is not installed, the air pipes of the low-radioactive LRW tanks shall be led to the open deck. In this case, the ends of the pipes shall be as high and as far as possible from the accommodation and service spaces, from the control station machinery spaces and air intakes of the ship's ventilation system. Several air pipes may be combined into one pipe, the diameter of which shall be increased accordingly. In such case, however, any possibility of the LRW overflow from one tank into another shall be prevented. An exception is made for a special overflow tank, if any, which is covered by the requirements of 6.1.8 and 6.1.9. Air pipes of the medium- and low-radioactive LRW storage tanks shall not be combined. Connections of air pipes with tanks and air pipes between themselves shall be welded. Pressure/vacuum valves shall be fitted on the outlets of the air pipes of the LRW storage tanks irrespective of their volumetric radioactivity and adequate RM shall be provided. Low-radioactive LRW storage tanks provided their air emissions in the opinion of the competent sanitary authorities are not unacceptable for, the environment may be exempted from the latter requirement. No shut-off means (except the cases referred to in 6.1.10) are allowed on the air pipes.

6.1.9 In addition to the air pipes, the LRW storage tanks operating only under hydrostatic pressure shall be fitted with an overflow system for the LRW collection and discharge when the main tanks are overfilled. The system shall comply with the requirements of Part VIII "Systems and Piping" of the Rules for the Classification.

Several overflow pipes may be combined into one pipe with an appropriate increase of the diameter. In this case, however, the LRW overflow from one tank to another through the overflow system, when one of the tanks is overfilled or at a heavy list of the vessel, is not allowed. A separate tank shall be available and provided with biological shielding, where necessary, for medium-radioactive LRW overflow from the tanks through an independent system. It can be located in the same space where the medium-radioactive LRW storage tank

is arranged. Air pipes of different radioactivity LRW overflow tanks located within one watertight compartment may be combined with air pipes of the appropriate tanks.

The overflow system from each LRW storage tank shall be provided with a device signalling the LRW overflow. The device shall be of adequate strength or shall be protected from possible damages. In addition to the signalling means required by Part VIII "Systems and Piping" of the Rules for the Classification, the overflow tank shall be provided with a low-level alarm for the case referred to in 9.5, Part VII "Special Systems" of the Rules for the Classification and Construction of Nuclear Ships and Nuclear Support Vessels[1]. All indications and alarms shall be led to the main handling operations control room and valve control station.

6.1.10 Shut-off valves of a bellows type having remote control and local position indicators with the information being displayed in the main handling operations control room and valve control station shall be fitted on the air pipes of the LRW storage tanks where an excessive pressure is likely to arise. The valves shall be permanently open and to be closed only in the course of handling operations that involve a pressure increase in the tanks.

It is recommended that these valves be interlocked with fittings for compressed air (gas) supply to the tanks to squeeze LRW out of the tanks, thus preventing air (gas) supply into the tanks when the valves on the air pipes are open. The excessive air shall be discharged either into the space where the tanks are located or directly into the exhaust part of the special ventilation system equipped with filters providing the required cleaning effect.

The tanks shall be protected against an inadmissible pressure increase. Where the tank structure and protection device (refer to 6.1.5.9) fail to prevent active water ejection in the course of handling operations, the excessive air (or air-water mixture) shall be discharged into a special drain tank or another insulated tank.

6.1.11 The requirements of Part VIII "Systems and Piping" of the Rules for the Classification are also applicable to the LRW storage tanks and their air and overflow pipes.

[1] Hereinafter referred to as "these Rules".

6.2 EQUIPMENT FOR LRW TREATMENT OF NS VESSELS

6.2.1 In addition to the tanks and containers indicated in 6.1, referred to the equipment of the LRW treatment are separators, mechanical and ion-exchange filters, evaporators, cementing tanks and pumps with their fittings, instrumentation and control devices.

6.2.2 Tanks used as supply, collecting and other tanks in the LRW treatment system shall have rounded corners, conical or elliptical bottoms, medium agitators and mechanical appliances for cleaning bottom surfaces from residues.

6.2.3 Equipment for the LRW treatment containing radioactive media shall be isolated with shields to prevent direct streaming of radiation. The shields shall be easily detachable and shall not interfere with control and maintenance of the equipment.

6.2.4 Equipment for the LRW treatment refers to the third class of safely according to the requirements of Section 5, Part II "Safety Standards".

6.2.5 Equipment for the LRW treatment shall withstand loads with acceleration $3g$, remain in operation with a heel up to 15° either side and a trim 5°.

6.2.6 Valves of the systems and equipment for the LRW treatment shall be of the bellows type, made of corrosive-resistant materials, have local manual control as well as local position indicators and symbols in line with those on the control panel. Identification plates with font not less than 10 shall be made of a corrosive-resistant metal.

6.2.7 The LRW treatment pipe joints shall be welded, and appropriate measures shall be taken to ensure full penetration of the weld root. Other types of joints are subject to agreement with the Register.

6.2.8 Evaporators used in the LRW treatment shall be capable of providing the quantity and purity of the condensate produced as required by the technical documentation approved by the Register. The outer surfaces of the evaporators with operating temperature of 60 °C and over shall be thermally insulated.

6.2.9 Design of equipment for the LRW treatment shall provide the performance of internal survey using remote control means.

6.2.10 Pumps used for the LRW treatment shall be made of corrosion-resistant metals and have waterproof construction.

6.2.11 Tanks for keeping cementing components shall provide their storage in a dry and bulk condition.

Connecting elements for filling the tanks and cementing tanks shall ensure tightness of connections.

6.2.12 The construction of the cementing tanks and agitators shall allow for their cleaning from cementing mortar.

6.2.13 Complex of the LRW treatment equipment shall include laboratories for chemical and radiological analyses.

6.2.14 Design of the LRW treatment equipment complex shall include a document on analysis of likely emergency situations and failures of the equipment, their consequences and measures of response.

7 HANDLING OF GASEOUS RADIOACTIVE WASTE

7.1 All escape routes for gaseous radioactive waste shall be monitored.

7.2 Radioactive gases and aerosols shall be discharged into environment through the pipelines and vent ducts meeting tightness requirements and fitted with radioactivity filtering and monitoring equipment.

7.3 Gaseous radioactive waste may be compressed and stored, provided that pressure vessels and appropriate pipelines meet the requirements of these Rules.

Radioactivity risks shall be analyzed in the design in case of depressurization of the cylinder containing gaseous radioactive waste.

7.4 The total volumes and radioactivity levels of aerosols and gases being discharged into the atmosphere shall be continuously and progressively monitored. These parameters shall not exceed the standards as specified in the Sanitary Radiation Safety Rules.

7.5 Gaseous radioactive waste discharge lines shall be fitted with automatic, remote and local shutdown means to prevent uncontrolled discharge.

8 FUEL ASSEMBLIES STORAGE FACILITIES OF REACTOR CORES

8.1 NEW FUEL ASSEMBLIES STORAGE FACILITIES

8.1.1 Where provision for new fuel assemblies storage is made on board ship, an appropriate space shall be fitted with racks for new fuel assemblies storage, as well as with fittings for installation and secure fastenings of transport containers with new fuel assemblies.

8.1.2 Racks and transport container fixing devices with new fuel assemblies shall exclude a possibility of their movement due to lists or trims of the ship, including capsizing.

8.1.3 It is not recommended to lay pipes through the storage spaces for new fuel assemblies if those pipes do not serve these spaces. If laying of such pipelines is necessary, they shall not have detachable joints within the storages. Laying steam pipes in the new fuel assemblies storage spaces is not allowed.

The new fuel assemblies storage spaces shall be equipped with a bilge system. It is recommended that an independent bilge (stripping) system be installed.

8.1.4 The storage space for new fuel assemblies shall be provided with a properly equipped assemblies condition incoming control station and a station for preparation of new fuel assemblies for process operations. These stations shall have two-way communication with the handling operations control room and the station from where repairs of the served ship are controlled.

The equipment of incoming control station for new fuel assemblies shall check the compliance of new fuel assemblies with the manufacturer's specifications.

8.1.5 Transport-handling appliances in the storage spaces for new fuel assemblies shall prevent damage of containers with new fuel assemblies or the assemblies themselves in the course of handling operations.

8.1.6 Appliances to be used for heating of the storage spaces for new fuel assemblies shall prevent air temperature and humidity rising above the values specified in the requirements for new fuel assemblies storage conditions.

8.1.7 The storage space shall be equipped with a permanent spontaneous chain reaction alarm system and technical means of ensuring radiation and nuclear safely.

8.2 IRRADIATED FUEL ASSEMBLIES STORAGE FACILITIES

8.2.1 Where irradiated fuel assemblies may be stored on board a ship, the following shall be provided:

.1 special storage facilities of adequate capacity, having fittings for fixing the covers. The main items of irradiated fuel assemblies storage facilities (covers, plugs, etc.) shall be unified, and these items shall be properly marked to identify the particular set they belong to. Closures of individual cells (boxes, holders) as well as those of every section and the whole storage facility shall be equipped with stoppers to prevent them from spontaneous opening in case of the ship motions.

Storage facilities shall have radiation protection that reduces an equivalent dose power on exposed surfaces to the values set by the requirements of normative documents of the current sanitary legislation;

.2 devices for directing and accurate placement of each individual irradiated fuel assembly of the core in the box cell or storage facility holder;

.3 devices for irradiated fuel assemblies boxes safe loading and unloading from storage facilities and transfer thereof to the shore transport means or special vessels;

.4 an independent storage facility or section with appropriate equipment to receive and store emergency irradiated fuel assemblies. If storage of such irradiated fuel assemblies is provided, the storage facility shall be fitted with a separate exhaust ventilation duct. Design provisions shall be made to prevent such space from flooding it with water;

.5 possibility to carry out radiation-hazardous handling operations with irradiated fuel assemblies in the ship's spaces isolated from the environment. It is recommended that an alarm for seal failure of the spaces be installed.

The design shall be such as to prevent any possibility of uncontrolled release of radioactive gases and aerosols during loading or unloading of irradiated fuel assemblies to/from storage facilities. Provision shall be made in storage facilities for local air sampling to measure specific radioactivity of radioactive gases or aerosols.

8.2.2 Irradiated fuel assemblies storage facility shall be suitable for storage of all core rods. Sectional storage facilities (for several sets of the core rods) are allowed.

The design of the top plates of the storage facility closures shall allow for their partial opening. Furthermore, to reduce a combined radiation level in the course of handling operations with irradiated fuel assemblies, provision shall be made inside the storage facility for a cover for each individual irradiated fuel assembly or groups of irradiated fuel assemblies in case several irradiated fuel assemblies are supposed to be kept in one box.

The design of irradiated fuel assemblies storage facilities shall provide nuclear and radiation safely and prevent spontaneous nuclear chain reaction under any possible conditions of irradiated fuel assemblies storage. Biological shielding of storage facilities shall provide radiation protection in case they are loaded with the irradiated fuel assemblies of the highest radioactivity.

8.2.3 Irradiated fuel assemblies storage facilities shall be made of stainless steel. The interior surface coatings of storage spaces and equipment shall allow for multiple decontamination thereof.

The design of irradiated fuel assemblies storage facilities and their equipment shall provide a possibility for their drainage, periodical internal examinations and necessary repairs.

8.2.4 Where irradiated fuel assemblies shall be stored under continuous residual heat dissipation conditions, a triple-circuit cooling system shall be provided. The primary and secondary cooling circuits shall be closed. In case of sectional storage facilities, heat dissipation shall be provided from each section separately. High-purity process water shall be used as a heat-dissipation medium in the irradiated fuel assemblies cooling circuit and

intermediate circuit. The intermediate circuit heat carrier may be cooled in heat exchangers cooled with sea water by ship's general-purpose means.

Standby heat dissipation means shall be provided in the irradiated fuel assemblies cooling circuit and intermediate circuit. Both main and standby heat dissipation means for the irradiated fuel assemblies cooling circuit shall be supplied with electrical power from the main and emergency sources of electrical power. Continuous monitoring of heat carrier radioactivity in the irradiated fuel assemblies cooling circuit and at least periodical monitoring of heat carrier radioactivity in the intermediate circuit and sea water at the heat exchanger outlet shall be provided.

Means shall be provided in the heat dissipation system for water cleaning from mechanical impurities and radioactive contamination. Fittings installed directly on storage facilities shall be remote controlled and have position indicators with displaying the information on their position in the main handling operations control room and in the valve control station. Where provision is made for local control of the fittings they shall have an appropriate biological shielding. The fittings used shall have signal devices and local indicators of their position.

8.2.5 Irradiated fuel assemblies storage facilities shall be provided with a process water sectional flooding system, a bilge system and an independent ventilation system with air intake from under the closures (upper plates) of the storage sections to prevent water from being entrained into the ventilation system (refer to 7.15, Part VII "Special Systems").

8.2.6 The capacity of the equipment (pumps, heat exchangers, etc.) serving the systems of the irradiated fuel assemblies storage facilities shall be based on the calculation with regard to possible design accidents. The storage flooding or emptying rates shall be proved.

8.2.7 Where irradiated fuel assemblies are loaded directly into the storage facility (section, container) filled with water, the storage facility shall be fitted with an overflow system for water excess being overflowed into a special overflow tank to be installed according to 6.1 and equipped with air pipes of an adequate cross-sectional area and continuously operating remote level indicators with information being displayed in the main handling operations control room. The overflow tank capacity shall be proved by calculation. The tank may be located outside the storage space. In such case the overflow pipes and the tank shall have biological shielding.

It is allowed to provide one overflow tank for all sections of the irradiated fuel assemblies storage facility. In this case, however, its capacity shall be increased, and any possibility of water overflow from one section to another through the overflow tanks shall be prevented.

Air pipes of the overflow tank shall comply with the requirements of 6.1.8.

8.2.8 The water shall be pumped out of the irradiated fuel assemblies storage facility (or section thereof) or overflow tank by means of electrically driven pumps of watertight construction or other means preventing radioactive water leaks. Where such means can operate only if filled with water, provision shall be made for interlock of their starting in case no water is available in the pumps and stopping upon reaching the lower water level in the irradiated fuel assemblies storage facilities. A possibility of inadvertent process water drainage and storage facility emptying in case of any pipe damage because of process water ejection shall be prevented.

8.2.9 Every section of the irradiated fuel assemblies storage facility (in case of a sectional design) shall be fitted with a heat monitoring system and continuously operating remote process water level indicator with entire level range visual, and upper and lower level audible signalling with information led to the main handling operations control room and the valve control station.

The heat-monitoring system and level-indication system shall be designed so as to allow for repairs and component replacement without emptying the section.

For direct supervision of the handling operations a properly shielded position fitted with two-way communication with the main handling operations control room and the station from where repairs of the served ship are controlled shall be provided in the storage facility space.

8.2.10 Upon manufacture and installation on board, the overflow tank of the irradiated fuel assemblies storage facility and systems serving the tank shall be tested for integrity and leak tightness.

Trays made of stainless steel or an appropriate barrier on the deck plating shall be placed under the fittings installed. All pipe connections and fitting-to-pipe connections shall be welded.

8.2.11 Irradiated fuel assemblies shall be loaded into a storage facility (section) through a special arrangement enabling to coordinate and mate the axes of the transfer container and holders (box cells) in the storage facility plates.

8.2.12 Provision shall be made for an expansion tank for priming of the heat dissipation system of irradiated fuel assemblies storage facilities, replenishing the leaks and heat expansion compensations.

8.2.13 The sea cooling water for heat dissipation from the secondary circuit coolant of the storage facility cooling system shall be supplied from at least two independent sea valves. Provision shall be made for sea cooling water supply when the ship is docked. In order to prevent the secondary-circuit coolant from supercooling at low sea water temperatures, provision shall be made for its recirculation, i.e. partial discharge of the sea water into the intake sea valve trunk.

Twin mechanical strainers, one of which shall be in operation, shall be provided in the sea water system.

Use may be made of the sea cooling water from the ship system, provided it meets the requirements of this para and has an adequate capacity reserve.

8.2.14 A special container properly protecting the personnel against penetrating radiation shall be provided for irradiated fuel assemblies transfer from the nuclear reactor into the irradiated fuel assemblies storage facility on board the NS vessel. The container shall be designed so as to allow for its control during irradiated fuel assemblies unloading from the nuclear reactor and prevent irradiated fuel assemblies from open transfer.

8.2.15 The design of non-fixed handling equipment working in conjunction with vessel's machinery and arrangements (containers, temporary storage facilities, essential rigging, etc.) is subject to review by the Register during design and manufacture from the perspective of its operation and RS. Places for permanent or temporary storage of heavy handling equipment shall be adequately strengthened, provided with arresting or other fixing devices and biological shielding, where necessary.

9 FUEL ASSEMBLIES HANDLING EQUIPMENT COMPLEX

9.1 The requirements of this Chapter cover the handling equipment for new fuel assemblies and irradiated fuel assemblies of the reactor plant.

9.2 For each type of the reactor plant, handling equipment shall be developed, fitted with the technical means excluding possibility of nuclear or radiation accident in the course when dismantling and installing the reactor equipment, when unloading and loading the fuel.

The complex shall include the following equipment:

.1 operating floor;

.2 machine tool for cutting core rod liner welds, resistance thermal elements, thermo-electrical and core rod liner cutting converters;

.3 three-operation handling container;

.4 movement control mechanism with a support;

.5 gripping device for extraction of compensation group rod lengtheners and pins;

.6 device for locking a compensating group;

.7 device of unloading of ionization chamber suspensions;

.8 device for tightening and untightening nuts for the pressure flange securing and shifting of the flange and reactor cover;

.9 pumping station;

.10 device for checking compensating group travels and forces;

.11 gripping device for placing and fixing rod-type fuel assemblies;

.12 gripping device for loading new fuel assemblies;

.13 measuring device;

.14 device for welding of core rod liners, resistance and platinum thermometers;

.15 inspection device;

.16 control and monitoring system of machinery actuator drives;

.17 container for storage, transportation and placement of a neutron source.

9.3 The handling equipment shall ensure safety of personnel and environment when handling fuel assemblies. The current radioactive irradiation norms shall not be exceeded in the course of handling operations of fuel assemblies. Integrity of the cores and fuel assemblies shall be maintained during handling.

9.4 In the course of handling, core or fuel assemblies heat shall be removed.

9.5 Provision shall be made in the handling equipment for reliable gripping of the removable shield with the core or without it or fuel assemblies, their extraction out of the reactor, sealing of the shield with or without the core in the container and sealing of the container with irradiated fuel assemblies.

9.6 Cargo handling gear of the handling equipment complex shall comply with the requirements of the Rules for the Cargo Handling Gear.

Duplication of electrical power supply and redundancy of the control channels shall be provided.

9.7 The materials used for handling equipment components affected by radioactive contamination shall be suitable for multiple decontaminations.

9.8 The instrumentation used in handling equipment shall meet the requirements of Part VII "Machinery Installations" of the Rules for the Classification.

9.9 Hydraulic tests of the handling equipment shall be carried in accordance with the requirements approved by the Register.

9.10 Survey of the handling equipment during its manufacture shall be carried out in compliance with the provisions of the Guidelines on Technical Supervision during Construction of Nuclear Ships and Floating Facilities, Nuclear Support Vessels and Manufacture of Materials and Products.

9.11 The scope of technical design documentation of the fuel assemblies handling equipment complex is given in 3.4, Part I "Classification".

Russian Maritime Register of Shipping

Rules for the Classification and Construction of Nuclear Ships and Nuclear Support Vessels
Part IX
Radiation Safety

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