



**Dismantlement of nuclear facilities
decommissioned from the Russian navy:**
Enhancing regulatory supervision of nuclear and radiation safety



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Regulatory supervision of nuclear and radiation safety during dismantlement of facilities from Russian Navy. Enhancing regulatory control, nuclear safety and radiation protection, environmental protection

Abstract:

The availability of up to date regulatory norms and standards for nuclear and radiation safety, relevant to the management of nuclear legacy situations, combined with effective and efficient regulatory procedures for licensing and monitoring compliance, are considered to be extremely important. Accordingly the NRPA has set up regulatory cooperation programs with corresponding authorities in the Russian Federation. Cooperation began with the civilian regulatory authorities and was more recently extended to include the military authority and this joint cooperation supposed to develop the regulatory documents to improve supervision over nuclear and radiation safety while managing the nuclear military legacy facilities in Northwest Russia and other regions of the country.

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Emneord:

Regulatory supervision of nuclear and radiation safety during dismantlement of facilities from Russian Navy. Enhancing regulatory control, nuclear safety and radiation protection, environmental protection

Resymé:

Tilgjengeligheten på oppdaterte regulerende normer og standarder for kjernesikkerhet og strålevern som er relevante for forvaltningen av atomarven etter den kalde krigen, kombinert med effektive lisensieringsprosedyrer og overvåking er svært viktig. Statens strålevern har hatt samarbeid med ulike tilsynsmyndigheter i Russland. Samarbeidet begynte med de sivile myndighetene og ble senere utvidet til å inkludere også den militære myndighet. I samarbeid utvikles det regulerende dokumenter for å forbedre tilsyn av kjernesikkerhet og strålevern for å avvikle de nukleære militære anlegg i Nordvest-Russland og andre regioner av landet.

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Dismantlement of nuclear facilities decommissioned from the Russian navy:

Enhancing regulatory supervision of nuclear and radiation safety

Cooperation between the Directorate of State Supervision over Nuclear and Radiation Safety, Ministry of Defense of the Russian Federation (DSS NRS) and Norwegian Radiation Protection Authority

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Abbreviations

NPS	Nuclear-Powered Submarine
NS	Nuclear Service
STB	Shore Technical Base
VMF	The Navy
SRC	State Research Centre
GRW	Gaseous Radioactive Waste
LRW	Liquid Radioactive Waste
SZ	Supervised Zone
RAZ	Restricted Access Zone
IRS	Ionizing Radiation Source
ITRA	Integrated Technical and Radiological Assessment
RF MoD	Russian Federation Ministry of Defense
ICES	International Centre for Environmental Safety, Minatom (Ministry of Nuclear Energy), Russia
PG	Procedural Guidelines
LLW	Low-Level Radioactive Waste
IMMI	Institute of Industrial and Marine Medicine
NIKIET	Research and Development Institute of Power Engineering
SS	Surface Ships
NRPA	Norwegian Radiation Protection Authority
SEC NRS	Scientific and Engineering Centre for Nuclear and Radiation Safety
NPF	Nuclear Power Facility
VLLW	Very Low-Level Waste
SFA	Spent Fuel Assembly
SNF	Spent Nuclear Fuel
TSA	Temporary Storage Site at Andreyev Bay
TSG	Temporary Storage Site at Gremikha
LSF	Long-Term Storage Facility
QAP	Quality Assurance Program
PHW	Potentially Hazardous Works
SG	Steam Generator
DS	Depot Ship
RW	Radioactive Waste
RS	Radiation Safety
RAS	Radioactive Substances
SR	Source of Radiation

RM	Radiation Monitoring
RC	Reactor Compartment
RR	Reactor Room
ILW	Intermediate-Level Waste
SRZ	Shipyard
SSZ	Sanitary Shelter Zone
PPE	Personal Protective Equipment
RMS	Radiation Monitoring System
SRPB	Shipcutting Radiation Process Building
E&T	Equipment and Tooling
CPS	Control and Protection System
NF	Northern Fleet
SSCR	Self-Sustained Chain Reaction
TC	Transportation Container
PF	Pacific Fleet
SRW	Solid Radioactive Waste
DSS NRS	Directorate of State Supervision over Nuclear and Radiation Safety
FMBC	Burnazyan Federal Medical and Biological Centre, Federal Medical-Biological Agency, Russia
SevRAO	"Northern Federal Radioactive Waste Management Enterprise" (SevRAO)
FZ	Federal Law
FMBA	Federal Medical-Biological Agency, Russia
FNR	Federal Norms and Rules
FDMB EP	Federal Directorate for Medicobiologic and Extreme Problems
BST	Bioshield Tank
TsKB	Central Design Bureau
CCLS	Centre for Radioactive Waste Conditioning and Long-Term Storage
OO	Operator Organization
NM	Nuclear Material
NRS	Nuclear and Radiation Safety
NI	Nuclear Installation
NPI	Nuclear Power Installation

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Executive Summary

A large-scale effort is currently underway to dismantle nuclear-powered submarines and surface ships as well as related nuclear service vessels, which have been decommissioned from active service in the Russian navy. This requires implementing the following practical activities:

- unloading of spent nuclear fuel;
- dismantlement of the nuclear submarines, nuclear service ships and nuclear-powered surface ships;
- decommissioning and dismantlement of other radiation hazardous facilities used in servicing;
- ecological rehabilitation of the contaminated land and offshore areas at sites of temporary storage, including those at Andreyeva Bay and Gremikha village in the Kola Peninsula;
- management of existing and newly generated radioactive waste, and
- monitoring and inspection of the facilities being dismantled, the rehabilitated and adjacent areas using a set of indicators characterizing nuclear, radiation and ecological safety, as well as monitoring the personnel and public radiation doses and the environmental impact from radioactive releases.

Essential to these activities are:

- ensuring nuclear, radiation, fire and industrial safety;
- preventing industrial emergencies;
- developing and checking the availability of industry standards, national regulations, norms and rules;
- monitoring the environment as regards radiological and radio-ecological conditions;
- ensuring emergency preparedness response;
- providing advance warning to local bodies of executive power and population as regards radiation-hazardous activities; and
- effective communication with the public and other stakeholders.

The availability of up to date regulatory norms and standards for nuclear and radiation safety, relevant to the management of nuclear legacy situations, combined with effective and efficient regulatory procedures for licensing and monitoring compliance, are considered to be extremely important. Accordingly the NRPA has set up regulatory cooperation programs with corresponding authorities in the Russian Federation, as part of the Norwegian government action plan for nuclear activities and the environment in northern areas. Cooperation began with the civilian regulatory authorities and was more recently extended to include the role of the military authority. Initial work in that area has already been reported in the NRPA report series. This described the joint development by the Department of State Supervision over Nuclear and Radiation Safety of the Ministry of Defence of Russia (DSS NRS, RF MOD) and the Federal Medical-Biological Agency of Russia (FMBA) of new regulatory guidance on “Safety Provision while Managing Radioactive Waste Containing Nuclear Materials at the Enterprises of the State Atomic Energy Corporation “Rosatom” in the Northwest of Russia”.

In accordance with Russian law, the RF MOD has developed and put into force procedures for supervision of nuclear and radiation safety at the federal level. These procedures set out a framework for determining compliance with regulatory requirements, as determined in accordance with the methodology established and approved by the RF MOD and agreed with relevant federal executive bodies and Rosatom. However, arising out of the initial regulatory cooperation work, it was recognised that the complexity of submarine and related dismantling work has required the development of enhanced regulatory guidance specific to the activities mentioned above. There were regulatory gaps in the decision making procedures used for evaluating the dismantlement processes regarding safety of workers, the public and the environment. Previously, only the top regulatory layer was in place.

Accordingly, a further project, described here, was set up in order to draft more detailed regulatory Guidelines in this context.

The steps taken in the project, described in this report, included:

- analysis of the requirements of international conventions, Russian national laws and other regulatory documents;
- analysis of the main stages of the radiation facility dismantlement and spent nuclear fuel and radioactive waste management process;
- developing and validating decision making criteria, and
- development of enhanced regulatory Guidelines.

The intent of developing these Guidelines was: to improve supervision over nuclear and radiation safety while managing the nuclear military legacy facilities in Northwest Russia and other regions of the country: to provide better description and improve the quality of the operator actions, and to support proper application of the nuclear and radiation safety supervision procedures. A full draft regulatory guidance document is included as an appendix to the report, entitled: "Methodology for Evaluating the Compliance with Nuclear and Radiation Safety Requirements of Contractors Performing Dismantlement of Nuclear Submarines, Nuclear-Powered Surface Ships and Nuclear Service Ships Decommissioned from the Navy". This draft has since been officially approved by the relevant state authorities.

1 Analysis of the requirements of International Conventions, Russian Federal Laws and other regulatory documents

1.1 Principal international agreements signed by the Russian Federation

In this Chapter we discuss the requirements of international agreements, Russian laws, norms and regulations (see List /1/) to be applied to the development and validation of a set of criteria for evaluating the nuclear and radiation safety compliance of contractors performing dismantlement of nuclear-powered submarines, surface ships with nuclear installations on board and nuclear service ships as well as SNF and RW management.

Russian legislation is a hierarchical three-tier system:

1. International level:

- international agreements (conventions) signed by Russian Federation – voluntary commitments.

2. Federal level:

- Russian federal laws – legislative system's principal documents;
- presidential regulatory statutes (decrees, ordinances) and regulatory statutes by Russian government (decrees, ordinances); and
- mandatory acts by federal executive authorities.

National nuclear power authorities may also enact statutes prescribing the specific manner in which various safety requirements, principles, criteria, norms and rules shall be implemented.

3. Industry level:

- industry regulations (industry standards, norms, rules, orders, instructions) obligatory to organizations and companies operating in a particular industry .

There are 9 international conventions regulating the use of nuclear power in this country. Each one stipulates that the national legislation, procedures and facilities be brought into compliance with the requirements of these conventions.

The International Convention for the Safety of Life at Sea /3/

An international conference on the safety of human life at sea held in London in 1960 discussed the problems of using nuclear power for commercial ships and pointed out the grave consequences if a nuclear-powered ship experiences any disturbances in its operation. The text of this Convention lists a few rules outlining the general requirements and principles as regards operation of nuclear-powered ships. The Conference adopted a number of recommendations concerning nuclear-powered ships (Appendix C to the Final Resolution) to be used as an application guide for the Rules included in the International Convention for the Safety of Life at Sea of 1974. USSR signed this Convention on 02.11.1979 and enacted on 25.05.1980. The Federal Sea and River Transport Agency is responsible for implementing and maintaining the Global Maritime Distress and Safety System.

Convention on the Liability of Operators of Nuclear Ships /4/

In accordance with Section 4, Art. I of the Brussels Convention, not only a company authorized by the government to operate such a ship can be a Nuclear Ship Operator but also the government itself when it operates a nuclear ship. Since the majority of nuclear ships are state-owned, either the governments or government agencies responsible for the ship shall be the Operators.

The Brussels Convention is based on the following principles:

- Absolute liability principle;
- Limiting the liability to nuclear ship Operator, i.e. the company authorized by the government to operate the ship;
- The principle of time- and scope-limited liability;

- Financial security coverage for nuclear damage liability; and
- Alternative (multiple) jurisdiction.

The weakness of this Convention is that it applies to military nuclear-powered ships only. Liability of the Military for damages from ships should be regulated by international public, not private law. This Convention however, for the most part, contains the provisions of international private law. The Brussels Convention was adopted on May 25, 1962, but it is still not in effect, since it has not been ratified by any state who has issued a nuclear ship operation license.

Convention on Early Notification of a Nuclear Accident /5/

The Convention on Early Notification of a Nuclear Accident was ratified by USSR on 14.11.1986. This Convention requires implementing the following main provisions in national legislation:

- notification of a nuclear accident or danger of a nuclear accident; and
- establishing a national authority responsible for sending and receiving nuclear accident warnings and information.

According to this Convention, nuclear accident is an accident at an installation or in an operation which has caused or may cause a radioactive emission and which has resulted or may result in an international transborder emission. The installation or operation is as follows:

- any nuclear reactor;
- any nuclear fuel cycle facility;
- any RW handling facility;
- shipment or storage of nuclear fuel or RW;
- production, use, storage, removal and shipment of isotopes for agricultural, industrial, medical purposes or for research in these areas; and
- using isotopes for producing electricity in spacecraft.

These provisions have been implemented in Russian legislation: Art.29 of FZ #68 of 21.12.94; Art.66 of FZ #170 of 21.11.95; Russian Government Decree #794 of 30.12.2003 (as amended in Russian Government Decree #335 of 27.05.2005, Sections 16, 22), "Regulations on an Emergency Warning and Response Subsystem at Organizations (Facilities) Under the Supervision and Within the Jurisdiction of Rosatom" (agreed by the Russian Ministry of Civil Defense and Emergency Response on 5.12.2004, # 02-10251).

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency /6/

It was ratified by USSR on 14.11.1986 and enacted on 26.02.1987. This Convention requires implementation of the following main provisions in national legislation:

- providing assistance to a Signatory of this Convention in need (Art.2.);
- creating a legal basis for consolidating the responsibility for the general management, control and coordination of the assistance efforts conducted at this Party's territory (Art.3); and
- providing the information about corresponding national authorities to the member states and the IAEA (Art.4).

Convention on the Physical Protection of Nuclear Material /7/

The Convention was ratified by USSR on 04.05.1983 and enacted on 08.02.1987. According to this Convention, each member state within its jurisdiction and in accordance with international law, takes necessary measures to protect nuclear materials transported through its territory or carried on board an aircraft or ship under its jurisdiction. Each member state refuses to or disallows importation of nuclear materials from another state, who has not signed this Convention, if the member state has not received a guarantee that this material will be protected while transported internationally. A member state does not allow transit of nuclear materials through its territory between two non-signatories unless it has received an assurance from them that the material will be fully protected.

Convention on Environmental Impact Assessment in a Transboundary Context /8/

All parties to this Convention should implement all necessary measures to prevent significant transborder impact from planned activity and measures to mitigate and control such impact. The Convention applies to:

- nuclear power stations and other facilities with nuclear reactors, except research facilities with up to 1 kWt peak power;
- nuclear fuel production or enrichment facilities, spent nuclear fuel regeneration facilities, RW collection, removal and processing facilities.

The environmental impact assessment should be performed before the planned activity, which may produce significant transborder impact, has been sanctioned or started.

Convention on Nuclear Safety /9/

The Convention was enacted on 24.10.1996, the purpose is as follows:

- ensure high level of nuclear safety based on stronger national measures and international safety cooperation;
- establish and maintain at nuclear facilities effective safeguards against potential radiation hazard so as to protect the population and environment from harmful ionizing radiation; and
- prevent accidents resulting in radiation leaks and mitigate their consequences.

According to this Convention, the most important international legal principles ensuring nuclear safety are:

- responsibility of a state for the safety of nuclear installations on its territory or under its jurisdiction;
- responsibility of an Operator for the safe operation of a nuclear facility;
- keeping apart regulatory functions and nuclear energy management functions;
- keeping the exposure of the population and the environment to ionizing radiation below permissible limits;
- preventing accidents which may result in radiation leaks and mitigating their consequences; and
- preventing transborder radiation and other types of negative impact from a nuclear installation.
-

Convention on Civil Liability for Nuclear Damage /10/

Ratified on 21.03.2005. This Convention calls for:

- appointing a person who bears the responsibility for nuclear installation operation (Operator);
- implementing the single incident liability principle for the Operator;
- limiting the extent of Operator liability;
- providing the insurance or some other form of financial security covering Operator financial liabilities for nuclear damages; and
- implementing the principle of exclusive Operator liability for nuclear damages.
-

Joint Convention on the Safety of Spent Fuel and Radioactive Waste Management /11/

Ratified on 04.11.2005, enacted on 19.04.2006. This Convention deals with safe handling of SNF and RW generated in nuclear reactors, its purposes are as follows:

- ensure and maintain high level of safety in SNF and RW management by means of stronger national measures and international safety cooperation;
- ensure effective safeguards at all steps of SNF and RW management so as to protect the population and the environment from harmful ionizing radiation now and in the future; and

- try and prevent radiation leaks and mitigate their consequences if they do occur at all steps of SNF and RW management.

The International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships /12/

Applies to ships carrying irradiated nuclear fuel (INF), plutonium and HLW in containers. According to the Code, there are three classes of ships depending on the total activity of carried radioactive materials:

- Class INR 1 – ships carrying radioactive substances with less than 4000 TBq total activity;
- Class INR 2 – ships carrying INF or HLW totaling up to 2×10^6 TBq and ships carrying plutonium with up to 2×10^5 TBq;
- Class INR 3 – ships carrying INF or HLW and ships carrying plutonium without limitation as to the total activity;

1.2 Federal Laws, Federal Norms and Rules and regulatory documents approved by Rostekhnadzor

According to Section 5.6.4 /1/, a nuclear power installation stopped for decommissioning should be regarded operational until all of its nuclear fuel has been removed. During this time, all requirements to the personnel, documentation, etc. remain the same as for a fully operational unit. Reduction in the maintenance and the number of personnel and the decommissioning of certain systems (elements) is performed in accordance with the changes that have been made in the NPI design and in the Operating Manual for the ship.

The supervision over nuclear safety during NPI decommissioning is continued until all nuclear fuel has been removed. After defueling, the ships are transferred to the "Radiation Source" (RS) category in the corresponding Rostekhnadzor accounting documents. The supervision over radiation safety during NPI decommissioning continues until all radioactive equipment has been disposed of.

The radiation safety requirements to the ionizing radiation source management process may be divided into three groups (Art.14 /3/): regulatory, supervisory and organizational. The regulatory requirements:

- ensure compliance with federal laws and regulations, local regulations, radiation safety norms and rules; and
- ensure compliance with the requirements of state authorities and nuclear safety supervision and control agencies.

The supervisory requirements:

- ensure systematic monitoring of radiological conditions, emissions and discharges of radioactive substances;
- monitor and record individual radiation exposure doses; and
- exercise of civil rights as regards radiation safety.

The organizational requirements:

- implement radiation safety measures;
- conduct activities supporting radiation safety arrangements;
- provide training and certification of personnel in radiation safety;
- perform regular medical examination of personnel;
- provide information on the levels of ionizing radiation at work stations and on the individual exposure dose; and
- provide notifications about accidents and process procedure disturbances that violate radiation safety;

Decisions to decommission a nuclear power installation of a ship and (or) service ship.

The decision to decommission a nuclear power installation of a ship or service ship is made by the Russian government or by federal executive authorities. Decommissioning proposals are prepared by Rosatom corporation (Art.7 /2/).

The decision of the nuclear power management agency appointing the decommissioning contractor.

According to Russian law, Art.34 /2/, the Operator Organization (OO) is an organization that was entitled to locate, design, construct, operate and decommission a nuclear power facility as well as to manage nuclear materials and radioactive substances. According to Art. 35 /2/, OO maintains the safety of a nuclear installation, source of radiation or storage facility, establishes Safety Control services, provides information about safety status of a nuclear installation, source of radiation or storage facility to state safety authorities.

OO:

- ensures that a nuclear installation, source of radiation or storage facility are used strictly for their intended purposes;
- implements quality assurance programs at all stages of nuclear installation (source of radiation, storage facility) design, operation and decommissioning;

- implements measures aimed at accident prevention and mitigation of negative impact on the personnel, population and the environment;
- ensures safe management and storage of nuclear materials and radioactive substances;
- ensures full social protection of the personnel in accordance with existing legislation;
- keeps records of individual radiation exposure doses for personnel;
- develops and implements accident protection measures for the personnel and population;
- controls and keeps account of nuclear materials and radioactive substances;
- provides physical protection for nuclear installations, sources of radiation, storage facilities, nuclear materials and radioactive substances;
- implements fire safety measures;
- performs radiation control in the Sanitary Shelter Zone and Supervised Zone;
- performs personnel selection and training, maintains personnel qualification level, provides the required amenities; and
- informs the population about levels of radiation in the Sanitary Shelter Zone and Supervised Zone.

License to decommission a nuclear power installation of a ship and (or) service ship

State regulation of the nuclear safety includes licensing of nuclear power related activities, supervision of safety and safety inspections (Art. 23 /2/).

Art. 40 /4/ says: potentially hazardous activities are subject to licensing in accordance with Russian legislation. A prerequisite for a license is a protocol of sanitary and healthcare inspection confirming sanitary compliance of the facilities, buildings and equipment, which the applicant intends to use in his activities:

- in the area of ionizing radiation sources;
- in the area of nuclear material and radioactive substance management;
- collecting, recycling, deactivation, transportation and disposal of RW.

The types of licensed activities listed in Art.17 /5/ are:

- recycling of weapons and military hardware ;
- cargo transportation by sea, river and rail;
- on-and-off loading of hazardous cargo;
- collection, reuse, decontamination, transportation, disposal of Hazard Class I - IV waste (Hazard Class I - V waste accumulation activity and Hazard Class V waste collection, reuse, decontamination, transportation and disposal are not subject to licensing).

The following activities are subject to licensing (Art.10 /3/):

- research in the area of ionizing radiation source management;
- ionizing radiation source design and construction;
- fabrication of process equipment, radiation protection equipment;
- mining, production, transportation, storage, use, maintenance, recycling and disposal of ionizing radiation sources.

According to Art. 26 /2/, the licenses are issued by the state authorities, which regulate Operator safety.

Art.4 /2/ lists the types of activities related to nuclear power. Among them there are:

- decommissioning of Nuclear Power Facilities (NPF);
- handling of nuclear materials and radioactive substances in their production, use, processing, transportation and storage;
- ensuring nuclear power safety;
- control over nuclear, radiological, technical and fire safety of NPFs, sanitary and epidemiological well-being of the population;
- all types of nuclear power research;
- physical protection of NPFs, NM and RAS;
- NM and RAS control and accounting;
- training NPF, NM and RAS specialists.

Following the decision to decommission ship's NPI, the Operator should obtain a license for the NPI decommissioning and ship dismantlement (Section 4.1 /6/) .

Work authorizations issued to NPF personnel

Some types of work, related to nuclear power, may be performed only by authorized personnel, with the authorizations issued by the state safety supervision authorities (Art. 27 /2/). The list of positions requiring authorization and the required qualifications are determined by the Russian government.

One of the requirements is the absence of medical contra indications, including psychophysiological ones. The list of medical contra indications and the requirements to medical and psychophysiological examinations are determined by a federal executive authority.

Authorized employee is fully responsible for any violation of rules during his/her work. In case of violations, the authorization document can be terminated by the same state safety supervision authority.

In accordance with Art. 40 /2/, the captain and crew of a nuclear-powered or radiation source-equipped ship should complete a special training course in the use of nuclear power and have permits for their operation.

Ship and (or) service ship nuclear power installation decommissioning program

In accordance with Section 5.6.2 /1/ and Section 3.2.2 /6/, an Operator, not later than 5 years before NPI service life expiration, shall develop a decommissioning program based on the Nuclear Power Installation Decommissioning Project, including the Integrated Technical and Radiation Condition Assessment (ITRA) (Section 12 /6/).

The Operator shall complete the following organizational and operational arrangements in preparation for ship's NPI decommissioning (Section 4.1 /6/):

- remove spent nuclear fuel from reactors and put the reactor plant in a nuclear-safe mode;
- remove the sorbents from activity filters;
- remove radioactive service fluids from Nuclear Power Installation systems;
- decontaminate ship systems and facilities;
- transfer all RW to land-based storage facilities or to service ships;
- put the dismantled materials contaminated with radioactive substances in temporary storage;
- perform ITRA on the ship;
- prepare a report supporting safety arrangements to be used in NPI decommissioning;
- prepare a plan of physical protection measures for ship's NPI, the RAS and RW generated during decommissioning activities;
- change nuclear ship status and transfer it to the category of "tied up" ship;
- obtain a license for NPI decommissioning and ship recycling.

Art.41 /12/ says that environmental requirements to the decommissioning process apply to military and defense facilities, weapons and military hardware with the exception of emergencies, which do not allow environmental considerations.

Nuclear plant placement projects should provide for their safe decommissioning (Section.6 Art.40 /12/). NPF projects shall include provisions (the methodology and arrangements) for their future decommissioning (Art.33 /2/).

According to Section 5.6.1 /1/, the decommissioning requirements are to be taken into consideration at the stages of NPI design, construction and operation. Ship project shall include (Section 3.1.2 /6/):

- the concept of NPI decommissioning;
- main safety arrangements to be used in NPI decommissioning;
- the evaluation of the total amount (volume) and total activity of RW generated during NPI decommissioning;
- forecast of radiological situation onboard during NPI decommissioning;
- proposals on the NPI system (element) dismantlement and (or) the extraction of the reactor unit (compartment, installation) as a whole and the recommended decontamination and dismantlement technologies;
- the principle of creating the NPI decommissioning database; and

- the main arrangements for NPI, RAS and RW physical protection.

Decommissioning activities continue until ship NPI achieves a certain final condition as defined in the project and this condition is confirmed by an appropriate document (certificate, conclusion) from the Operator (Section 5.1.9 /6/). The NPI decommissioning program shall specify the times of the preparation and decommissioning stages (3.2.4 /6/).

Ship and (or) Service Ship NPI decommissioning contractor organizations

In accordance with Art. 37 /2/, the Operator contractors are organizations who perform research and development in the area of nuclear power, design, build and decommission NPFs, design and manufacture equipment for NPFs, perform other types of work and provide other services related to nuclear power. The amount and quality of the works and services provided by these contractor organizations should satisfy the requirements of nuclear industry norm and rules. The contractors are fully accountable for the quality of their work and services.

Availability of the safety analysis report on NPI decommissioning

In accordance with Section 4.1 /6/, the Operator shall develop a safety analysis report on the decommissioning of a ship (service ship) NPI.

Decommissioning work quality assurance programs (QAP)

The Operator shall organize and coordinate QAP at all stages of NPF creation, operation and decommissioning (Art. 35 /2/) to ensure that all NPI creation and operation activities are conducted as prescribed and produce required results (Section 25 /2/). In accordance with Section 2.3 /6/, QAP is required to ensure proper safety during decommissioning of a ship's (service ship's) NPI.

Report on the Integrated Technical and Radiological Assessment of an NPI decommissioned from a ship and (or) service ship

According to Section 5.6.3 /1/, decommissioning is preceded by all-round assessment of the NPI. Using the results of this assessment, the Operator develops the NPI decommissioning project and prepares the decommissioning safety analysis report. The NPI assessment is performed using project, design and operational documentation (Section 4.1 /6/).

The measurements shall be performed using certified measurement methodologies (Part1, Art.5 /8/). Measurement results should be in units permitted for use in Russian Federation. The assessment is performed using metrologically certified equipment (instruments, apparatuses, etc.) and methodologies approved by the Operator (Section 4.2 /6/).

Technical assessment of NPI is performed to obtain data on the technical condition of all NPI systems (components) as well as ship structures (Section 2.1 in Appendix /6/). The radiological assessment is performed to obtain data on radiological conditions in the reactor compartment and other rooms of the ship and on the amount, the volumetric and total activity of RW on board, its physical state and radionuclide composition (Section 3.1 in Appendix /6/).

Radiation Monitoring System

Operator shall regularly check the levels of radiation at workplaces, inside facilities, on company territory, in sanitary shelter zones (SSZ) and in supervised zones (SZ), as well as monitor radioactive substance emissions and discharges (Section 14 /3/, Section 35 /2/, Section 31 /2/). SSZ is a territory around an ionizing radiation source where, under normal operating conditions, the exposure of population to radiation may exceed the specified limit. SZ – the territory outside SSZ, where radiation is monitored. For ships and other waterborne platforms equipped with nuclear installations, the SSZs and SZs are established in the locations where they are commissioned, ports of moorage and at the place of their decommissioning.

Art. 22 /4/ says that the radiation level shall be monitored at the places where radioactive waste is used, decontaminated, stored or buried. According to Section 5.3.7 /6/, radiation is monitored as follows:

- inside ship – using a radiation control system equipped with an automatic acoustic alarm and warning lights together with mandatory periodic measurements using portable radiation control devices;
- at the places of NPI decommissioning – using the regular radiation monitoring system.

The radiation control systems monitoring the ship and the facilities of the NPI decommissioning contractor shall ensure the following (Section 5.3.8 /6/):

- control of the individual radiation doses and control of the radiological contamination of the skin, protective clothing and individual protective equipment;
- radiation control of the dismantled NPI systems, RW and reusable materials;
- monitoring of the spread of radioactive substances inside the ship and through the territory of the home base;
- control of the integrity of the physical safeguards; and
- radiation control inside the ship, in SSZ and SZ around the home base.

In accordance with Section 4.13 /11/, handling of RW shall be accompanied by radiation monitoring performed as required by the appropriate regulatory documents. According to Section 5.1.10 /13/, radiation monitoring is performed at all stages of RW handling. Radiation monitoring includes:

- personnel exposure monitoring;
- in-process control to determine the intensity of gamma-radiation and the activity concentrations of the aerosols and gases;
- monitoring of the RW handling system components;
- monitoring of the RW storage facilities;
- monitoring of the RW transportation equipment.

Radiation monitoring is an essential part of the radiation safety system; it provides necessary data on the levels of radiation and on personnel exposure doses (Section 3.10.1 /14/). According to Section 5.5.9 /1/, the SZ in the home base area should be checked regularly for radiation, including the contamination of the bottom sediment.

Art. 3 /3/ says that one of the most important principles of radiation safety – the principle of norm-setting – is based on the requirement that the total personnel exposure doses from all sources of radiation shall not exceed allowable limits. This objective is achieved, among others, by setting sanitary norms and hygienic standards (Section 9 /3/).

A ship with NPI shall be provided with a personnel exposure accounting system (Section 5.3.4 /1/). The monitoring of personnel exposure at each stage of nuclear power installation decommissioning shall take into account possible changes in the level of radiation to which the personnel is subjected during the decommissioning process (Section 5.3.9 /6/).

The working areas and RW handling areas, where radiation intensity may fluctuate over a wide range, shall be provided with fixed radiation monitoring units (devices) with automatic alarm systems (Section.5.3.10 /6/).

In accordance with Section 3.1.2 /15/, the Operator must show that the expected individual doses of exposure of the personnel and population during SFRA removal operations are within allowable limits, that the collective doses are minimized and the amount of radionuclides generated in these operations does not exceed the annual limit for their emissions and discharges into the environment.

Agreement of RW parameters with the organization who accepts RW for storage

To be buried at a RW burial site, RW must meet certain criteria (Section 5.5 /11/).As required by the regulatory documents, RW burial acceptance criteria are defined in the project and operating documentation. In accordance with Section 2.4 /19/, a sub-surface burial site may be used for the disposal of RW that meet the disposal criteria as defined in regulatory documents.

Emergency response instructions to personnel should there be an accident during decommissioning of a nuclear power installation of a ship and (or) service ship

The Operator develops and implements accident prevention and impact mitigation measures for the NPI, radiation source and the storage facility (Section 35 /2/) and provides emergency response training to personnel (Section 10 /17/). As required by Art. 36 /2/, the Operator must develop action plans for the protection of nuclear facility employees and the population in emergencies including NM and RS transportation accidents. These plans should include:

- Operator responsibilities and emergency response procedure; and
- the procedure for operator interaction with state authorities, local authorities and nuclear power regulation authorities.

At shipyards there must be action plans for the protection of population from radiation in case of accidents at NPIs, in nuclear fuel and RW storage facilities (Section 5.4.1 /1/). In accordance with Section 4.5.2 /1/, Operator ensures the development of action plans for nuclear ships for the protection of crew in nuclear emergency. In accordance with Section 1.2.5 /18/, the sender, the receiver and the carrier must implement measures for transportation accident and incident prevention and impact mitigation.

The Operator must develop and implement emergency response training and emergency response exercise programs and methodologies and organize emergency response exercises (Section 5.4.7 /1/).

Availability of annual and milestone progress reports on the decommissioning of ship (service ship) NPIs

In accordance with 5.1.15 /1/, the Operator must prepare annual NPI safety reports containing the results of ship (service ship) NPI safety monitoring and the NPI safety analysis for the report period based on the safety indicators including a broad analysis of NPI failures and incidents.

Following the completion of each decommissioning stage, there must be an analysis of the results, assessment of the actual amount of RW generated in the process and the amount of emissions into the environment (Section 5.1.6 /6/).

SNF and RW management

Discharge of nuclear materials and radioactive substances from ships equipped with NPIs and radiation sources into the oceans, seas and other water bodies in the amounts over the limits specified in the nuclear safety regulations and rules, is not allowed (Section 42 /2/).

There must be arrangements to prevent radioactive contamination of sea water or any other water body during ship repairs and during the time from stopping the NPI or radiation source and until its decommissioning. Should there be a radiation leak above the limit, ship captain or crew manager must take measures to stop or limit the leak, its spreading into the environment and immediately report the incident.

Notification of states located in the potential radiation impact zone from nuclear accidents on-board ships or other water-borne platforms equipped with NPIs or sources of radiation, is performed in accordance with international agreements signed by Russian Federation and Russian legislation.

There should be a reliable protection of Nuclear Facility employees, population and the environment from over-the-limit radiation impact and radioactive contamination (Art. 47 /2/). RW storage should be considered as an intermediary stage in preparation for their processing or burial. The temporary (or "process") storage of irradiated fuel assemblies aimed at improving the safety and reducing the future management costs and their processing to extract valuable components is performed in accordance with Russian legislation.

According to Rostekhnadzor regulations, the compliance with Nuclear and Radiation safety rules, norms and instructions in handling SNF and RW from service ships is supervised at the following stages:

- operation of nuclear fuel storage facilities onboard nuclear service ships;
- transportation of nuclear fuel within enterprise territory;

- operation of RW storage facilities; and
- operation of RW processing facilities.

1.3 Radiation facility dismantlement requirements and spent nuclear fuel and radioactive waste management requirements

In 1986, the Supreme Soviet issued Decree No. 1095-296 "Dismantlement Procedures for Navy Ships with Nuclear Power Installations" /1/. According to this Decree, reactor compartments were to be buried in abandoned underground mines in the area of Vidyaevo. However, this idea proved to be unworkable. It was also expected that in 50 to 70 years the reactor compartments would be recovered for final disposal.

In July 1992, Russian government issued Decree No. 514 "On Measures Providing for the Pilot Recycling of Decommissioned Navy Submarines and Surface Ships" /2/, which became one of the first comprehensive guidelines in this area. This Decree established the self-financing principle and gave the shipyards the freedom to use the services of commercial contractors including foreign investors. This Decree also ordered the shipyards to perform pilot recycling of 13 nuclear subs (nine of them from the Northern Fleet, including 3 with titanium hulls). In the Russian Northwest, the recycling was conducted by Severodvinsk firms: "Sevmash", "Sever" and "Nerpa" shipyards. In the East, submarine dismantlement was performed by the Far-Eastern "Zvezda" shipyard. The Navy retained only the tasks of removing SNF, reception of RW, shipment and storage of reactor compartments as well as preparation and transfer of nuclear subs and surface ships to shipyards in accordance with the "Guidelines on the Preparation for Dismantlement of Decommissioned Navy Submarines with Nuclear Power Plants on Board" No. 714/13/01045 of May 4, 1991.

On August 31, 1992, Russian Federation Decree No. 644-47, "On Providing the Comprehensive Recycling of Decommissioned Nuclear-powered submarines and Russian Federation Ministry of Transportation Vessels with Nuclear Facilities on Board," /3/ approved the nuclear submarine decommissioning program and schedule as well as made provisions for the construction of the submarine recycling facilities. Research and Development Institute of Power Engineering (NIKIET) became the prime contractor. The dismantlement procedure was as follows:

- nuclear submarine reactors are defueled;
- reactor compartments are brought to environmentally safe state for long-term storage, radioactive equipment remains in place;
- reactor compartment is removed from the hull, the end sections are cut and recycled;
- reactor compartment is shipped to a storage facility and placed in a prepared storage station;
- reactor compartment is kept in long-term storage with appropriate monitoring of the area around the facility.

In 1996, Russian Federation Government issued Decree No. 344-24, "On Providing for the Comprehensive Recycling of Decommissioned Nuclear-powered submarines and Russian Federation Ministry of Transportation Vessels with Nuclear Facilities on Board," /4/. These regulatory guidelines expanded and refined the above dismantlement procedure.

The created legal framework for submarine recycling was not supported by necessary funding to the Navy, which put the Navy, as regards its nuclear fuel removal and processing responsibilities, in a very difficult position.

The situation changed on May 28, 1998 when Russian government issued Decree No. 518, "On Facilitating the Recycling of Decommissioned Navy Nuclear-powered submarines and Surface Vessels with Nuclear Power Plants on Board and Ecological Rehabilitation of Navy Facilities Posing Radiation Hazard" /5/, which put Russian Minatom in charge of the dismantlement of nuclear submarines and surface vessels with nuclear power plants on board, the reduction of radiation hazard at their stationing sites and the ecological rehabilitation of Russian Ministry of Defense facilities used for temporary storage of SNF, solid and liquid RW, relieving Russian Ministry of Defense from these functions.

Just as before this Decree, the submarine dismantlement in the North of Russia was performed by five shipyards (No.35, No.10, "Nerpa", "Zvezdochka" and "Sevmash"). The active zones from reactors are removed by the personnel of Navy's refueling depot ships as well as by the specialists from Murmansk ocean company ("Imandra" FMB) and the shore-based defueling complex operated by "Zvezdochka". The same facilities were used for preparing train loads of SNF shipped to areas outside Murmansk and

Severodvinsk. The responsibility for coordinating all these efforts, providing necessary resources and organizing interagency cooperation was taken by Russian Minatom.

By Decree No. 471 of June 20, 2000 /6/ Russian Government approved the Guidelines on Licensing the Defense-Related Nuclear Material Handling Activities (Licensing Guidelines). Section 6 of these Guidelines says that Defense-Related Nuclear Material Handling Activities without a license are not allowed. The following defense-related activities require a Nuclear Material Handling Activities license:

- disposal of military NPIs (List item 25);
- operation of facilities (buildings and installations) used for the Military NPI disposal activities posing nuclear and radiation hazard (List item 31).

Thus, the dismantlement of nuclear subs and surface ships with NPIs and nuclear service ships as well as SNF and RW management requires a license.

The contractors participating in the disposal of radiation facilities and SNF and RW management should comply with the following (see Provision 17 of the Licensing Guidelines):

- Russian Federation legislation;
- norms and rules on nuclear, radiation and industrial safety;
- norms and rules on radioactive material physical protection and state secret protection;
- norms and rules on radioactive material control and accounting;
- environmental, sanitary, hygiene and fire-protection norms and rules; and
- Licensing Guidelines.

On January 30, 2001, Russian Minister of Nuclear power approved the Concept of Comprehensive Recycling of Nuclear Submarines and Surface Ships with Nuclear Power Installations, which provides the guidelines for all stages of their dismantlement and recycling and for the ecological rehabilitation of Navy facilities in the Northern and Eastern Russia posing nuclear hazard.

The planning of nuclear submarine and surface ship dismantlement works is performed based on the Dedicated Federal Recycling programs:

- Dedicated Federal Recycling program "Industrial Recycling of Weapons and Military Hardware (2005 — 2010)" /7/.
- Subprogram "Industrial Dismantlement and Recycling of Nuclear Submarines, Surface Ships with Nuclear Power Installations on Board, Nuclear Service Ships and Rehabilitation of Technical Bases on Shore (2005 — 2010)" /8/.
- "Rosatom State Nuclear power Corporation Long-Term Action Program" /9/.

The above regulatory documents by the Russian government outline the general requirements to the planning and organization of the dismantlement and recycling process as a whole. The specific nuclear and radiation safety requirements, which should be included in the Guidelines under development, are established by:

- the Licensing Guidelines, approved by Russian Government Decree No. 471 of June 20, 2000;
- the Concept of Comprehensive Recycling of Nuclear Submarines and Surface Ships with Nuclear Power Installations on Board.

1.4 Sanitary norms and rules regulating the health aspects of radiation safety

The main focus of state-sponsored safety regulations was and still remains the radiation safety of the personnel, population and the environment both in civil and defense nuclear industry. Several laws have been passed, state safety regulation agencies created, basic federal sanitary guidelines developed and continue to be developed – all in a very short time frame.

The law "On Radiation Safety of Population" became the basis of a new (non-limit) concept of the cumulative effective radiation exposure dose received over the life of a person. This differs greatly from the earlier Critical Organs concept based on the control over the radiation doses received by the personnel and population.

The main hygienic rates (allowable dose limits) for exposure to radiation from ionizing sources in Russia are:

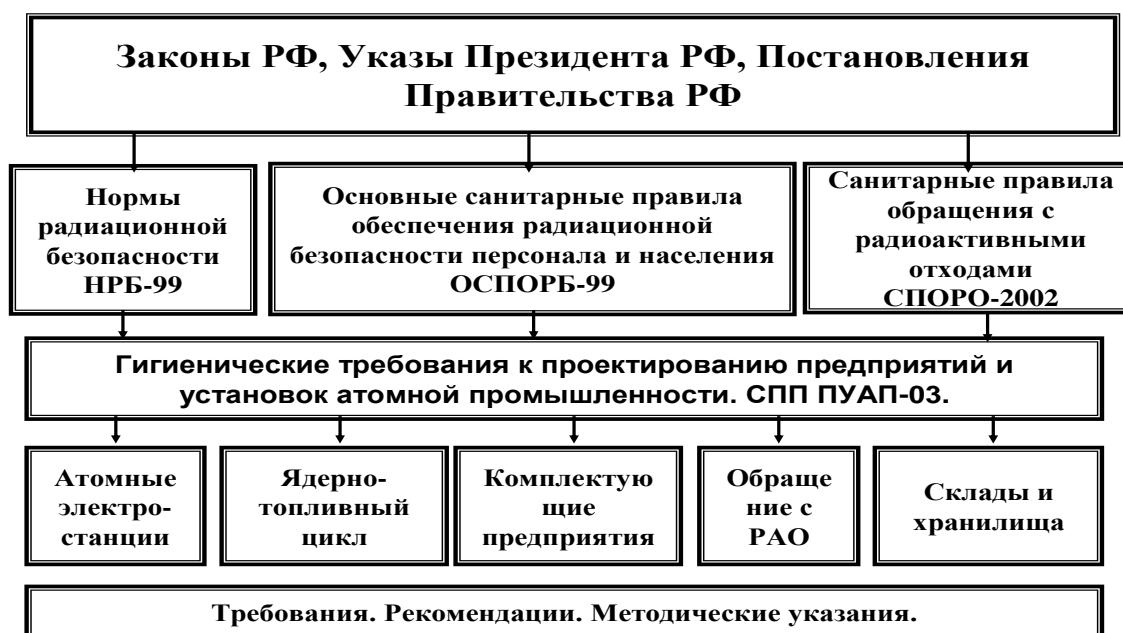
- for the population, the average annual effective dose is 0.001 Sv or 0.07 Sv over the lifetime (70 years);
- the annual effective dose for a particular year may be larger, provided that the average value over any five consecutive years does not exceed 0.001 Sv;
- for personnel, the average annual effective dose is 0.02 Sv or 1 Sv over the working life (50 years);
- the annual effective dose for a particular year may be up to 0.05 Sv, provided that the average value over any five consecutive years does not exceed 0.02 Sv.

The limit doses do not include doses from natural and industrial radiation background and the doses received in medical procedures. Existing sanitary rules are based on the established main hygienic norms (allowable dose limits). Existing Russian sanitary-epidemiological rating system is conceptually in agreement with the world radiation safety regulation system /1/.

Sanitary legislation stresses the priority of sanitary norms over all other human safety regulation norms (Fig.1.4.1).

The basic document regulating radiation rates is NRB-99/2009. This document establishes the fundamental principles of radiation safety, such as "validation, rate setting and optimization", which form the basis of the radiation safety management strategy. OSPORB-99 /2/ and SPORO-2002 /3/ establish the radiation safety requirements aimed at ensuring a system approach in the determining of allowable levels of radiation impact and assessing the magnitude of this impact under the shop-floor conditions. The requirements of national radiation safety standards (NRB-99, OSPORB-99 and SPORO-2002) are further elaborated by 60 regulatory documents and 128 implementation guidelines.

Fig. 1.4.1 illustrates the hierarchical structure of Russian sanitary legislation.



Законы РФ, Указы Президента РФ, Постановления Правительства РФ	Russian Federation laws, Russian Federation President Decrees, RF Government Decrees
Нормы радиационной безопасности НРБ-99	Radiation Safety Norms NRB-99
Основные санитарные правила обеспечения радиационной безопасности персонала и населения ОСПОРБ-99	Sanitary Rules for Radiation Safety of Personnel and Population OSPORB-99
Санитарные правила обращения с радиоактивными отходами СПОРО-2002	Sanitary Rules for Radioactive Waste Handling SPORO-2002
Гигиенические требования к проектированию предприятий и установок атомной промышленности. СПП ПУАП-03.	Health Requirements to Nuclear Industry Facility Design. SPP PUAP-03.
Атомные электростанции	Nuclear Power Plants
Ядерно-топливный цикл	Nuclear Fuel Cycle
Комплектующие предприятия	System and Component Suppliers
Обращение с РАО	RW handling
Склады и хранилища	Storage facilities
Требования. Рекомендации. Методические указания.	Requirements. Recommendations. Guidelines.

Fig.1.4.1. Hierarchical structure of Russian sanitary legislation.

At the end of the 1980s and 1990s Russia started a wide-scale decommissioning of nuclear-powered fleet. The development of the regulatory base ensuring radiation safety of these activities included the following five areas:

- radiation safety in nuclear-powered shipbuilding industry;
- radiation safety at infrastructure facilities;
- radiation safety zoning;
- radiation monitoring;
- forecasting radiation accident consequences, supporting the necessity of protective measures

Radiation safety in nuclear-powered shipbuilding industry is addressed in /4, 5, 6/. These documents establish the basic provisions for workplace safety, protection of the environment and the health of workers performing dismantlement of nuclear submarines and nuclear service ships.

The MU2.6.1.38-05 /7/ guidelines were developed to ensure radiation safety at the dismantlement of the 1st generation nuclear submarines; it introduced the zoning principle and established the Dismantlement Product Management Rules.

Guidelines /8/ establish the requirements to equipment, services, to the management of the radiation control process, to personnel and population safety and the environment protection arrangements during fuel assembly removal.

Guidelines /9/ determines radiation safety requirements to disposed solid radioactive waste (SRW), radiation safety and monitoring requirements to the SRW disposal process.

The principles of the sanitary supervision over radiation safety are laid down in federal documents, which allows to extend the radiation safety requirements to other industries besides Nuclear and Shipbuilding and thereby ensure a unified radiation safety strategy applicable to any industry and any company /10,11/.

An important task in solving the problem of nuclear legacy in northwestern Russia is rehabilitation of former Navy technical bases on shore. In 2001, these bases were transferred to Minatom for their ecological rehabilitation. New regulatory guidelines establishing sanitary and management requirements to radiation safety were developed in support of this ecological rehabilitation. The Institute of Industrial and Naval Medicine provided Guidelines /12, 13/. The "Biophysics Institute" prepared documents /14, 15/, which determine the requirements to the radiation environment on the territory and in the facilities of the temporary SNF and RW storage sites managed by "SevRAO" and the territory of the Supervised Zone after rehabilitation; establish the criteria for radio-ecological and radiation-hygienic assessment of lands contaminated with radionuclides; formulate the requirements to the methods used in determining the quantity of radionuclides in the environment and the requirements to the system of standards, which is used to decide on the future fate of the transferred territories and on their rehabilitation.

To ensure safety of rehabilitation work, the "Biophysics Institute" developed Guidelines /16/ for ensuring radiation-safe design and construction of the infrastructure for safe RW and SNF management at Division #1 of "SevRAO".

In accordance with OSPORB-99 and SPORO-2002, standard requirements and radiation safety principles have been developed for the safe management of low- and intermediate-level wastes, which were included in the Guidelines (R TsKDH RAO-10) "Personnel, Population and Environment Protection During RW Handling at the Conditioning and Long-Term Storage Centre of "SevRAO""

The "Biophysics Institute" also prepared Guidelines /17/ aimed at ensuring effective sanitary supervision based on the principle of optimization. Guidelines /18/ is designed to provide effective individual protection. These guidelines take into account local natural and climatic conditions as well as the existing radiation-hygienic environment.

Guidelines /19/ determines the requirements to the handling process for industrial waste containing technogenic radionuclides with activities below LLW. These requirements complement the basic safety requirements established by OSPORB-99 and SPORO-2002. The Guidelines introduce the concept of very low-level waste (VLLW) and provide classification requirements for this waste category. Also, the guidelines provide VLLW burial eligibility criteria as well as the requirements to VLLW burial site and its decommissioning criteria. The Institute of Industrial and Marine Medicine (NII PMM) prepared Guidelines /20,21/, dealing with sanitary-hygienic, organizational and technical requirements to radiation protection of personnel during preparation for storage, and temporary storage (waterborne or land-based) of reactor sections.

Guidelines /22, 23/ are aimed at improving radiation safety of personnel and population in the Nuclear Shipbuilding industry, the main determinants were:

- radiation environment under normal operating conditions and in emergencies;
- the max radiation exposure for the population during normal operation is determined as a quota from the limit dose, which is set depending on the level already achieved; and
- the environmental and health impact of radiation and non-radiation factors.

NII PMM has developed Guidelines /24/ establishing the requirements to individual radiation exposure monitoring of personnel in the Nuclear Shipbuilding industry and population in the Supervised Zone, which take into account the specifics of radiation hazard in this industry. The "Biophysics Institute" has prepared Guidelines /25/ aimed at ensuring effective sanitary supervision of the individual radiation exposure doses during rehabilitation of former Shore Technical Bases. The actual monitoring tasks are performed using Guidelines /30/ developed by NII PMM and Guidelines MU 2.6.5.6-08 "Individual Radiation Dose Monitoring of Personnel at Division #1 of "SevRAO"" /26/, developed by the "Biophysics Institute".

Guidelines /27/ by NII PMM lay down the radiation safety requirements to the ship dismantlement and scrap metal handling processes. Guidelines /28/ is designed to ensure common methodological approach to radiation monitoring in the Nuclear Shipbuilding industry.

Guidelines /29/ by NII PMM is designed to improve the emergency response system and to ensure uniformity in the assessment of radiation impact from Nuclear Shipbuilding industry facilities on the environment and population.

The purpose of Guidelines "Operational Radiological and Medical Criteria for Decision Making in the Event of Nuclear Accident at "SevRAO" facility" by "Biophysics Institute" is to establish the criteria to be used for deciding on the emergency response.

To summarize, this review examines only the problem of providing regulatory basis for the dismantlement of nuclear ships and service ships and the problems of rehabilitation of former Navy Technical Basis on shore. It shows that the existing sanitary legislation address practically all the radiation safety concerns related to the disposal of nuclear legacy in northwestern Russia.

1.5 Requirements to the radiation facility dismantlement process

The industry regulatory documents that define the process side of the nuclear ship dismantlement fall into several different categories depending on what they are concerned with:

- nuclear safety and SNF handling;
- radiation safety and radiation control;
- RW handling;
- scrap metal monitoring;
- environment monitoring; and
- personnel training.

Nuclear safety and SNF handling documents:

- RD5.IMYAN.105-2005 "Nuclear Safety at Shipbuilding Industry Facilities" /1/. The Guidelines determine organizational and technical requirements to nuclear safety arrangements and monitoring at the nuclear-hazardous facilities of the Shipbuilding industry;
- RD5.IMYAN.108-2006 "Investigation of Nuclear Accidents and Emergencies at Shipbuilding Industry Facilities. Rules." /2/. These Rules establish:
 - nuclear accident and nuclear emergency (nuclear event) classification;
 - investigation procedure for nuclear events at Shipbuilding industry facilities performing, among other things, nuclear ship dismantlement; and
 - the requirements to the management of the corrective actions and to the notification of the concerned parties and the public;
- NYADI.0220.00.027 "Organization of Irradiated Fuel Removal at RosSudoStroyeniye Land-Based Facilities. Guidelines" /3/. The Guidelines determine:
 - the organization of the planning, preparation, implementation and documenting of the main stages of SNF removal process at RosSudoStroyeniye Land-Based Facilities.
 - relations and interaction between facility services; and
 - relations, duties and responsibilities of facility executives, officials of the state and industry Nuclear Safety Supervision authorities, of the Federal Medical and Biological Agency services and of the Shipbuilding Industry Directorate, Federal Nuclear power Agency, services.

Radiation safety and radiation control documents:

- RD5.IMYAN.106-2005 "Nuclear Safety at Shipbuilding Industry Facilities" /4/. These Guidelines regulate the system of radiation safety arrangements being implemented by the Shipbuilding industry;
- RD5.IMYAN.109-2006 "Organization of Radiation Safety at Rosprom Facilities Handling Radioactive Substances, Radioactive Waste and Sources of Ionizing Radiation" /5/. These Guidelines establish the procedure and the main requirements to the organization and implementation of radiation safety control at Rosprom facilities handling radioactive substances, radioactive waste and sources of ionizing radiation.
- RD5.IMYAN.076-2007 "Control and Accounting of Individual Exposure Doses for Shipbuilding Industry Personnel. Guidelines." /6/. These Guidelines define the requirements to the organization and implementation of the individual internal and external exposure dose control for personnel in the Shipbuilding industry; and
- NYADI.000.0230.00.002 "Radiation Safety on Decommissioned Navy Submarines Transferred to Dismantlement Contractors. Main Organizational and Technical Requirements" /7/. This document outlines the main organizational and technical requirements to radiation safety on decommissioned navy nuclear submarines handed over to dismantlement contractors.

RW handling documents:

- RD5.IMYAN.092-2009 "Radioactive Waste Handling Rules for Shipbuilding Industry Facilities." /8/. This guiding document establishes the requirements to radiation safety of the personnel and population while handling RW at the Shipbuilding industry facilities; and
- NYADI.0312.00.035 "Liquid and Solid Radioactive Waste Management at the Facilities of RosSudoStroyenie, Performing Nuclear Submarine Construction, Repair, Modernization and Dismantlement Work. Guidelines" /9/. This document provides recommendations on the implementation of the federal nuclear power norms and rules while managing liquid and solid radioactive waste at the Shipbuilding industry facilities performing nuclear submarine dismantlement work;

The main scrap metal monitoring document:

- RD5.AEISh 3365-2003 "Radiation Monitoring of Scrap Metal from Dismantled 1, 2 and 3rd Generation Nuclear Submarines and Surface Ships with Nuclear Power Plants on Board" /10/. This document determines:
 - general requirements to radiation monitoring of scrap metal from dismantled nuclear submarines, surface ships with nuclear installations on board and nuclear service ships;
 - scrap metal radiation monitoring purpose and procedure;
 - general requirements to radiation assessment of scrapped nuclear submarines, surface ships with nuclear installations on board and nuclear service ships;
 - radiation safety requirements to ship dismantlement and scrap management; and
 - the rights and responsibilities of parties in scrap management.

The environment monitoring is regulated by:

- RD5.AEISh.2946-99 "Radiation Monitoring of the Environment at Facilities Performing Construction, Testing, Repair and Recycling of Ships and Vessels with Nuclear Power Installations on Board and Floating Service Platforms. Guidelines" /11/. These Guidelines determine the basic principles to be used in the monitoring and the development of monitoring programs for tracking the radioactive contamination of the environment and the radiation exposure doses for Group B personnel and individuals from local population during normal operation of the facility and during potential NPI accidents.

Personnel training requirements

- RD5.IMYAN.107-2005 "Certification of Shipbuilding Industry Personnel Working in Nuclear power" /12/. These guidelines determine: personnel training and certification procedure; periodicity of nuclear and radiation safety knowledge testing; composition of the knowledge testing commission and its formation rules; processing of the knowledge testing results; procedure for authorizing personnel to work in the area of nuclear power, handling of nuclear materials, radioactive substances, technogenic sources of ionizing radiation, radioactive waste, their control and accounting at the facilities and in the organizations of the Shipbuilding industry.

1.6 National Standard requirements

Nuclear submarine, surface ship with nuclear installations on board and nuclear service ship dismantlement processes and the management of SNF and RW generated in these processes are regulated by Russian national standards /1-3/, based on the requirements of federal laws and international conventions.

Among national standards, regulating the organizational and technical aspects of nuclear submarine, surface ship with nuclear installations on board and nuclear service ship dismantlement processes is the "Dismantlement of Navy Ships and Vessels. General Provisions" national standard /3/. This standard implements the provisions of the following federal laws: "On Environmental Impact Assessment", "On Radiation Safety of Population", "On Protection of Environment", "On Production and Consumer Waste", "On Protection of Atmospheric Air", "On Precious Metals and Stones". This standard regulates the organizational and technical side of Navy ship and vessel dismantlement process, including NPSs, surface ships with nuclear installations on board and nuclear service ships (ships with nuclear installations) and establishes the basic safety requirements (including environmental safety) of the processes used.

The standard determines:

1. The organizational aspects of Ships with NPI decommissioning from the Navy and their transfer to dismantlement contractors
2. General requirements to the Ship with NPI dismantlement documentation
3. The dismantlement stages for a Ship with NPI:

I.	Ship with NPI decommissioning from the Navy, preparation for temporary waterborne storage at a Navy base. Temporary waterborne storage by a Navy crew. Ship transfer to dismantlement contractor.
II.	Ship delivery to dismantlement contractor facilities. Preparation for dismantlement
III.	SNF removal, shipment and processing.
IV.	Reactor compartment or reactor section cutting and preparation for storage. Cutting and dismantlement of ship hull and structures, pre-sales processing of ship equipment and cabling and (or) selling of equipment and cabling. Putting reactor section afloat, reactor compartment (room) or reactor section shipment to temporary storage facility.
V	Cutting reactor compartment (room) from the reactor section
VII	Reactor compartment (room) long-term storage
VIII.	RW management.
VIII.	Disposal of Submarine reactor compartment or Surface Ship with NPI on Board reactor room.

4. This Standard also determines:

- specifics of the Ship with NPI on Board dismantlement process at SNF; RW, reactor compartment and floating reactor section management;
- ecological safety requirements to the Ship with NPI on Board dismantlement process;
- fire and explosion safety and unsinkability requirements to ships with NPIs; and
- ferrous, non-ferrous and precious metal handling requirements.

2 Analysis of the main stages of the radiation facility dismantlement and spent nuclear fuel and radioactive waste management process

2.1 Ship decommissioning from the Navy, temporary waterborne storage and transfer to contractor for disposal.

2.1.1 Ship with NPI decommissioning from the Navy and preparation for temporary waterborne storage at a naval base.

NPS, Surface Ship with NPI on Board and Nuclear Service Ship decommissioning from the Navy is performed in accordance with existing legislation (Section 7.1.1 /1/, Section 3.1.1 /2/). The stage of decommissioning and preparation for temporary waterborne storage at a Navy base (as regards nuclear and radiation safety) includes (Item 1 of Table 1 /2/):

- NPI decommissioning in accordance with Navy regulatory guidelines;
- System and equipment shut-down to ensure waterborne storage safety, hull "enveloping" (if necessary); and
- Preparation of the Work Acceptance Certificates.

NPI decommissioning in accordance with Navy regulatory guidelines.

Section 3.1.21 /2/ says that NPI decommissioning involves deactivating the NPI and ensuring safety of the crew (personnel), population and the environment.

For each ship class, there should be a decommissioning project containing (as regards NPI) the following (Section 7.1.2 /2/, Section 13.1 /3/, Section 11.1 /4/):

- NPI nuclear safety insurance procedure, the requirements and arrangements for its implementation;
- requirements to the SNF content before defueling and in the first stage system;
- radiation monitoring - scope and equipment;
- requirements to NPI physical protection before defueling;
- the list of potentially hazardous operations in the steam generator decommissioning, unloading of SNF (incl. associated operations) and the requirements to these operations;
- nuclear and radiation safety arrangements in the fuel management, solid, liquid and gaseous waste management;
- the list of potential accidents, estimation of their consequences and emergency response recommendations to crew (personnel).

Also, the NPI decommissioning operations must be preceded by PHW safety analysis and provided with appropriate Nuclear Safety rules (Section 7.1.2 /2/).

Before ship decommissioning, an Interagency Commission performs Integrated Technical and Radiological Assessment (ITRA) and submits nuclear safety proposals to the Operator and State Nuclear and Radiation Safety Supervision Authority (Section 13.4 /3/, Section 11.3 /4/).

System and equipment shut-down to ensure waterborne storage safety, hull "enveloping" (if necessary).

There are obligatory Storage Safety arrangements for the NPIs of decommissioned nuclear submarines prepared for waterborne storage at naval bases /6/, /7/, /8/).

Preparation of work acceptance certificates.

Ship decommissioning ends with a Navy Commission's Certificate confirming compliance with the decommissioning project and describing the actual condition of a specific NPI, this Certificate is then filed with the Ship Transfer to Dismantlement Contractor documents (Section 13.4 /3/, Section 11.3 /4/).

2.1.2 Ship temporary waterborne storage at a naval base, preparation for transfer to dismantlement contractor.

Decommissioned nuclear submarine is put in a temporary waterborne storage in a holding station and is maintained by the Navy as required by regulatory guidelines, which determine the basic procedure of NPS decommissioning, its preparation for waterborne storage, organization of maintenance, ensuring unsinkability, fire and explosion safety as well as crew routine until transfer to dismantlement contractor. The fuel remains on board (in the reactor mechanism) (Section 7.1.2 /1/)

Interim storage (Fig. 2.1.1) is a dismantlement process stage when a ship prepared for dismantlement is kept and preserved in its storage place for a prescribed period /10/.



Fig. 2.1.1. Heavy nuclear-powered missile cruiser "Admiral Ushakov" in temporary waterborne storage at "Zvezdochka" berth.

From the moment of decommissioning and until their transfer for dismantlement, inactivated nuclear submarines and surface ships with NPIs on board are stored in accordance in special guidelines /1/.

The stage of decommissioning and preparation for interim waterborne storage at a Navy base (as regards nuclear and radiation safety) includes (Item 1 of Table 1 /2/):

- Maintaining ship systems and equipment;
- Ensuring unsinkability, fire and explosion safety, nuclear and radiation safety (if required);
- Changing the water in BST;
- Daily inspections of ship by the duty personnel;
- Regular ship inspections including annual inspection of underwater hull by divers;
- Preliminary assessment of radiological situation on ship; and
- Preparing a Certificate of Readiness for ship transfer to dismantlement contractor.



Fig. 2.1.2. "Echo-II" class NPS in temporary waterborne storage.



Fig. 2.1.3. "Typhoon" class NPS being dismantled at "Sevmash" berth.

2.1.3 Ship transfer to dismantlement contractor

Russian Ministry of Defense prepares and transfers ships to dismantlement contractors in accordance with regulatory guidelines determining the procedure for and the scope of the dismantlement work, interaction and responsibilities of the parties (/7/, /8/).

Russian Ministry of Defense transfers ships with NPIs on board to dismantlement contractors in accordance with section 4.9 /2/. The Navy crew is replaced by a civilian dismantlement contractor crew. Transfer takes place at a naval base or the water space of a dismantlement contractor, using a procedure established by a federal executive agency authorized to manage federal property /14/.

The ship transfer stage includes (Item 3 in Table 1 /14/):

- Creating a Joint Ship Acceptance Commission.
- Transferring to dismantlement contractor the operational and technical documentation ensuring the nuclear and radiation safety, unsinkability, fire and explosion safety.
- Transferring to dismantlement contractor a Reactor Mechanism Condition Report.
- Replacing Navy crew with a civilian crew and documenting the fact.

Interaction between the Navy and dismantlement contractor during nuclear submarine temporary storage at a Naval base from the time of submarine acceptance by the contractor and its transporting to contractor's water space is regulated by /13/ and /17/.

2.1.4 Preparation of a nuclear service ship by Navy for relocating to dismantlement contractor.

Preparation by the Navy of a service ship for relocating to dismantlement contractor is the first stage of the dismantlement process (Section 1.2.2 /18/). Service ship transfer for dismantlement (preparation for temporary waterborne storage) is performed under (Section 1.3.1 /18/).

Service ships shall be transferred by the Navy to dismantlement contractors for dismantlement (preparation for temporary waterborne storage) in a nuclear-safe condition (Section 4.1.1 /18/). Radiation safety during service ship transfer from the Navy to a dismantlement contractor shall be maintained in accordance with Russian legislation /19/, /24/ and existing radiation safety guidelines /11/, /15/, /20-23/.

When preparing a service ship for dismantlement, the Navy shall (Section 2.1.1 /18/):

- remove SNF (for deport ship), high-level solid radioactive waste, fuels, lubricants and service fluids;
- decontaminate equipment and ship structures to the extent ensuring radiation safety of personnel;
- prepare ship for hot, fire and explosion dangerous works.

In addition, inside nuclear service ship hull may be stored mid-level and low-level solid radioactive waste generated in the ship preparation for dismantlement process (containers with solid waste, structural elements with fixed level of contamination, structural elements with induced activity) following their mandatory certification.

Following completion of the preparation works (by the Navy jointly with dismantlement contractor and representatives from SevRAO or DalRAO) the nuclear service ship is subjected to Integrated Technical and Radiological Assessment (Section 2.1.3 /18/).



Fig.2.1.4. PM-32 Depot Ship

Dismantlement contractor (simultaneously with the preliminary technical and radiological assessment) prepares its facilities and services for nuclear service ship reception for dismantlement (Fig. 2.1.4). Naval Force command and dismantlement contractor shall notify the state ordering customer ("Rosatom") about their preparedness for nuclear service ship transfer and receipt (Section 2.1.4, 2.1.6 /18/).

Nuclear service ship transfer is effected by a special Commission established by a joint order of Fleet Commander and Chief Executive Officer of dismantlement contractor. The Commission includes representatives from the Navy, dismantlement contractor, DSS NRS, FMBA, State Sanitary Supervision Authority (GSEN), "SevRAO" (or "DalRAO") (Section 2.3.2 /18/). With the Commission in place, nuclear service ship is transferred from Navy crew (Section 2.4.4 /18/) to a civilian duty crew provided by the dismantlement contractor (Section 2.4.1 /18/).

The responsibility for unsinkability, fire and explosion safety of the nuclear service ship until the Delivery-Acceptance Certificate has been signed rests with the Navy crew (Section 2.4.6 /18/).

Section 2.1 conclusions

- The analysis in Section 2.1. of the dismantlement stages, which are important for assessing the safety of process operations for nuclear facility personnel, population and the environment, including:
 - ship decommissioning from the Navy and its preparation for interim waterborne storage at a Naval base.
 - ship temporary waterborne storage at a Naval base, its preparation for transfer to dismantlement contractor.
 - ship transfer to dismantlement contractor, has shown that most of the work is performed by the Military.

- The "Methodology for Evaluating the Compliance with Nuclear and Radiation Safety Requirements of Contractors Dismantling Nuclear Submarines, Nuclear-Powered Surface Ships and Nuclear Service Ships Decommissioned from the Navy at SNF and Radioactive Waste Management" guidelines under development is aimed at evaluating the compliance of companies, i.e. dismantlement contractors.

- Therefore, it would be reasonable:
 - not to include into the Guidelines the issues, which are Navy's responsibility;
 - to define the requirements of the "Methodology for Evaluating the Compliance with Nuclear and Radiation Safety Requirements of Contractors Dismantling Nuclear Submarines, Nuclear-Powered Surface Ships and Nuclear Service Ships Decommissioned from the Navy" as regards Navy responsibilities in a separate MoD document, applicable only to the appropriate Navy units.
 - the Guidelines under development must address the issues related to acceptance by dismantlement contractors of Ships with Nuclear Installations on Board from the Navy for dismantlement (the stage of ship transfer for dismantlement).

2.2 Preparation for dismantlement

Before delivering the ship to dismantlement contractor for holding anchorage and subsequent dismantlement, the Navy must complete the following works on board:

- remove ammunition, weapons, pyrotechnic devices;
- remove personal possessions of the crew;
- remove fuels and lubricants, except small quantities necessary for towage;
- drain tanks and pipelines of systems not needed for unsinkability, fire and explosion safety;
- decontaminate contaminated facilities and equipment using procedures outlined in existing regulations;
- ensure NPI nuclear safety;
- remove fire- and explosion-dangerous objects and combustible materials.

The Contractor develops or places an order for the development of Ship Towing Project (the list of Towing Project Documents should include the documents specified in /1/, /2/, /3/); prepares a Towing Plan and agrees it by appropriate Navy services and Russian Shipping Register; tows the ship to its water space in accordance with the Towing Plan and the agreed time schedule.

The holding anchorage site must be equipped with an unsinkability center, fire and explosion safety center, radiation monitoring center and decontamination center. The floating dock equipment must be tested and ready for dock operations in accordance with /5/.

After ship delivery, the following is performed in preparation for its dismantlement:

- mooring the ship to the berth;
- installing gangways, false floors, cross-walks, covers;
- connecting the ship to industrial utilities, occupational safety systems, survivability systems;
- establishing and equipping the Restricted Access Zone for ships with NPIs on board;
- operations preparatory for hot, fire and explosion dangerous works;
- radiological assessment of the ship by contractor's Radiation Safety Service;
- storage at Contractor's facilities of radioactive waste generated in the work process;
- other works, which were not performed during the preparation at the Navy base.

In accordance with Regulation /6/, the responsibility for fire and explosion safety, radiation safety, dismantled ship physical protection is on the Duty Service.

Dismantlement work shall be performed in accordance with the design and process documentation for ship dismantlement, developed by the ship and system designers. This includes:

- defueling documentation;
- safety documentation;
- reactor section formation and shipping documentation;
- forward and aft section recycling documentation;
- entire ship recycling documentation; and
- sales documentation for recycle products.

The Contractor needs required permits and licenses (including license period extension) to perform ship dismantlement and recycling work.

2.3 Spent nuclear fuel unloading, shipping and processing

The most important stage as regards nuclear safety during NPS dismantlement is defueling. Defueling removes up to 90% of the activity from the ship, which makes the task of its subsequent storage so much simpler. After a long-term storage of SNF in reactor prior to ship dismantlement, the level of residual heat is much reduced and there is no need for spent fuel assemblies to be stored in the basin of a depot ship. The fuel may be unloaded directly into a transport container. After defueling the reactors may be used as long-term storage containers for high-level solid radioactive waste.

Spent nuclear fuel should be removed from preliminarily drained reactor, which minimizes LRW. Liquid waste is generated in the process of decontaminating the wet fuel assemblies when they are extracted and shipped. Dry defueling significantly reduces radioactive contamination. The design of the active zone, reactor installation and reactor compartment make up a system of protective barriers preventing the spread of fission products at the defueling and SNF storage stage. It includes:

- fuel mixture;
- fuel assembly shell;
- firm and impervious primary circuit;
- reactor compartment limited by the closure bulkheads and the submarine hull between them.

At the defueling stage the last two are missing. Because of this, safety requirements for the defueling stage are much more rigorous.

Radiological impact at the defueling stage.

Radiological impact during SNF unloading under normal conditions includes penetrating gamma-radiation from fission products in the extracted fuel assembly, the products of activation of reactor internal structures and radionuclides deposited on the primary circuit surfaces. Protection of personnel from penetrating radiation is ensured by the transfer equipment design and organizational arrangements. There is an additional radiological impact from fission products that escape from primary circuit coolant during operations with open reactor and are inhaled into the lungs. Radiation monitoring at the defueling stage must include monitoring of gamma-radiation and of the activity of the air inside the reactor compartment and expelled from its ventilation system outlet.

Radiation impact of defueling on the population and the environment is possible only if there are accidents involving release of activity from the fuel into the environment. The assessment of radiation consequences and radiation risks was performed for scenarios including cladding failure in operation, damage to fuel assemblies as a result of dropping a container with fuel assemblies or damage to fuel assemblies in the process of their unloading including fuel assembly rupture.

The most serious consequences may result from an accident causing a self-sustained chain reaction (SSCR). The radiological impact in this case includes: external exposure to radiation from fission products as the radioactive cloud passes over, external exposure to surface radionuclides in the cloud trail (fallout), internal exposure to fission products inhaled and ingested with food.

Radiation monitoring for a SSCR accident with radioactivity released into the environment is aimed at reducing the radiological consequences and includes monitoring the air, land, surface water bodies and food.

Radiological impact at the stage of SNF storage and shipping.

Removed SNF is stored in sealed casings, which serve as protective barriers for fission products. Additional protection in storage and shipping is provided by containers. The main radiation impact factor under normal SNF storage and shipping conditions is penetrating gamma-radiation from fission products. Radiation safety of the personnel and population is achieved by a bioshield included in the design of SNF

storage facilities, storage and shipping containers. Radioactivity may be released only if the casing or container is damaged, for instance as a result of an external event (fire, container drop) when the loads exceed the design limits. The scope of radiation monitoring at this stage should include monitoring of the penetrating gamma-radiation in the storage and transportation facilities as well as of the structural integrity and impermeability of protective barriers.

At the stages of SNF unloading and management, the safety is ensured by arrangements aimed at preventing personnel errors and at implementing the required safety and process procedures.

Analysis of dismantled NPS radiation and environmental safety. Radiation risk assessment.

The analysis of radiation and environmental safety at the stage of SNF unloading was performed for the city of Severodvinsk and in regard "Zvezdochka" shipyard operations, based on the analysis of the radiation impact of the Design and Beyond-Design Accidents and the assessment of the radiation risk.

➤ **Radiation impact of the design accidents**

Radiation consequences of design accidents at the stage of defueling are caused by the release into the atmosphere of fission products from fuel assemblies damaged in a drop or during the unloading process. The maximum figure is for a scenario when all the volatile fission products from a damaged assembly (krypton-85, iodine-129) have been released. The maximum effective radiation exposure for population in an accident involving damage to fuel assembly during unloading would be 10^{-6} Sv (0.1 mRem).

➤ **Radiation impact of the beyond-design accidents**

If a submarine sinks during defueling, it will be in a coastal zone, in shallow waters, close to a base or a shipyard. This will facilitate prompt salvage. Based on past experience, the time until the ship is lifted is around 2 months. Should the submarine sink during defueling, its reactor will be flooded with sea water. The consequences of releasing the radiation into the water are estimated 0.5 mSv of population exposure dose and this comes entirely from sea food.

An airplane crash into an NPS is an extremely low probability event. An airplane hitting the reactor compartment during defueling may produce grave radiation consequences, since there are no design barriers in this case such as submarine hull and reactor cover. An airplane crash would cause fire in the section from burning jet fuel. According to studies, the dynamic impact will not be strong enough to destroy reactor core and release fission products from SNF.

A fire in the section, if it's localized and takes a few hours to extinguish, will not cause release of fission products from nuclear fuel in reactor core. The radiation consequences in this case are caused by the release into the atmosphere of the primary circuit coolant activity, mostly in the form of caesium-137. The effective exposure dose for population will not exceed $3 \cdot 10^{-3}$ mSv, which is much lower than the 1 mSv population exposure limit specified in NRB-99.

Conservative estimates show that the direct hit from an aircraft and the resulting fire with the fuel assembly container on the table of the guide mechanism or inside the reactor compartment will damage the container (cause loss of its leak integrity) and heat the fuel assemblies to 800–850 °C.

Most of the released activity will be carried with smoke into the atmosphere. Studies show that the population exposure dose will be determined by the radiation from caesium-137 fallout. The effective annual population exposure dose at the edge of sanitary shelter zone will be $1.1 \cdot 10^{-3}$ Sv, which is not above the levels, as specified in NRB-99, requiring protective population exposure reduction measures.

The most dangerous accident that may happen at the stage of defueling is an accident involving self-sustaining chain reaction (SSCR). We should say here that the possibility of SSCR accidents has been totally eliminated by proper technical and organizational arrangements. They are considered here as

hypothetical events for illustrating the possible consequences of not complying with the safety rules and for protective measure planning purposes.

The radiation consequences of a SSCR accident are due to the emission of radionuclides, which the SNF contained and those generated during the burst. The effective annual exposure dose at the edge of sanitary shelter zone will not exceed 100 mSv (12 mSv from the radioactive cloud, 74 mSv from the fallout, and 14 mSv due to inhalation). At the city border, the population exposure dose will not exceed 63 mSv, which does not require compulsory evacuation but calls for protective measures (restrictions on the consumption of local food, etc.).

➤ **Radiation risk assessment.**

Risk assessment at the defueling stage helps to identify the most potentially dangerous accidents so that we can try to exclude them or reduce their probability and thereby improve the safety of this phase in nuclear submarine life cycle. Multiple violations of the regulations or external factors may, indeed, cause the release of the radioactivity accumulated in SNF into the environment at the defueling stage. Thus, it is important to control the reliability of personnel as was pointed out in the FMBA PRM project (see FMBA report on the "Monitoring the Risks of Personnel Losing its Professional Reliability at Operations with Spent Nuclear Fuel at Andreyeva Bay so as to Improve the Radiological Safety" project. Moscow, 2009).

Among all possible accidents, there are accidents with localized radiological consequences, which should be considered only in the context of personnel safety. This category includes dropping the container with fuel assemblies and damage to the assemblies during their unloading. The second category produces graver consequences that should be considered as risk factors for population. This category includes SSCR accidents and NPS sinking during defueling.

Because of existing design, technical and organizational safeguards a SSCR accident is considered as an extremely low probability event. The probability of SSCR accident is estimated at $3.3 \cdot 10^{-6}$ 1/year. The risk of an SSCR during defueling does not exceed $2.4 \cdot 10^{-8}$ 1/year. The risk of a submarine that has a leaking primary circuit sinking during defueling is $\sim 8 \cdot 10^{-4}$. The risk of an NPS sinking during defueling does not exceed $7.0 \cdot 10^{-8}$ 1/year.

Thus, the radiation risk of the defueling process is estimated at $\sim 10^{-7}$ 1/year. This is lower than the unconditionally acceptable risk limit of $1 \cdot 10^{-6}$ 1/year specified in NRB-99.

2.4 Preparing reactor compartment or reactor section for storage

Reactor section cutting must be performed by a company that has necessary capacity and facilities. Reactor section cutting includes the following main steps:

- reactor defueling;
- putting NPS into dock;
- cutting the sub into three sections – forward section, reactor section with reactor compartment and aft section;
- removing bulky equipment;
- preparing reactor section for temporary storage;
- cutting forward and aft sections into portions;
- putting the reactor section afloat, acceptance by the customer;
- recycling of the remaining products from submarine dismantlement;
- collecting, temporary storage and transfer of toxic industrial waste for disposal;
- ensuring reactor section survivability, preparation for its shipping to temporary storage site;
- implementing reactor section corrosion protection measures;
- ensuring reactor section radiation safety during its cutting and storage.

The reactor section is cut and formed in accordance with Central Design Bureau (TsKB) documentation – TsKB is NPS designer company. This documentation has been developed using /1-9/.

The reactor section may be shipped to its storage place using a floating transportation dock or other means of transportation such as lifting pontoons or a specially equipped barge. The floating storage period for reactor section should be 10 years at the minimum.

After cutting, the structures of the forward and aft sections are removed from the dock. Dismantled structures are cut into pieces not larger than 800x500x500 mm in accordance with GOST 2787-1997. During recycling the metal is separated and sorted.

The forward and aft section equipment recycling process includes:

- preliminary sorting of equipment during dismantlement;
- disassembly of equipment to extract/sort ferrous and non-ferrous metals;
- collecting and sorting of liquid and solid waste;
- sorting ferrous and non-ferrous scrap into different groups;
- cutting bulky parts to size;
- storing commercial scrap before shipping;
- selling the scrap.

The electrical equipment recycling process includes:

- preparing secret equipment for recycling;
- dismantling and sorting the electrical equipment into two groups: with precious metals and alloys and without such metals;
- extracting components and assemblies containing precious metals and alloys;
- disassembly of electrical equipment;
- processing of components and assemblies containing precious metals, returning the remaining product to the recycling contractor;
- sorting the metal scrap and non-metal materials.

2.5 Cutting the reactor compartment from reactor section

Reactor compartment cutting must be performed by a company that has necessary capacity and facilities. To prepare the reactor compartment for cutting:

- perform radiological assessment of the reactor section;
- unload SNF from reactor section reactors;
- remove liquid radioactive waste (heat transfer fluids from the primary, second and third circuits of the steam generator, fluids from feed and drain tanks);
- remove from reactor compartment all liquid and gaseous mediums, lubricants and toxic materials and (if necessary) valuable equipment and products even if they do not constitute solid radioactive waste;
- drain all tanks then open and clean them; wash, steam-clean and ventilate all oil and fuel tanks and pipelines; and
- prepare the reactor section for hot and fire-hazardous works.

The reactor section is formed and prepared for long-term storage using the design documentation developed by TsKB on the basis of /1-9/. The process of a single-compartment reactor section formation and preparation for long-term storage includes a number of steps, among them:

- external radiological assessment to determine the limits of the supervised zone, and provide recommendations on the use of gamma-radiation shields;
- establishing a radiological Restricted Access Zone (RAZ) with restricted access and radiological control; and
- installing a radiation monitoring system in the Supervised Zone.

The reactor compartment is then cut from the reactor section, the external surface of the section is covered with a radiation-resistant, easily decontaminated anticorrosion coating, with 10-12 years of service life in the coastal climate of Northwestern Russia.

The section is then marked with radiation hazard warning signs and an identification plate is attached showing:

- NPS project number;
- NPS serial number;
- the date of reactor shutdown;
- the date of completing the preparation of the section for long-term storage;
- single-compartment reactor section manufacturer.

The size and weight of a reactor section prepared for long-term storage should not be over:

- length – 14.2 m;
- width – 12.5 m;
- height – 12.2 m (with supports);
- weight – 1510.0 t (including additional solid radioactive waste and supporting structures).

The main radiological and technical parameters of a reactor section prepared for long-term storage should be documented in a certificate. The format of a certificate for a single-compartment reactor section is developed by TsKB – the NPS designer firm.

2.6 Long-term storage of reactor compartment

Nuclear submarines and ships with nuclear installations on board are dismantled using the "postponed" disposal method for radiation-hazardous equipment, which involves holding the equipment inside reactor compartments of nuclear submarines and reactor rooms of nuclear surface ships, specially prepared for long-term storage /1/.

The reactor compartments and reactor rooms are held in long-term storage facilities until their radiation intensity drops to a level at which they can be safely disposed of (about 70 years after the shutdown). In Northwestern Russia there is a shore-based long-term storage facility for 150 reactor compartments in the area of Saida inlet, Kola Bay. In the Far-Eastern Russia, a 100-reactor compartment long-term land-based storage facility is being built in the area of Razboynik Bay. The planned commissioning date – in the year 2015.

All the shipyards, with the exception of "Nerpa", which has the infrastructure for transferring the reactor section onto a floating transportation platform, continue to cut and prepare three-compartment floating reactor sections (see Fig.2.6.1, 2.6.2). The technology used in the preparation of three-compartment sections, allows keeping them in floating storage up to 10-12 years.



Fig.2.6.1. Three-compartment reactor section from dismantled NPS in a floating dock



Fig. 2.6.2. Three-compartment reactor sections from dismantled NPS in a floating temporary storage facility at Razboynik Bay

As the new long-term reactor compartment storage facility at Saida undergoes commissioning, "Nerpa" shipyard started to prepare for the long-term storage at this facility the reactor compartments from dismantled nuclear submarines and those from the reactor sections currently in floating storage whose storage time has expired (see Fig.2.6.3). The preparation of reactor compartment for long-term storage at a land-based long-term storage facility is performed in accordance with guidelines /2, 3/ and the Process Instructions /4/.

To reduce the intensity of radiation from reactor shell, a volume is created in the lower part of the compartment using sheet steel, which is filled with concrete.



Fig. 2.6.3. Preparation of the reactor compartment from dismantled Project 705 nuclear sub with titanium hull at "Nerpa" shipyard.

Reactor compartments are stored in an open storage area of the LSF. During their long-term storage the compartments are subjected to weather, causing the paint coat to crack and the open surfaces of the reactor compartment shell to corrode with the flaked paint and corrosion products dropping to the ground. To ensure the longest possible life of the paint covering the outer surfaces of reactor compartment shell (15 to 20 years), a protective coating from an Israeli "DENBER" company is used (the life is 20 years minimum). The anticorrosion coating is applied during reactor compartment preparation for the long-term storage in accordance with the Process Instructions /4/.

To maintain integrity of the anticorrosion coating on the outer surfaces of reactor compartments, a special reactor section cleaning and painting facility is being built at Saida. This project is financed the international technical aid money, the donor is Germany. The facility should be completed by the end of 2010.

With this facility in place, the final painting of the reactor compartments prepared at "Nerpa" (application of anticorrosion coating to external metal surfaces) will be performed here.

Prepared compartments are shipped from "Nerpa" to the land-based long-term storage facility on board a specially equipped floating transfer dock (PD-42) ("Pallada") (see Fig.2.6.4 (a) and Fig.2.6.4 (b)).



(a)



(b)

Fig. 2.6.4. (a, b). Transfer of a reactor compartments prepared for long-term storage from "Nerpa" slipway to "Pallada" floating dock and reactor compartment disposal for shipment.

Fig.2.6.5. shows reactor compartment shipment from "Nerpa" shipyard to Saida LSF on board "Pallada" floating dock. At present there are 40 reactor compartments the land-based LSF. Fig.2.6.6 shows the disposition of reactor sections from dismantled nuclear submarines at "Saida" as of 01.01.2008.

Nuclear submarine reactor section (nuclear ship reactor room) is a sealed structure containing radioactive equipment and materials. In accordance with Guidelines /5/, low- and intermediate-level solid radioactive wastes generated in the NPS dismantlement process are placed in the reactor compartment. The waste should be packaged in certified containers. Also, reactor compartments may be used to put in large-size solid radioactive waste, which is disposed as directed by NPS designer.



Fig. 2.6.5. Reactor compartment shipment from "Nerpa" shipyard to Saida LSF on board "Pallada" floating dock.

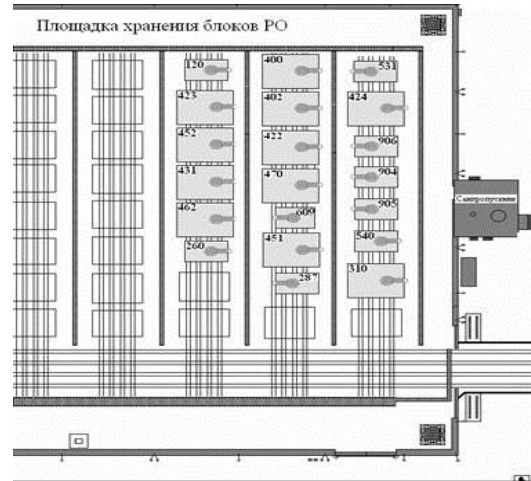


Fig. 2.6.6. Disposition of reactor sections from dismantled nuclear submarines at "Saida" as of 01.01.2008.

Fig. 2.6.7 and 2.6.8 show the disposition of reactor compartments in long-term storage stations at "Saida" LSF



Fig. 2.6.7 Reactor compartment in a long-term storage station at "Saida" LSF



Fig.2.6.8 Disposition of reactor compartments in a long-term storage stations at "Saida" LSF

Regulatory guidelines /5/ determine the maximum quantity (weight) of solid radioactive waste, which may be loaded in the reactor compartment. Each container with solid waste has a packing list inside, showing the type of waste and its characteristics, is labeled as required in /6/ and provided with a certificate.

Reactor compartment formation includes removing all the coolants from all circuits and draining all service fluids and water from ship system pipelines, equipment, feed and train tanks as well as holds. The activity from radioactive equipment and solid waste stored in the reactor compartment at a distance of 1 meter from the compartment does not exceed 10 micro-roentgen/hr of gamma-radiation dose rate /6/.

It is not allowed to store high-level solid waste in the reactor compartment (with the exception of Reactor Control and Protection System cartridges placed in reactors and the ion exchange resins in the activity filters of the three heat-transfer circuits if and when permitted by the Steam Generator designer), as well as flammables, activity filter traps, liquid radioactive waste, toxic chemicals, fuel assemblies, fuel elements or their components.

Reactor compartment maintenance and operation in a land-based LSF does not require control of its internal conditions.

The reactor sections kept at a land-based LSF are operated by trained regular personnel, who have the required technical skills and medical clearance.

The LSF at Saida is operated in accordance with Technology /7/, which determines the single-compartment reactor section handling procedure. There is organizational and operating documentation for Saida LSF developed on the basis of this Technology.

The Technology determines the main process procedures used at Saida:

- ensuring radiation safety of personnel and population during reactor section shipping, maintenance and storage;
- ensuring protection of the environment and population during reactor section long-term storage in a land-based storage area; and
- ensuring safe shipping and storage of reactor sections.

The safety of the long-term storage of reactor sections in accordance with /2/ at Saida is ensured by the following departments:

- Radiation and Environmental Safety;
- Security and Physical Protection;
- Communications and Warning;
- Power Supply;
- Health and Amenities;
- Shipping and Dispatching Service; and
- Records Management and Storage.

Reactor section maintenance during long-term storage includes:

- Regular inspection of the mechanical security of reactor section mounting on the supports and supports condition (once every six months and following any abnormal events or accidents at the LSF);
- Radiation control (once every six months) conducted in accordance with LSF construction project as agreed by GosSanEpidNadzor (Section 2.4.4 OSPORB-99 /8/);
- Checking the integrity of fasteners at the reactor compartment access openings (once every six months);
- Renovation of the anticorrosion coating(once every 20 years) in accordance with /4/;
- Checking the leak integrity of reactor compartment once every 10 years
- Taking a gas sample from reactor compartment internal volume once every 10 years; and
- Removing snow from under the reactor compartment shell to prevent the bottom of the shell from touching the snow.

Any deficiencies in the reactor compartment preparation for long-term storage discovered during the warranty period should be remedied in accordance with /9, 10/.

2.7 Radioactive waste management

Generation of liquid and solid radioactive waste during dismantlement of nuclear submarines, surface ships with nuclear installations on board and nuclear service ships is an inevitable part of the process. In NPS dismantlement, LRW is generated in the following processes:

- preparing the primary circuit for long-term storage, taking samples;
- disassembly of CPS units;
- unloading reactor active zone;
- draining the second and third circuits;
- draining internal and external bioshield tanks (BST);
- deactivation of removable NPS equipment, reactor compartment, apparatus and instrumentation; personal protective equipment, etc.;
- draining the primary circuit drain tanks and reactor compartment hot water tank.

Table 2.7.1 shows the NPS dismantlement operations generating LRWs and the approximate LRW quantities for each, Table 2.7.2 - the Project 1144 surface ship dismantlement operations and the quantities. Table 2.7.3 shows the types and characteristics of LRW generated from the dismantlement of one Project 1144 surface ship. To ensure conservative approach, the quantities shown in Fig. 2.7.1 and 2.7.2 are the maximum possible quantities. It is virtually impossible for forecast the quantity of LRW generated in a special laundry. A conservative figure for LRW from dismantlement is 150 - 270 m³.

The SRWs from NPS dismantlement include unrecyclable parts and materials as follows:

- NPI large-sized equipment (steam generator, compressors, pumps, filter coolers, etc.), primary circuit fittings and piping;
- filter materials removed from the Primary and the Third circuit activity filters (if required);
- metal structures, tooling, pieces of electric wire, etc;
- PPE, E&T, isolation (plastics, polyethylene, rubber, etc.);
- filters from Special Ventilation and vacuum systems;
- decontamination wastes;
- spent sources of ionizing radiation used for auxiliary purposes (gamma-ray inspection, checking the operation of radiation control instrumentation).

Table 2.7.1: Approximate quantities and specific activity of LRWs generated at the dismantlement of one Project 971 nuclear submarine

LRW description	Volume m ³	Specific activity, Bq/kg	LRW type
1 Low-salinity LRW			
1.1 Water drained from the primary circuit	20	$3.7 \cdot (10^5 - 10^8)$	Distillate
1.2 Process water from the third circuit	25	$3.7 \cdot (10^3 - 10^5)$	Process water (acidic, alkaline)
2 Saline LRW			
2.1 Reactor Compartment and E&T decontamination water	10	$3.7 \cdot (10^2 - 10^4)$	Process water (acidic, alkaline)
2.2 Water drained from bioshield tanks			
2.2.1 Water drained from the external bioshield tank	75	$3.7 \cdot 10^2$	Sea water

LRW description	Volume m ³	Specific activity, Bq/kg	LRW type
2.2.2 Water drained from the internal bioshield tank	30	$3.7 \cdot (10^2 - 10^3)$	Retarding solution (potassium chromate)
2.3 Water from special laundry		$3.7 - 3.7 \cdot 10^2$	Alkaline solution
Total	≈150	–	–

Table 2.7.2: Approximate quantities and specific activity of LRWs generated at the dismantlement of one Project 1144 nuclear submarine

LRW description	Volume m ³	Specific activity, Bq/kg	LRW type
1 Coolant from the primary circuit and process water from the third circuit	100 – I Cat. 100 – III Cat.	$3.7 \cdot (10^6 - 10^8)$	Distillate
2 Reactor Compartment and E&T decontamination water	50	$3.7 \cdot (10^6 - 10^8)$	Acidic and alkaline water
3 Process water from hot water tank and the holds.	20	$3.7 \cdot (10^6 - 10^8)$	Process water
4 Water from special laundry	–	$3.7 - 3.7 \cdot 10^2$	Alkaline solution
Total (excluding the laundry)	≈270	–	–

Table 2.7.3: Description and characteristics of LRWs generated from the dismantlement of one Project 1144 surface ship.

LRW description	Category	Chemical nature	Radionuclide composition
Solutions from the primary circuit	Low-level radionuclides (β-γ radiation)	Low-salinity non-organic	³ H, ¹⁴ C, ⁵¹ Cr, ⁵⁴ Mn, ⁵⁷ Mn, ⁵⁵ Fe, ⁵⁹ Fe, ⁵⁸ Co, ⁶⁰ Co, ⁹⁰ Sr, ⁹⁰ Y, ⁹⁵ Zr, ⁹⁵ Nb, ⁹⁹ Mo, ¹³⁴ Cs, ¹³⁷ Cs, ¹³⁸ Ba, ¹⁴⁰ La, ¹⁴⁴ Ce, ¹⁰⁹ Rh, ¹⁰⁶ Ru, ¹³¹ I, ¹⁵⁴ Eu, ¹⁵² Eu, ¹⁵³ Gd, ¹⁸⁷ W
Spent decontamination fluids	Low-level radionuclides (β-γ radiation)	Saline, non-organic	¹⁴ C, ⁵¹ Cr, ⁵⁴ Mn, ⁵⁷ Mn, ⁵⁵ Fe, ⁵⁹ Fe, ⁵⁸ Co, ⁶⁰ Co, ⁹⁰ Sr, ⁹⁰ Y, ⁹⁵ Zr, ⁹⁵ Nb, ⁹⁹ Mo, ¹³⁴ Cs, ¹³⁷ Cs, ¹³⁸ Ba, ¹⁴⁰ La, ¹⁴⁴ Ce, ¹⁰⁹ Rh, ¹⁰⁶ Ru, ¹³¹ I, ¹⁵⁴ Eu, ¹⁵² Eu, ¹⁵³ Gd, ¹⁸⁷ W
Laundry solutions	Low-level radionuclides (β-γ radiation)	Organic; Saline, non-organic	⁶⁰ Co, ⁹⁰ Sr, ¹³⁷ Cs

Table 2.7.4 shows the quantities of SRWs for Project 971 sub and Table 2.7.5 for Project 1144 surface ship. Table 2.7.6 shows the types and characteristics of SRW generated from the dismantlement of an NPS (one Project 1144 surface ship).

Table 2.7.4: Approximate quantities and characteristics of SRWs generated at the dismantlement of one Project 971 nuclear submarine

SRW description	Quantity, m ³	Contamination level, β-particles/(cm ² ·min)	Specific activity, Bq/kg
1 Metal structures (equipment, piping, fixtures)	8	10 ² – 10 ³	1·10 ² – 1·10 ⁶
3 Waste cloth, PPE, planking, cork, canvas, paper, timbers, etc.	10	10 ² – 6·10 ²	10·10 ⁶
4 Plastics, rubber, wires, hoses, etc	50	10 ² – 10 ³	1·10 ² – 1·10 ⁶
Total:	≈ 80	–	–

Table 2.7.5: Approximate quantities and characteristics of SRWs generated at the dismantlement of one Project 1144 surface ship

SRW description	Quantity, m ³	Contamination level, β-particles/(cm ² ·min)	Specific activity, Bq/kg
1 NPI equipment (metal structures, piping, etc.)	15	Above 50	3.7·(10 ⁸ – 10 ⁹)
2 Insulating coatings, PPE, cork, asbestos cloth, etc.	8	Below 50	3.7·(10 ⁵ – 10 ⁶)
3 Pieces of electric wire, drainage hoses for "dirty" water, rubber coating, plastics, etc.	30	Below 50	10 ⁴
Total:	53	–	–

Table 2.7.6: The types and characteristics of SRWs generated from the repair and dismantlement of an NPS (one Project 1144 surface ship).

SRW description	Category	Physical nature	Processing method	Radionuclide composition
1 Metal structures	Low-level radionuclides (β-γ radiation)	Non-combustible	Decontamination, shredding	⁶⁰ Co, ⁹⁰ Sr, ¹³⁷ Cs
2 Waste cloth, clothing, PPE, planking, cork, canvas, etc.	Low-level radionuclides (β-γ radiation)	Combustible	Compression; burning; shredding	⁶⁰ Co, ⁹⁰ Sr, ¹³⁷ Cs
3 Plastics, rubber, wires, hoses	Low-level radionuclides (β-γ radiation)	Combustible	Compression; shredding	⁶⁰ Co, ⁹⁰ Sr, ¹³⁷ Cs
4 Secondary SRW	Intermediate-level Low-level radionuclides (β-γ radiation)	Non-burning	Not processed	⁵⁵ Fe, ⁶⁰ Co, ⁶³ Ni, ⁹⁰ Sr, ¹³⁴ Cs, ¹³⁷ Cs
Notes				
<p>1 The values are for Project 667 submarine – a typical representative of the second and third-generation submarines.</p> <p>2 For Project 941 subs, most of the SRW activity is due to the following radionuclides: ⁶⁰Co, ⁹⁰Sr, ¹³⁴Cs, ¹³⁷Cs, ¹⁵²Eu, ¹⁵⁴Eu, ²⁴¹Am, ²³⁹Pu.</p> <p>3 The "Radionuclide composition" column shows only the radionuclides contributing most of the equivalent exposure dose, the contribution of other components is negligible.</p> <p>4 Secondary SRWs are those generated in RW processing.</p>				

The first step in RW management is collection. As required by regulatory documents, RW should be collected in specially allotted and equipped sites located at or in close proximity to the places where RWs

are generated. RW is collected and sorted into different categories and groups according to their classification, handling and processing methods.

Special containers for LRW, containers for SRW and bins for large-size equipment should be manufactured to supply specifications, and certified as required by existing regulations.

Full LRW and SRW containers should be closed securely.

The LRW and SRW transportation system should ensure safe carriage of RW along the agreed and approved routes between facilities where they are generated, temporarily stored and processed by means of special lifting and transport vehicles.

LRW and SRW may be put into interim storage only in separate dedicated facilities for different waste categories. RW storage should be considered as an intermediary stage in preparation for their processing or burial. The time of the interim storage after receiving RWs and sending them to processing and (or) burial should be as specified in the project.

The processing methods are selected based on RW characteristics, process performance, interim storage time and conditions, shipping conditions and the RW burial procedure used by the Prime Contractor.

At each stage of RW management you should take into consideration the factors, which determine the magnitude of the radiation hazard as well as the specifics of the procedure. The main determinants of the degree of the radiation hazard:

- RW physical state;
- the amount of activity;
- the type and intensity of ionizing radiation
- half-life period of the radionuclides;
- type and condition of the container (package).

There is a risk of radiation accident during RW management operations (due to violation of rules and regulations and poorly maintained waste-handling equipment). So, in addition to organizational arrangements, it is necessary to ensure proper maintenance of the equipment and facilities.

2.8 Reactor compartment dismantlement

This Section has been prepared based on the "Key Organizational and Process Solutions for Comprehensive Reactor Compartment Dismantlement" NIADI.222.0015, "Onega" Process Engineering and Research Bureau 1995 The Organizational and Process procedure for reactor compartment dismantlement includes preparatory activities and RS dismantlement activities, including setting up process positions, development of RW flow diagram, performing operations at different positions. The preparatory stage comprises:

- unloading the active zone;
- removing all service fluids from I, II, III circuits, bioshield tanks and other ship systems;
- draining the holds;
- decontaminating the compartment;
- sealing the hull; and
- radiologic assessment of the reactor compartment.

The entire reactor compartment dismantlement cycle is split into several process stages. The works include:

- preparing RC for shipping to Dismantlement Contractor;
- shipping RC to Dismantlement Contractor;
- installing RC in SRPB;
- partial dismantlement of "clean" hardware;
- cutting hull structures;
- dismantlement of "contaminated" hardware;
- final cutting of hull structures;
- sending the metal for processing;
- LRW processing;
- SRW processing;
- SRW packaging;
- interim storage of SRW containers;
- transporting the SRW containers to regional burial site; and
- handing over the SRW containers to the regional burial site for burial.

In accordance with existing rules and regulations, the Building should meet the Radiation Safety, Seismic Resistance and Fire Safety specifications. All the rooms of SRPB (with the exception of some welfare and service facilities) should be included in the Restricted Access Zone (RAZ).

SRPB layout should match the process cycle and meet regulatory requirements as well as take into account the existence of "clean" zone and RAZ. Auxiliary buildings and facilities are in the "clean" zone RAZ accommodates:

- SRW storage facility;
- defective item storage facility;
- storage facility for nominally clean metal;
- storage facility for empty SRW containers.

SRPB design should ensure ecological safety of the RC dismantlement process. The following should be provided:

- SSZ Zone and Supervised Zone (SZ);
- arrangements aimed at protecting SRPB territory from radioactive contamination during RC storage, shipping and dismantlement;
- filtering out of radioactive aerosols from the air discharged from RAZ rooms into the atmosphere;
- radiation monitoring of the soil, water resources and the atmosphere in the vicinity of SRPB.

3 Development and validation of the decision making criteria

3.1 Analysis of the data validating the nuclear and radiological safety of the Radiation Facility Dismantlement and Spent Nuclear Fuel and Radioactive Waste Management activities

3.1.1 Documents validating nuclear and radiation safety at the stage of NPI Decommissioning

The following Nuclear and Radiation Safety documents are analyzed at the stage of NP Decommissioning:

- decommissioning program;
- decommissioning works safety validation report;
- decommissioning work quality assurance program;
- personnel emergency protection plan;
- Inventory Count Certificate for the equipment and facilities to be decommissioned (cut and recycled);
- Radiological Assessment Certificate for the equipment and facilities to be decommissioned (cut and recycled);
- list of decommissioning contractors and the information about their RosTechNadzor licenses;
- certificate of physical protection for storage locations of radioactive substances, sources of radiation, RAS and RW storage facilities.
- RAS and RW control and accounting certificate;
- organizational plans for technologically complex and labour intensive works resulting in high exposure doses for the personnel;
- agreement of all necessary RW parameters with the organization, which accepts RW for storage;
- availability of annual and milestone progress reports on the decommissioning of ship (service ship) NPIs.

Nuclear installations (NI) here are floating, transportation and transportable platforms with nuclear reactors; nuclear service ships designed for storing and carrying nuclear materials. Radiation sources here are ships with nuclear reactors transferred into the category of radiation sources; nuclear service ships designed for storing and carrying RAS and RW.

Decommissioning program.

Ship NI decommissioning program is a document specifying the types of NI decommissioning works and corresponding process procedures, the order of their implementation and the required human, financial and materials resources at each NI decommissioning stage.

The program should incorporate the safety principles:

- staying within the limits of allowable personnel and population exposure doses, staying within the limits of allowable RAS emissions (discharges) and reducing the radiation impact from NPI on the personnel, population and the environment to minimum practicable values;
- minimizing the amount (volume) of generated RW;
- eliminating from the process any reused materials (elements) with radioactive contamination levels above the limits specified in sanitary rules for radiation safety.

Decommissioning works safety validation report

This report should substantiate the selected decommissioning option based on the following:

- possible continued use of the decommissioned NI and ship;

- estimated technical and radiological condition of the NI at the moment of reactor decommissioning and the feasibility of forecasting the NPI and ship condition during NI decommissioning;
- assessments of possible radiological impact on the personnel, population and the environment;
- existing safety rules and regulations;
- estimates of the quantities, types and physical state of generated RW;
- availability of RW management equipment and processes;
- availability of RW storage facilities, etc.

The following is to be prepared and presented:

- RW generation diagram and the estimates of RW types and total quantities;
- diagrams for RW management (separate for SRW, LRW and GRW) at a specialized RW management facility.

The Safety Validation Report should show in what way the following is to be achieved:

- staying within the exposure dose limits for the personnel, population and the environment;
- minimizing the quantities (volumes) of RWs generated;
- reducing the RAS released into the environment to an absolute minimum.

The Safety Validation Report should detail the requirements as to the types and scope of radiological monitoring as well as specify the protection equipment to be used by the personnel and the air filtration equipment in the local ventilation systems.

The report must show that the radiation monitoring system will remain functional after reactor shut-down throughout the entire period of the decommissioning works and is capable of measuring:

- specific activity of the wastes and reused materials;
- intensity of gamma-radiation in the rooms;
- intensity of gamma-radiation from separate assemblies and items of equipment;
- surface beta-contamination of equipment and rooms;
- specific volumetric activity of particulate air pollutants.

Also, you must show that the external dosimetry system ensures control over the release into the environment of any of the radionuclides or their mixtures generated from NPI decommissioning activities.

Decommissioning work quality assurance program.

QAP details the organizational and technical Quality Assurance arrangements influencing NI (SR) safety.

QAP must include the following sections:

- Quality assurance policy;
- Organizational aspects of quality assurance;
- Recruitment and training of personnel;
- Regulatory documents;
- Document management;
- Element, component, material and service procurement management;
- Operator and Subcontractor Organization operations;
- Supervisory control;
- Test control;
- Metrological assurance;
- Software and Analytical Methodology quality assurance;
- Reliability assurance;
- Non-conformity control.
- Corrective measures;
- Quality assurance documentation; and
- Inspections.

Personnel emergency protection plan.

Emergency protection plans for Decommissioning Contractor personnel, population and the environment should be developed and prepared before starting the NPI decommissioning work. These plans must be

harmonized with the Protection Plan for the population residing in close proximity to the decommissioning facilities.

The Population Protection Plan should provide for coordination of efforts between facility- and territory-based Civil Defense and Emergency units, Russian Federation Subjects, local administrations as well as ministries and agencies taking part in the emergency response and protection. The Personnel and Population Protection Plan must be agreed by local authorities and governmental Radiation Safety Supervision and Control agencies.

The Plan must specify the organizational and technical measures and actions to be taken to protect the personnel in the event of an accident as well as the Radiation Emergency Procedure. Ship's Plans should be revised at least once every five years. The information in Ship Plans that is changed frequently (personnel lists, telephone numbers, etc.) should be regularly updated.

Inventory count certificate on the equipment and facilities to be decommissioned (cut and recycled).

Technical assessment of NPI is performed to obtain data on the technical condition of all NPI systems (components) as well as ship structures.

Radiological Assessment Certificate for the equipment and facilities to be decommissioned (cut and recycled).

Radiological assessment is performed to obtain data on radiological conditions in the reactor compartment and other rooms of the ship and on the amount and activity of RWs on board, their physical state and radionuclide composition. The radiological condition info includes:

- gamma-radiation dose rates, levels of radioactive contamination of surfaces in ship rooms (compartments), concentrations of radioactive particulate pollutants and gases in the air in ship rooms (compartments);
- gamma radiation dose rates, levels of radioactive contamination of the infrastructure (piers, docks, slipways, shops, etc.) used for NPI decommissioning and concentrations of radioactive particulate pollutants and gases in the air in the Sanitary Shelter Zone and the decommissioning activities zone.

The radiological assessment information includes:

- the list of radiologically contaminated facilities, detailing the area, types of the surfaces and coatings, radionuclide composition and activity levels of contaminated surfaces;
- LRW quantities, their activity, radionuclide and chemical composition;
- SRW quantities, their activity, radionuclide and chemical composition.

Once the radiological assessment of ship rooms (compartments) has been completed, the following shall be determined:

- ship radioactive contamination zones and lines;
- levels of surface contamination;
- levels of sub-surface contamination; and
- quantities and radionuclide composition of radioactive sediments.

List of decommissioning contractors, RAS and RW Control and Accounting Certificate.

Both the List and the Certificate are in the set of documents required by Appendix 4 to the "Administrative Regulation on the Execution of the Licensing Function in the Area of Nuclear power by the Federal Service for Ecological, Technological and Nuclear power Supervision", validating the radiation and nuclear safety arrangements at NPF decommissioning /1/.

Organizational plans for technologically complex and labour intensive works resulting in high exposure doses for the personnel.

These plans should demonstrate compliance with the "validation, rate setting and optimization" principles formulated in Art. 3 of Federal Law No. 3-FZ "On Radiation Safety of Population".

Agreement of all necessary RW parameters with the organization, which accepts RW for storage.

This document confirms that characteristics of RWs transferred to RW Contractor match the design specifications of the RW storage facility.

Annual and milestone progress reports on the decommissioning of ship (service ship) NPIs.

Following the completion of each decommissioning stage, there must be an analysis of the results including estimates of the actual amounts of RW generated in the process and the amounts of emissions into the environment, which are then compared with the expected amounts as specified in the Ship NPI Decommissioning Program. On the basis of this analysis the need for an additional assessment is determined and recommendations are provided on its scope so as to ensure timely revision of the design documentation and implementation of organizational and technical arrangements aimed at the safety of future decommissioning activities and preventing unjustified increases in RW quantities.

3.1.2 Documents validating the nuclear and radiation safety at the Nuclear Material and Radioactive Substance management, use, shipping and storage.

The following documents should be evaluated for the Nuclear Material and Radioactive Substance management, use, shipping and storage:

- The list of facilities subject to the above activities.
- Safety validation report.

NF Safety Validation report is the main Nuclear Fuel Shipping and Storage safety validation document. In respect of nuclear fuel shipping and storage, the safety validation report should list potential disturbances in the normal operation and the events leading to the design and beyond-design accidents.

- The report should include a description of the Nuclear Fuel Accounting System and show that this system meets the requirements of appropriate rules and regulations. The requirements to the qualifications and skills of the reactor refueling personnel and the requirements to the support systems. The list of nuclear-hazardous operations and requirements to their execution.
- Memorandum of federal norms and rules regulating the nuclear power industry and other Nuclear Material and Radioactive Substance Management Safety documents and of their availability.
- Memorandum of project, design, operating and process documentation used in NM and RAS management.
- Quality assurance program (QAP)
- Memorandum of personnel training, nuclear and radiation safety knowledge testing, certification, safety briefing and clearance procedures.
- Schematic diagram of Nuclear and Radiation Safety Monitoring services.
- Nuclear material (radioactive substance and radioactive waste) control and accounting certificate.
- Nuclear Material (Radioactive Substance and Radioactive Waste) and Storage Facility physical protection certificate.
- List of contractor organizations including their services and the information about their RosTechNadzor licenses.
- Document setting the Allowable Radioactive Substance Emission and Discharge norms and limits.
- Radioactive Substance Emission and Discharge permits from authorized environmental protection agencies.

3.1.3 Ship NI dismantlement and SNF and RW management: Nuclear and Radiation Safety Requirement assessment criteria

The criteria used in the assessment of the Nuclear and Radiation Safety requirements are:

- Basic safety principles:
 - staying within the limits of allowable personnel and population exposure doses, staying within the limits of allowable RAS emissions (discharges) and reducing the radiation impact from NPI on the personnel, population and the environment to minimum practicable values based on existing sanitary norms, social and economic constraints;

- minimizing the amount (volume) of generated RWs; and
- eliminating from the process any reused materials (elements) with radioactive contamination levels above the limits specified in the existing sanitary rules for radiation safety;
- Decommissioning works safety validation report;
- Agreed and approved action plan to protect the personnel, population and the environment;
- QAP compliance with federal norms and rules (NP-056-04);
- Inventory count certificate on the equipment and facilities to be decommissioned;
- Radiological Assessment Certificate for the equipment and facilities to be decommissioned;
- List of decommissioning contractor organizations;
- RAS and RW control and accounting certificate;
- Organizational plan for the works resulting in high exposure doses for the personnel;
- Agreement of RW characteristics with the organization, which accepts RW for storage; and
- Progress reports on the decommissioning of ship nuclear installations.

The criteria used in the assessment of the Nuclear and Radiation Safety requirements to SNF and RW management activities are:

- The list of facilities subject to the above activities;
- SNF (RW) management works safety validation report. The safety validation report should demonstrate compliance with the safety requirements;
- A memorandum of federal norms and rules regulating the Nuclear power Industry and other safety standards.
- A memorandum of project, design, operating and process documentation used in NM and RAS management;
- Quality Assurance Program, meeting the requirements of federal rules and regulations (NP-41-02);
- Memorandum of personnel training, nuclear and radiation safety knowledge testing, certification, safety briefing and clearance procedures;
- Schematic diagram of Nuclear and Radiation Safety Monitoring services;
- Nuclear material (radioactive substance and radioactive waste) control and accounting certificate;
- Nuclear Material (Radioactive Substance and Radioactive Waste) and Storage Facility physical protection certificate;
- List of contractor organizations;
- Document setting the Allowable Radioactive Substance Emission and Discharge norms and limits, which should not exceed the limits specified in existing Radiation Safety regulations.
- Radioactive substance emission and discharge permit.

3.2 Assessment of contractor personnel competence

The following personnel participating in SNF unloading activities receives special training: personnel unloading SNF, personnel preparing SNF for shipment (container and rail car loading). "OKBM Afrikantov" provides training to persons who occupy the positions of Operations Supervisors, Shift Operations Supervisors and Assembly Shift Supervisors at Shore-Based SNF Unloading Facilities and Floating Technical Bases.

The training for engineering personnel includes 98 hours of lectures in the following subjects:

- NPIs, ensuring ship nuclear safety during defueling operations;
- Ensuring radiation safety during defueling operations;
- Transfer equipment make-up and design. Project 2020 and Project 326 M depot ship design;
- Defueling procedure;
- Working with lifting equipment and handling loads. Strapping.

The program also includes a 102-hr practical course in technology and equipment and 32 hrs of knowledge tests. Each subject ends with a test and when all are completed there is a certification. Successful students are issued a certificate giving them the right to perform SNF handling operations. The certificate is valid for 3 years, after which the person undergoes another training course and is re-certified.

For specific SNF management works performed in specific places (for instance handling fuel rod assemblies from Project 705 and Project 705K subs in Gremikha), the Centre organizes field training sessions in different subjects including theory, basic procedure and nuclear safety.

The workers participating in SNF handling operations complete a training program prepared and provided by "Onega" Process Engineering and Research Bureau. When the program is completed, there is a knowledge test. The Examining Commission includes representatives from "Onega", the shipyard and DSS NRS MoD. Every half-year, just about before each defueling cycle, there is a retraining. The instructors are certified "OKBM Afrikantov" and highly-skilled "Onega" specialists.

The scope and content of the courses, instructor qualifications, periodical re-training, long practical training sessions using simulators, computer software and real transfer equipment maintain personnel skills at a level that is high enough to safely perform reactor defueling (including potentially nuclear-hazardous operations), unload SNF from storage facilities and prepare SNF for shipment.

DSS NRS MoD performs routine inspections of "OKBM Afrikantov" and "Onega" training centres and its inspectors participate in the Personnel Certification Commissions. This ensures control over the proper level of training of SNF handling personnel.

The criterion used for determining the proficiency of engineering personnel who manages SNF handling activities is a valid Right-of-Activity Certificate (the validity period is 3 years) issued by "OKBM Afrikantov" Training Centre.

3.3 Assessment of territories, buildings, structures, facilities, rooms, equipment and transportation vehicles being used.

Location requirements

The location of a building, facility or equipment used in NPS, Surface Ship with NPI and Service Ship decommissioning and in SNF and RW (hereinafter Object) management should meet the requirements specified in /1/ and /2/. Preferred locations:

- outside potential housing development territories, suburban areas used for recreational purposes, outside health resort areas;
- preferably downwind from populated places and recreation areas, other industrial enterprises, etc.;
- outside the sanitary shelter zone of potable water supply areas; and
- outside agricultural lands or on the lands of inferior quality.

The final decision on the location of radiological facilities should be agreed with Radiation Safety authorities and local bodies of executive power on the basis of Preliminary Radiological and Hygienic Assessment of the territory and Environmental Impact Assessment.

Additional determinants are: natural factors influencing the safety of the facility, development prospects for the facility and the area and the impact on the radiation safety for the population and the environment. You should determine the actual radiological conditions at the proposed radiation facility site (zero background). The final decision is made by a State Commission, which includes a representative from GosSanEpidNadzor.

According to Section 3.2.8 of OSPORB, all nuclear-powered industry facilities, irrespective of their potential hazard category, are to be provided with a Sanitary Shelter Zone (SSZ) and a Supervised Zone (SZ). The size, structure and configuration of these zones are determined in the facility design documentation and may be changed by agreement with Federal GosSanEpidNadzor based on the actual safety parameters of the operating facility.

SSZ and SZ are monitored for radiation. SSZ radiation monitoring should provide radiological conditions data both at normal operation of the facility and during radiation accidents as well as information about Group B personnel exposure doses at normal operation. SZ radiation monitoring should provide radiological conditions data both at normal operation of the facility and during radiation accidents as well as information about exposure doses of population residing inside SZ. In the SSZ of a radiation facility no residential buildings, child or health-care facilities are allowed.

The areas accommodating production buildings, warehouses and radioactive material storage facilities should be safe from spring and waste-water flooding, they should provide unobstructed outflow for storm and melt water, have good natural airing conditions and access to direct sunlight. The sources of radioactive emissions into the atmosphere should be located downwind from all other buildings.

The site (guarded and fenced in territory on which the production, administrative, amenity and auxiliary buildings and facilities are located) should be divided into a notionally clean zone and a dirty zone depending on the type of work performed and the degree of potential radioactive contamination.

Facility layout should provide for a system of special transport routes with Clean and Dirty zones taken into account. The site should be provided with separate storm water drains for Clean and Dirty zones and a storm water treatment plant.

Exit gates should be equipped with dosimetric control posts and vehicle decontamination units. Category I and II facilities should have at least two access roads connecting the facility to motorways or railroads passing, as a rule, on two opposite sides of its territory.

Requirements to buildings and rooms

The workspace and the environment must be protected from radionuclides by a system of static (equipment, walls, floor slabs) and dynamic (ventilation and gas treatment) barriers.

If there are operations with open sources of radiation, the rooms used for each Class of work should be grouped together. If the facility conducts operations in all three Classes, there should be dedicated rooms for each Work Class.

Operations with open radiation sources with activity levels below the values specified in Appendix 4 to NRB-99/2009, may be conducted in rooms, which are not required to meet any radiation safety specifications. Class III works should be conducted in separate rooms, which meet the requirements to chemical laboratories. These rooms must be equipped with combined extract-and-input ventilation system and a bathroom. The works that may lead to air contamination (handling of powders, concentration by boiling, operations with volatile substances, etc.), should be conducted inside fume enclosures. Class II works should be conducted in rooms grouped together in a separate part of the building and isolated from all other rooms. If a Contractor performs Class II and III operations, which are parts of a single process, there may be a separate suite equipped to Class II requirements.

The layout should differentiate between permanent and temporary attendance rooms. These rooms must be equipped with a change facility or decontamination post. Class II rooms should be equipped with fume enclosures or hoods.

Class I works should be conducted in a separate building or an isolated part of a building with access through a separate entry with a decontamination post. The working rooms should be equipped with enclosures, chambers, canyons or other sealed equipment. As a rule, rooms are classified as belonging to one of the following three zones:

- zone 1 – unmanned rooms, housing process equipment and supply lines, which are the main sources of radiation and radioactive contamination . No personnel are allowed in unmanned rooms while process equipment is in operation;
- zone 2 – periodically attended rooms used for equipment repair and other works requiring partial disassembly of process equipment, for the disposal of Radioactive Material Loading and Unloading units, for temporary storage of raw materials, finished products and radioactive wastes; and
- zone 3 – permanently attended rooms (control rooms, operator stations, etc.).

To prevent cross-contamination there are decontamination posts between different zones.

Requirements to ventilation system

All work rooms and auxiliary rooms in the buildings, structures and facilities used for NPS, Surface Ship with NPI and Service Ship dismantlement and SNF and RW management (Rooms), irrespective of the degree of air contamination, must be provided with forced balanced ventilation.

The ventilation systems should prevent radioactive and other types of hazardous contamination. For organizations, whose radioactive emissions into the atmosphere may lead to more than 10 $\mu\text{Sv}/\text{year}$ of exposure for critical population group, the allowable emission limits shall be approved only after the State Sanitary Supervision authorities give an appropriate Sanitary and Epidemiological Conclusion.

The air may be released into the environment without cleaning if the total annual emissions with that air do not exceed the annual emission limit for this company. Also, the levels of external and internal exposure for the population should not exceed the established quotas. There should be separate ventilation systems for rooms where radioactive substances are handled and for room where no such work is done. The ventilation system must ensure safe working conditions at all process stages.

Requirements to heating, water supply and sewer systems

The rooms where open radiation sources are handled should be equipped with water or air heating systems. Organizations, working with open radiation sources of any class should have cold and hot water supply and sewer systems.

In Work Class I and II rooms, there should be mixer taps operated by pedal, elbow or non-contact device. The sewer system should provide for waste water decontamination and be equipped with waster water quantity and activity monitoring devices. Radioactive solution discharge tanks should be made from corrosion-resistant materials. Water supply, sewer pipes and other utilities passing inside walls and floor slabs should not weaken the protection against ionizing radiation.

Requirements to change facilities and decontamination posts

All the facilities used for NPS, Surface Ship with NPI and Service Ship dismantlement and SNF and RW management, in which Class I and II works are performed, should be equipped with a change facility. Work Class II facilities may be provided with a bathroom and a locker room with separate lockers for personal clothes and work clothes. The locker rooms and amenities should be equipped as specified in [/1/](#) and [/2/](#). Change facility must be located in the building, which is used for open radiation source handling. The change facilities for Work Class I rooms should be equipped with mandatory skin contamination monitoring devices.

Fixed decontamination posts separate workroom Zones 2 and 3. Depending on the type and scope of work, a decontamination post may include:

- space for changing and for keeping additional PPEs on racks or in lockers;
- device for washing and keeping additional footwear;
- space fitted with a disciplining barrier for changing the additional protective footwear;
- post for rinsing workers wearing pressure suits;
- changing room for changing the contaminated additional work clothes with a bench and containers for used work clothes;
- contamination control post equipped with radiation monitoring instruments and a washstand with cold and hot water and decontamination solution tanks for the hands.

Access to Work Class I - II rooms is available only through a clothes change facility with obligatory changing. Access to a room where repair or emergency work is conducted is available through a fixed or portable decontamination post or through a temporary sanitary check point where the workers are issued the necessary additional PPEs and personal dosimetric control devices.

Requirements to equipment

Process implementation and operating conditions should:

- minimize radiation impact on the personnel;
- provide for remote process control;
- provide for visual control over the process and equipment;
- provide for mechanization of loading operations;
- ensure reliability and maintainability of process equipment.

Process implementation, layout solutions and biologic protection system should minimize the risk of worker exposure or contacting radioactive or toxic substances while performing process operations or maintaining equipment. The equipment for nuclear fissile material processing and storage should be designed and operated as dictated by nuclear safety.

Requirements to carrier vehicles

RWs should be transported in strong, sealed containers using special vehicles and with sanitary-epidemiological certificate. Inside buildings and on the territory of organization, radioactive sources are carried in containers and packaging using special vehicles with the physical state of the radiation source, its activity, type of radiation, size and mass of the packaging taken into account and proper safety precautions. The levels of radioactive contamination of transportation vehicles should not exceed the values shown in Table 3.3.1.

Table 3.3.1: Allowable levels of radioactive contamination of transportation vehicle surfaces, freq/(cm² x min).

Contaminated object	Type of contamination			
	Removable		Non-removable (fixed)	
	Alpha-active radionuclides	Beta-active radionuclides	Alpha-active radionuclides	Beta-active radionuclides

External surface of the shielding container	Not allowed	Not allowed	Not regulated	200
External surface of the container car	Not allowed	Not allowed	Not regulated	200
Internal surface of the shielding container	1.0	100	Not regulated	2000
External surface of the shipping container	1.0	100	Not regulated	2000

The motor vehicles used in the transportation of radiation packages should be certified by state sanitary supervision authorities. The packages at the back of a truck should be put as far from the driver as possible.

Criteria for assessing the compliance with NRS requirements

To determine the compliance with NRS requirements to territories, buildings, structures, facilities, equipment and vehicles used for NPS, Surface Ship with NPI and Service Ship dismantlement and SNF and RW management, we propose to use as a yardstick the compliance with NRS regulations and standards as regards the design and operation of territories, buildings, structures, facilities, equipment and vehicles including:

- facility location is to NRS standards - i.e. outside potential housing development territories, suburban areas, sanitary shelter zones of potable water supply areas, downwind from other facilities, etc.;
- site SSZ and SZ are to NRS standards;
- site zoning is to NRS standards;
- the quality of actual works at the facility match the design requirements;
- production room planning and facility zoning is to NRS standards complete with necessary sanitary rooms (change facilities, decontamination posts) and interior finishing;
- facility sanitary and hygiene systems are to NRS standards;
- the equipment is to NRS standards; and
- the vehicles used for SNF and RW carriage are to NRS standards.

3.4 Assessment of works being performed (technologies)

Ship dismantlement /1/ - the stage that ends ship life cycle; it is also a process which includes a set of organizational and process arrangements to prepare the ship for storage, cutting and (or) sale and (or) sale of the recycled materials, SNF and RW management (for ships with NPI on board or service ships) or burial. The main criteria used in estimation of NPI nuclear safety /2/, /3/ are:

- exposure dose limits for the personnel, crew and the population;
- reactor core normal operation limits;
- the probability of accidents involving operational nuclear reactor;
- individual radiation risk in accidents;
- nuclear installation's internal self-protection features.

Nuclear safety at the dismantlement of a ship with NPI on board and at SNF handling shall be maintained by a set of measures aimed at preventing an uncontrolled self-sustained chain reaction and removing residual heat during:

- decommissioning of the ship from the Navy;
- decommissioning of the NPI and its storage in a nuclear-safe condition;
- ship transporting;
- auxiliary disassembly works as well as unloading, temporary storage and transporting of SNF within the dismantlement contractor territory.

In accordance with regulations /1/, /3/ the NPI decommissioning and defueling works should be preceded by:

- reactor core maintenance (before defueling) specifications;
- list of potentially-hazardous operations (PHW) and requirements to their execution;
- list of potential accidents, estimation of their consequences and emergency response recommendations to crew (personnel);
- safety validation report;
- nuclear safety instructions.

Among the main potentially nuclear-hazardous works are:

- works on the control and protection system and those, which have a risk of reactor controls being shifted or switched;
- operations changing physical conditions inside reactor (the temperature, pressure and the feed/discharge rate of the reactor Storage Mode Fluid);
- operations, which may lead to unauthorized change of reactor physical conditions; and
- installation and removal of locking devices on (from) reactor controls.

Using the PHW list, the contractor develops Nuclear Safety instructions. These instructions determine the management procedure for the works, the list of required documents and their preparation procedure, personnel clearance procedure, the responsibilities of the management and technical personnel, specific safety arrangements to be implemented.

During defueling and dismantlement the personnel is exposed to ionizing radiation from such technogenic sources as:

- engineering materials used in NPI circuit design;
- primary circuit coolant;
- corrosive deposits on the interior surfaces of cooling circuit equipment;
- radioactive particulate air contaminants
- radioactive wastes; and
- surfaces contaminated with radioactive substances.

The main radiation safety arrangements at Nuclear Ship Dismantlement, SNF and RW Management;

- engineering personnel clearance for working in RAZ depending on age, gender, health and previous exposure dose;
- personnel training, knowledge testing and compliance with Radiation safety rules and regulations;
- use of dedicated ventilation systems and other support systems;

- RAZ sizing and fencing;
- sanitary control at RAZ border;
- use of radiation protection devices;
- development, establishment and enforcement of personnel exposure limits;
- in-process control of radiation safety;
- development of design and process documentation regulating operations with Ionizing Radiation Sources;
- RW collection, temporary storage and disposal;
- informing the personnel and population about existing radiological conditions;
- preparation of crews (personnel) for emergency response;
- development of a list of potential radiation accidents including forecasts of their consequences and the ensuing radiological conditions;
- definition of the Radiation Accident Decision Making criteria;
- development and implementation of a Personnel and Population Protection and Radiation Emergency Response plan.

SNF extracted from ship reactors should be sent to Rosatom facilities for processing /3/. The fuel is prepared for shipment in accordance with existing standards. SNF is transported on board special vehicles in accordance with existing transportation plan. SNF prepared for shipping may be stored temporarily at Contractor's Temporary Container Storage Area. SNF management activities must ensure SNF control and accounting in accordance with existing standards.

Depending on RW type, contractors may decide on one of the following /5/:

- RW collection and conditioning;
- RW temporary storage;
- RW shipping;
- RW processing (contractors with their own RW processing facilities);
- transferring for processing to specialized companies.

The dismantlement activities should be conducted in such a manner as to minimize the quantity (volume, weight) and activity (volumetric, specific) of RWs generated in the process. The contractor should develop a process flow diagram for the management of RWs generated in ship dismantlement. This diagram should include RW quantities and properties. When reactor compartment (reactor room) is prepared for long-term storage, it may be used as a receptacle for additional RWs, which should be disposed there as required by Ship Design documentation and existing standards.

3.5 Assessment of the adequacy of the organizational and technical arrangements being implemented

Nuclear ship dismantlement and SNF and RW management activities* are unusual since they belong to two different domains at the same time – the domain of Russian Federation defense and security and the domain of Nuclear power. Also, these activities are conducted under Government's defense order. The establishment of NRS requirements for these domains has certain particularities listed in Art. 5 of Federal Law No. 184-FZ of 27.12.2002 "On Technical Regulation". According to this Article, the defense products (services), supplied under the Defense Contract; the Nuclear Power Industry items requiring NRS; the design, production, construction, erection, setup, operation, storage, shipping, sales, recycling and disposal processes related to the above products (services) and items are regulated by the requirements established by Government customers, federal executive agencies supervising defense, Nuclear Power Industry, NRS and (or) by the requirements specified in Government contracts (Agreements). The responsibilities in the area of state control (supervision) over NRS are regulated by Federal Law # 294-FZ of Dec. 26, 2008 "On Protection of Rights of Juridical Persons and Private Entrepreneurs Performing State Control (Supervision) and Municipal Control".

Given the above mentioned dual status of the dismantlement activities, the sources of the law, establishing NRS requirements for the Established Area of Activity, are Federal Laws and other Russian regulations and standards based on these Laws. Federal Laws regulating NRS are:

- Federal Law No. 3-FZ of Jan. 9, 1996 "On Radiation Safety of Population";
- Federal Law No. 52-FZ of March 30, 1999, "On Sanitary-Epidemiological Well-Being of the Population"
- Federal Law No. 7-FZ of Jan.10, 2002, "On Protection of the Environment"

In accordance with Art. 23 of Federal Constitutional Law #2-FKZ of Dec. 17, 1997, "On Russian Federation Government", Russian Federation Government, based on and in execution of Russian Constitution, Federal Constitutional Laws, Federal Laws and Presidential Decrees issues Governmental decrees and ordinances and enforces them. Governmental decrees and ordinances are mandatory in Russian Federation.

The main governmental statute establishing NRS requirements is Decree No. 471 of June 20, 2000 "On Approval of the Guidelines on Licensing the Defense-Related Nuclear Material Handling Activities".

Section 17 of these Guidelines says that the licensee (juridical person) must comply with Russian Federation legislation, NRS, environmental, sanitary and hygienic norms and rules when conducting license activities.

In accordance with Art. 9 of Federal Law #3-FZ of Jan. 9, 1996, state regulation of NRS in the Established Area of Activity is effected by establishing sanitary rules, norm, hygienic norms, radiation safety rules, state standards, orders, instructions and other documents concerning NRS.

According to Art. 39 of Federal Law #52-FZ of March 30, 1999 № 52-ФЗ " On Sanitary-Epidemiological Well-Being of the Population", Russia is governed by Federal Sanitary Rules, approved and enacted by a federal sanitary and epidemiological supervision agency properly authorized by Russian government. For juridical persons, sanitary rules are obligatory.

Some sanitary rules, which determine the sanitary aspects of NRS for the Established Area of Activity, have a status of Federal Norms and Rules in the Sphere of Nuclear power. In accordance with the List of Federal Norms and Rules in the Area of Nuclear power, approved by Russian Government Decree #1511 of Dec.1, 1997, Federal Norms and Rules concerning NRS include:

- SanPiN 2.6.1.2523-09 "Radiation Safety Norms" (NRB-99/2009);
- SP 2.6.1.2612-10 "Basic Sanitary Rules of Radiation Safety Ensuring" (OSPORB-99/2010);
- SP 2.6.6.1168-02 "Sanitary Rules for Radioactive Waste Handling" (SPORO-2002).

* * Hereinafter, unless otherwise specified, dismantlement of NPSs, surface ships with NPIs on board, nuclear service ships as well as SNF and RW management will be termed "the Established Area of Activity".

Basic Sanitary Rules, establishing sanitary-epidemiological requirements to the radiation safety of personnel at Nuclear-Powered Shipbuilding industry organizations participating in NPS dismantlement, facilities for temporary waterborne storage of reactor sections, facilities for long-term land-based storage of reactor sections, as well as the requirements while conducting nuclear service ship dismantlement, are:

- SP 2.6.1.2154-06 "Radiation Safety at Comprehensive Recycling of Nuclear Submarines";
- SanPiN 2.6.1.11-02 "Ensuring Radiation Safety at Design, Construction, Operation and Recycling of Nuclear Service Ships".

Federal NRS norms and rules as well as sanitary rules have the status of Regulatory Acts Passed by Federal Agencies. The adequacy of NRS requirements in the Established Area of Activity is determined by government customers (MoD of Russia, MinPromTorg of Russia, "Rosatom" Corp.).

NRS specifications are established in accordance with "General Regulations for Ensuring Nuclear and Radiation Safety of Marine Nuclear Power Installations" (OPB-K-98/05), approved by the Resolution #253/6/1421 of April 7, 2006 of Russian Federation Ministry of Defense, Federal Nuclear power Agency and Federal Industry Agency" and with "Marine Nuclear Power Installation Nuclear Safety Rules" (PBYa-B.08-88/05), approved by the Resolution #253/6/1422 of April 7, 2006 of Russian Federation Ministry of Defense and Federal Nuclear power Agency.

Also, NRS specifications are established in a set of guidelines, approved by the Federal Industry Agency and agreed by MoD. This set includes:

- RD5.IMYAN.105-2005 "Nuclear Safety at Shipbuilding Industry Facilities. ";
- RD5.IMYAN.106-2005 "Radiation Safety at Shipbuilding Industry Facilities".;
- RD5.IMYAN.107-2005 "Certification of Personnel of Shipbuilding Industry Using Nuclear power".

Pursuant to Russian Federation Decree #518 of May 28, 1998, "On Providing for the Accelerated Recycling of Decommissioned Nuclear-powered submarines and Surface Ships with Nuclear Installations on Board and for the Ecological Rehabilitation of Radiation-Hazardous Navy Facilities", "Onega" Process Engineering and Research Bureau has developed a set of regulatory documents agreed by Rosatom, Rosprom, FMBA and Russian Ministry of Defense as well as by contractor organizations. This set includes:

- NYADI.0220.00.017 "Civilian Crew of Submarines Decommissioned from the Navy and Transferred to Dismantlement Contractors. Standard Provisions";
- NYADI.0220.00.019 "Duty Personnel of Submarines Decommissioned from the Navy and Transferred to Dismantlement Contractors. Standard Provisions";
- NYADI.0220.00.020 "Mixed Crew of Submarines Decommissioned from the Navy and Transferred to Dismantlement Contractors. Temporary Provisions";
- NYADI.0220.00.021 "Unloading of Spent Nuclear Fuel at "RosSudoStroeniye" Enterprises. Temporary Provisions";
- NYADI.0220.00.025 "Interaction Between the Navy and Dismantlement Contractors at Temporary Storage of NPS in Naval Bases. Temporary Provisions";
- NYADI.0220.00.027 "Irradiated Fuel Removal at RosSudoStroeniye Shore-Based Facilities. Guidelines";
- NYADI.0220.00.031 "Irradiated Fuel Removal at RosSudoStroeniye Shore-Based Facilities with the Navy Crew On Board Dismantled NPSs. Guidelines";
- NYADI.221.0701 "Procedure for Transferring NPS and Surface Ships with NPIs On Board to Dismantlement Contractors. Temporary Provisions";
- NYADI.000.0230.00.001 "Ensuring Nuclear Safety at Nuclear-powered submarines Decommissioned from the Navy and Transferred to Dismantlement Contractors. Guidelines"; and
- NYADI.000.0230.00.002 "Ensuring Radiation Safety at Nuclear-powered submarines Decommissioned from the Navy and Transferred to Dismantlement Contractors. Basic Administrative and Technical Requirements".

Pursuant to Resolution #2.2877-pr of August 27, 2003 by Rosatom and the Navy, the Central Shipbuilding Technology Research Institute (now Shipbuilding and Ship Repair Centre) has developed Temporary Provisions regulating the transfer of decommissioned Nuclear Service Ships to dismantlement contractors and Specifications guiding the preparation of the dismantled Nuclear Service Ship (hull packaging) for temporary waterborne storage:

- LKIB.4130-015-2004 "Procedure for Transferring Nuclear Service Ships, Vessels and Floating Tanks decommissioned from the Navy to Dismantlement Contractors - "DalRAO" and "SevRAO". Temporary Provisions" (PPP SATO-2005), Approved by the joint Resolution #28-478 of April 24, 2006 of Nuclear power Agency , Federal Industry Agency and the Navy;
- LKIB.4130-019-2006 "Preparation for Storage and Waterborne Storage of Nuclear Service Ships Decommissioning from the Navy. Temporary Provisions" (PPKhP SATO-2006), approved by Federal Nuclear power Agency on Dec. 6, 2006.

The analysis shows that the organizational and technical arrangements being implemented as required by the legal and regulatory documents provide necessary and appropriate nuclear and radiation safety in the Established Area of Activity and may be used to develop criteria for assessing dismantlement contractor compliance with those requirements in the Established Area of Activity.

3.6 Development of an integral criterion for assessing the compliance with NRS requirements while conducting Radiation Facility Dismantlement and Spent Nuclear Fuel and Radioactive Waste management activities

To determine the level of contractor compliance with NRS requirements at dismantlement of decommissioned NPSs, Surface Ships with NPI and Service Ships we must calculate an index (P_s) showing the compliance of this contractor's dismantlement activities (hereinafter Object of Audit) with NRS requirements.

P_s shows how far the design (real) level of NRS compliance or $P_s(\text{design})$ differs from the baseline (target) level (full compliance) or $P_s(\text{base})$. The formula for P_s is:

$$P_s = \frac{P_s(\text{pacu})}{P_s(\text{баз})} \quad (1).$$

To assess Object of Audit's compliance with NRS requirements, the quantitative estimation of P_s is converted to a qualitative criteria-based one. Criteria, specified in the attached Methodology (Appendix 1), are used as compliance criteria. The compliance scale ranges from 0 to 1. When $P_s(\text{base})$ equals 1 it means that the Object of Audit is in full compliance with NRS requirements.

To ensure accurate assessment of NRS compliance, we have singled out the most significant influencing factors (1 level factors). These include:

- D factor (*document*), takes into account the completeness and quality of NRS validation data in dismantlement contractor documentation;
- P factor (*personal*), takes into account the Contractor personnel qualification as compared to the qualification requirements established by Federal executive agencies and "Rosatom"*;
- O factor (*object*), takes into account the condition of the territory, buildings, structures, facilities, rooms, equipment and vehicles used for works (services) in the Established Area of Activity;
- T factor (*technology*), takes into account the type of works (services) performed;
- A factor (*administration*), takes into account contractor administrative arrangements aimed at NRS;

Thus, the target function determining the design level of NRS compliance is as follows:

$$P_s(\text{pacu}) = F\{D, P, O, T, A\} \quad (2).$$

The Level 2 factors, directly relating to Level 1 factors, are the requirements established in NRS norms and regulations. The influence of Level 2 factors on Level 1 factors is accounted for by classifying all NRS violations as follows: by their significance (the risk of negative consequences) – critical and non-critical, and by their manifestation – actual and potential.

Actual, critical violation of NRS requirements (Category 1A) is a non-compliance involving human injury or death, damage to the environment and a threat of natural or technogenic emergencies.

Necessary and sufficient condition for identification of a Category 1A violation is the fact of an accident or incident, which is identified using INES scale. A specific scale of significant NRS violation events is given in the attached Methodology (Appendix 2). In the event of a Cat. 1A violation, DSS NRS MoD officials must take immediate action to put an end to human injury or death and damage to the environment. The specific actions to be taken in the event of a Cat. 1A violation are listed in the attached Methodology.

* How much $P_s(\text{design})$ is influenced by the P factor is determined using the criteria specified in a document, agreed by MinPromTorg of Russia and Rosatom, which establishes the Dismantlement Contractor Personnel NRS training program and procedure.

Potential, critical violation of NRS requirements (Category 1B) is a non-compliance, which is a direct threat to human life, health, the environment and which creates a threat of natural or technogenic emergencies but does not have the necessary and sufficient conditions to be qualified as Cat. 1A.

Cat. 1B violations are those which render operations in the Established Area of Activity illegal, including violations of NRS requirements established by:

- Federal laws;
- Presidential and Governmental decrees;
- laws and regulations by "Rosatom" and Federal agencies, which control the activities related to the dismantlement of military NPIs and (or) perform the functions of Government Customer under the NPS, Surface Ship with NPI and Service Ship Dismantlement and Shore Technical Base Rehabilitation Programs;
- governmental sanitary and epidemiological rules, which establish NRS requirements to the dismantlement process (sanitary and hygienic aspects);
- obligatory NRS norms and rules, which do not have the status of a law or regulation, introduced by "Rosatom" and Federal agencies supervising the activities related to the dismantlement of military NPIs and (or) performing the functions of Government Customer (Coordinator) under the NPS, Surface Ship with NPI and Service Ship Dismantlement and Shore Technical Base Rehabilitation Programs;

Also, Cat. 1B includes NRS violations related to realized Level P6 events (anomaly) according to the scale in the attached Methodology (Appendix 2). In the event of a Cat. 1B violation, DSS NRS MoD officials must take immediate action to prevent damage to human life, health and the environment. Specific actions to be taken in the event of a Cat. 1B violation are listed in the attached Methodology.

Actual, non-critical violation of NRS requirements (Category 2A) is a non-compliance which is not a threat to human life, health or the environment and does not pose a threat of natural or technogenic emergencies.

Cat. 2A violations reduce contractor performance in the Established Area of Activity as well as the functionality of the major work processes in this Area. There is no direct threat to human life, health, the environment or a threat of natural or technogenic emergencies.

Cat. 2A includes violations of NRS requirements established by standards, Governmental Customer specifications, technical documentation, (design, process, software documentation, specifications, guides, instructions and regulations), if their use is required by the Governmental Contract (Agreement).

In the event of a Cat. 2A violation, DSS NRS MoD officials must take action to eliminate or prevent it, prevent possible damage to human life and health, damage to plant and animal life, damage to the environment as well as prevent natural or technogenic emergencies. The necessary condition for identification of a Cat. 2A violation of NRS requirements is its non-systematic nature. If a Cat. 2A violation becomes systematic, or there is a consistent decline in Contractor performance in the Established Area of Activity and in the functionality of the major work processes with serious detrimental effect on contractor NRS compliance, the violation is classified as Potentially Critical (Cat. 1B). The response to such violations is to Cat. 1B.

Potential, non-critical violation of NRS requirements (Category 2B) is a non-compliance which is not a direct threat to human life, health or the environment and does not pose a threat of natural or technogenic emergencies, the probability of which can be forecasted only with a certain level of accuracy.

Cat. 2B is assigned to violations of regulatory requirements, which determine the procedure of implementing obligatory specifications (instructional guidelines, inspection guidelines, etc.). In the event of a Cat. 2B violation, DSS NRS MoD officials must take prescribed action to eliminate or prevent it, prevent possible damage to human life and health, damage to plant and animal life, damage to the environment as well as prevent natural or technogenic emergencies. The list of NRS norms and regulations containing requirements, which are considered as Level 2 factors is in the attached Methodology (Appendix 2).

According to Section 5 of GOST RV 50811-2006 "Dismantlement of Navy Ships and Vessels. General Provisions" there are 8 dismantlement stages. These stages, adapted to the particular object of dismantlement (NPS, surface ship with NPI on board or nuclear service ship), are listed in the attached Methodology (Appendix 4). Each one has a set of NRS requirements to be implemented by dismantlement contractor. Systematized requirements are included in the attached Methodology (Appendix 5). When preparing for Contractor audit, the members of the Audit Group preparing check lists should clarify, using the established procedure, the specific NRS requirements to be used.

The design index of NRS compliance for the Object of Audit is determined as follows:

$$Ps(\text{design}) = 1 - [W_{N1A}(A1...A3) \times N_{1A}(A1...A3) + W_{N1A}(P1...P5) \times N_{1A}(P1...P5)] - W(D) \times [W_{N1B} \times N_{1B}(D) + W_{N2A} \times N_{2A}(D) + W_{N2B} \times N_{2B}(D)] - W(P) \times [W_{N1B} \times N_{1B}(P) + W_{N2A} \times N_{2A}(P) + W_{N2B} \times N_{2B}(P)] - W(O) \times [W_{N1B} \times N_{1B}(O) + W_{N2A} \times N_{2A}(O) + W_{N2B} \times N_{2B}(O)] - W(T) \times [W_{N1B} \times N_{1B}(T) + W_{N2A} \times N_{2A}(T) + W_{N2B} \times N_{2B}(T)] - W(A) \times [W_{N1B} \times N_{1B}(A) + W_{N2A} \times N_{2A}(A) + W_{N2B} \times N_{2B}(A)],$$

(3)

where:

$Ps(\text{design})$ - the design index of NRS compliance for the Object of Audit;

$W_{N1A}(A1...A3)$ – weight coefficient (significance) of actual critical Level A1...A3 violations (accidents) as per the Methodology;

$N_{1A}(A1...A3)$ – number of occurrences of actual critical Level A1...A3 violations (accidents) as per the Methodology;

$W_{N1A}(P1...P5)$ – weight coefficient (significance) of actual critical Level P1...P5 violations (incidents and serious incidents) as per the Methodology;

$N_{1A}(P1...P5)$ – number of occurrences of actual critical Level P1...P5 violations (incidents and serious incidents) as per the Methodology;

$W(D), W(P), W(O), W(T), W(A)$ – weight coefficient (significance) of Level 1 factors;

$N_{1B}(D), N_{2A}(D), N_{2B}(D)$ – number of NRS violations belonging to, respectively, Cat.1B (potential, critical), 2A (actual, non-critical) and 2B (potential, non-critical), found while auditing the D factor;

$N_{1B}(P), N_{2A}(P), N_{2B}(P)$ – number of NRS violations belonging to, respectively, Cat.1B (potential, critical), 2A (actual, non-critical) and 2B (potential, non-critical), found while auditing the P factor;

$N_{1B}(O), N_{2A}(O), N_{2B}(O)$ – number of NRS violations belonging to, respectively, Cat.1B (potential, critical), 2A (actual, non-critical) and 2B (potential, non-critical), found while auditing the O factor;

$N_{1B}(T), N_{2A}(T), N_{2B}(T)$ – number of NRS violations belonging to, respectively, Cat.1B (potential, critical), 2A (actual, non-critical) and 2B (potential, non-critical), found while auditing the T factor;

$N_{1B}(A), N_{2A}(A), N_{2B}(A)$ – number of NRS violations belonging to, respectively, Cat.1B (potential, critical), 2A (actual, non-critical) and 2B (potential, non-critical), found while auditing the A factor;

$W_{N1B}, W_{N2A}, W_{N2B}$ – weight coefficients for the corresponding NRS violation categories - for Cat.1B (potential, critical), 2A (actual, non-critical) and 2B (potential, non-critical) respectively

The weight coefficients were determined by expert evaluation method in combination with qualimetry of the experts. The specific weight coefficient values and the final formula are shown in the attached Methodology. If $Ps(\text{design})$ comes out negative, it is equated to zero. Since the baseline level of NRS compliance $Ps(\text{base})$ is assumed to equal 1, the Ps index of Object of Audit's compliance with NRS requirements has exactly the same value as $Ps(\text{design})$.

Even if a single Level A1...A3 (accident) event has occurred, Ps falls into the "extremely unsatisfactory" range (Appendix 1), characterizing extremely low Object of Audit's compliance with NRS requirements. Even if a single Level P1...P5 (incident, serious incident) event has occurred, Ps falls into the

"unsatisfactory" range, characterizing low Object of Audit's compliance with NRS requirements. Following this, an assessment of Contractor NRS compliance is performed as described in Appendix 1 to the Methodology.

References

Chapter 1

Section 1.1.

1. List of regulations and regulatory documents related to the activity of the Federal Service for Environmental, Technological and Nuclear Supervision. P-01-01-2009. Section II. State regulation of safety in the use of nuclear energy. Entered by the Order of the Federal Service for Environmental, Technological and Nuclear Supervision of March 17, 2010 No. 178.
2. Federal Law dtd. 15.07.1995 No. 101-FZ "On international treaties of the Russian Federation.
3. International Convention for the Safety of Life at Sea, 1960. Ratified by the Presidium of the Supreme Council of USSR on 9 July 1965. Entered into force for the USSR on November 4, 1965.
4. International Convention on the Liability of Operators of Nuclear Ships. 1962 Adopted by the XI session of the Diplomatic Conference on Marine legislation. Not in force because it has not been signed by any state possessing nuclear vessels.
5. Convention on Early Notification of a Nuclear Accident. 1986. Signed by the Government of the USSR on 09/26/1986
6. Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency. 1987. Adopted by the General Conference of the International Atomic Energy Agency at a special session in Vienna on September 26, 1986
7. Convention on the Physical Protection of Nuclear Material. 1987. Signed on behalf of the USSR, on May 22, 1980. Ratified by the USSR Supreme Soviet Presidium on May 4, 1983
8. Convention on Environmental Impact Assessment in the Trans-boundary Context. Espoo (Finland), February 25, 1991. The text of the Convention is not published officially.
9. Convention on Nuclear Safety. 1996 Adopted on 17th June, 1994 by the Diplomatic Conference convened by the International Atomic Energy Agency. Adopted by the Decree of the Government of the Russian Federation on April 3, 1996 No. 377.
10. Convention on Civil Liability for Nuclear Damage. 1997 (Consolidated text of the Vienna Convention on Civil Liability for Nuclear Damage of 21 May 1963, as amended by the Protocol of September 12, 1997). Ratified by the State Duma of the Russian Federation of March 2, 2005.
11. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. 1998. Ratified by the State Duma of the Russian Federation on October 21, 2005.
12. Code for the Safe Carriage of irradiated nuclear fuel, plutonium and radioactive waste in containers on board ships. INF Code MSC.118 (74).

Section 1.2.

1. NP-022-2000. General provisions to ensure the safety of nuclear installations of ships. M., Gosatomnadzor, 2000.
2. Federal Law of November 21, 1995 No. 170-FZ "On the use of nuclear energy."
3. Federal Law of January 9, 1996 No. 3-FZ "On radiation safety of the population."
4. Federal Law of March 30, 1999 No. 52-FZ "On the sanitary well-being of the population."
5. Federal Law of 8 August 2001 N 128-FZ "On Licensing of Certain Types of Activities".
6. NP-037-02. Security regulations for the decommissioning of nuclear power installations. Gosatomnadzor, M, 2002.
7. RD-06-05-98. Instructions for oversight over nuclear and radiation safety of nuclear propulsion plants of vessels and nuclear service vessels.
8. Federal Law of 26 June 2008 No. 102-FZ "On ensuring the unity of measurements".
9. NP-029-01. Regulation of nuclear safety of nuclear ships. M., Gosatomnadzor, 2001.
10. Federal Law of 27. December 2002 No. 184-FZ "On technical regulation".
11. NP-058-04. Safety in Radioactive Waste Management. General Provisions. M., Rostekhnadzor, 2004.

12. Federal Law of January 10, 2002 No. 7-FZ "On Environmental Protection".
13. RB-010-2000. Ensuring the safe handling of radioactive waste of ships and other vessels with nuclear reactors and radiation sources. M., Gosatomnadzor, 2000.
14. RD 31.20.40-86. Addition to the provisions of technical operation of the Navy. Nuclear-powered ships and nuclear service vessels. USSR Ministry of Marine Fleet.
15. RB-016-01. Requirements to Report for Nuclear and Radiation Safety Analysis of unloading spent fuel assemblies in the implementation of an integrated Lepse project. M., Gosatomnadzor, 2001.
16. NP-072-06. Rules to re-classify nuclear materials as radioactive waste. M., Rostekhnadzor, 2006.
17. Federal Law of 21 June 1997 No. 116-FZ "On industrial safety of hazardous production facilities".
18. NP-053-04. Safety regulations for transporting radioactive materials. M., Rostekhnadzor, 2004.
19. NP-069-06. Near surface disposal of radioactive waste. Safety requirements. Approved by the Resolution of Rostekhnadzor from 28.04.2006 No. 1.

Section 1.3.

1. Resolution of the CPSU Central Committee and USSR Council of Ministers No.1095-296 "Procedure for scrapping decommissioned Naval ships with nuclear installations".
2. Resolution of the Government of the Russian Federation of 24 July, 1992 No. 514 "On measures on organization of a pilot dismantling of submarines and surface ships, decommissioned from the Navy."
3. Resolution of the Government of the Russian Federation of 31 August 1992 No.644-47 "On comprehensive dismantling of nuclear-powered submarines decommissioned from the Navy and ships with nuclear installations of the Ministry of Transport of the Russian Federation."
4. Resolution of the Government of the Russian Federation of 1996 No. 344-24 "On measures to ensure the dismantlement of decommissioned nuclear-powered submarines and ships, as well as nuclear vessels of the Ministry of Transport of the Russian Federation."
5. Resolution of the Government of the Russian Federation of 28 May 1998 No.518 "On measures to accelerate the dismantling of nuclear-powered submarines and surface ships with nuclear power installations decommissioned from the Navy, and environmental remediation of hazardous facilities of the Navy."
6. Resolution of the Government of the Russian Federation of 20 June 2000 No. 471.
7. Order of the Government of the Russian Federation of 17 February 2001 No. IR-P7-02738.
8. Decree of the Russian Federation of 30 December 2005 No. 2355-rs.
9. Decree of the Russian Federation of 6 August 2008 No. 1128-r.
10. Resolution of the Government of the Russian Federation of 20 September 2008 No. 705.

Section 1.4

1. 2. SP 2.6.1.799-99 "Basic Sanitary Regulations of Radiation Safety Provision (OSPORB - 1999)."
2. SP 2.6.6.1168-02 "Sanitary Regulations to Handle Radioactive Waste (SPORO-2002)".
3. R2.6.6.37-02 «Hygienic regulations set for dismantling NPS».
4. MU2.6.1.04-05 "Radiation Safety at dismantling nuclear-powered submarines."
5. R2.6.1.62-04 "Radiation-hygienic requirements for dismantling nuclear service vessels"
6. MU2.6.1.38-05 "Radiation Safety for dismantling of nuclear-powered submarines of the first generation."
7. R2.6.1.35-02 "Radiation safety while unloading the irradiated fuel assemblies of decommissioned nuclear-powered submarines" (RBV-2002).
8. R2.6.6.42-02 "Radiation-hygienic requirements for placement of solid waste in the reactor compartments of decommissioned nuclear-powered submarines."
9. Sanitary Regulations "Radiation Safety for dismantlement of nuclear-powered submarines" (STC-2006).
10. Sanitary rules "Providing safe working conditions at enterprises of nuclear shipbuilding (SP PAS-2006).
11. Methodological guidelines ME 2.6.1.58-02 "Criteria and methods for assessment of contaminated land adjacent to the bases of the Navy"
12. Methodological guidelines ME 2.6.6.22-05 "Radiation Safety in the works for the rehabilitation of the coastal technical bases.

13. R 2.6.1.25-07 "Criteria and standards of rehabilitation of territories and facilities contaminated by radionuclides. Federal State Unitary Enterprise" Northern Federal Enterprise for Radioactive Waste Management, Federal Agency for Atomic Energy.
14. MU 2.6.1.37-07 "Organization of radiation monitoring of environmental objects in the vicinity of the Federal State Unitary Enterprise" Northern Federal Enterprise for Radioactive Waste Management, Federal Agency for Atomic Energy.
15. R 2.6.1.29-07 "Hygienic requirements for radiation safety of the personnel and population at designing and organizing the work of SNF and RW management in branch No. 1 of the Federal State Unitary SevRAO.
16. ME 2.6.5. 05 - 08 "Peculiarities of application of the ALARA principle at SNF and RW management at Branch No. 1 SevRAO.
17. 2.2.8.020 ME-09 "Requirements for use of personal protection equipment when working at facilities of FSUE SevRAO and FSUE DaljRAO.
18. R 2.6.5.04-08 "Hygienic requirements for management of industrial waste in the Federal State Unitary Enterprise (Northern Federal Enterprise for Radioactive Waste Management)".
19. Guide R2.6.1.42-03 "Radiation and environmental safety at the sites for temporary storage afloat of reactor units from dismantled NPS" .
20. Guide R2.6.6.57-04 "Radiation-hygienic requirements for long-term storage of single compartment reactor units of decommissioned nuclear-powered submarines."
21. Methodological guidelines ME 2.6.1.52-03 "Radiation-hygienic zones of nuclear shipbuilding enterprises. Operating conditions and justification for the boundaries. "
22. Methodological guidelines ME 2.6.1.36-02 "Sanitary protection zone and surveillance zone at enterprises of nuclear shipbuilding. Operating conditions and justification for the boundaries. "
23. R2.6.1.55-04 "Organization of individual dosimetric monitoring of the personnel of the enterprises of nuclear shipbuilding and population in the surveillance zone"
24. MUK 2.6.5.7-08 "Conducting individual dosimetric monitoring of the personnel exposure at Branch No. 1 SevRAO.
25. MU 2.6.5.6-08 "Conducting individual dosimetric monitoring of the personnel exposure at Branch No. 1 Federal State Unitary Enterprise SevRAO.
26. MU 2.6.1.32-01 "radiation monitoring/control of scrap metal formed during the decommissioning of nuclear-powered submarines" and methodical guidelines "Radiation-hygienic requirements for the system of radiation monitoring of sites for long-term storage of single-compartment units of reactor compartments.
27. MU 2.6.1.61-04 "Identification of individual effective and equivalent doses and control of the personnel exposure at enterprises of nuclear shipbuilding and ship repair.
28. MU 2.6.1.56-04 "Assessing the impact of radiation-hazardous work performed by nuclear shipbuilding enterprises on the environment and population."
29. MU 03-98 "Radiation survey of nuclear-powered submarines during their transfer from the Navy for dismantling".

Section 1.5.

1. RD5.IMYAN.105-2005 "Guide for nuclear safety at the facilities of the shipbuilding Industry".
2. RD5.IMYAN.108-2006 "Investigation of nuclear accidents and emergencies at the enterprises of the shipbuilding industry. Rules ".
3. NYADI.0220.00.027 "Organization of unloading irradiated spent nuclear fuel at the onshore facilities of Rossudostroeniye. Regulations ".
4. RD5.IMYAN.106-2005 "Guide for radiation safety at the facilities of the shipbuilding Industry".
5. RD5.IMYAN.109-2006 "Guid on the organization of radiation safety of enterprises and organizations of Rosprom handling radioactive substances, radioactive waste and sources of ionizing radiation".
6. RD5.IMYAN.076-2007 "Organization of control and accounting of individual doses to the personnel at the enterprises of the shipbuilding industry. Methodical guidelines ".
7. NYADI.000.0230.00.002 "Radiation Safety in nuclear-powered submarines decommissioned from the Navy and transferred to the enterprises implementing dismantling. Main organizational and technical requirements ".
8. RD5.IMYAN.092-2009 "Rules of radioactive waste management in the enterprises and organizations of the shipbuilding industry".

9. NYADI.0312.00.035 "Organization of LRW and SRW management at Russian shipbuilding enterprises engaged in construction, repair, modernization and dismantling of nuclear-powered submarines. Methodical guidelines ".
10. RD5.AEISH 3365-2003 "radiation monitoring/control of scrap metal formed during the decommissioning of nuclear-powered submarines of the 1, 2 and 3 generations, and surface ships with nuclear installations."
11. RD5.AEISH.2946-99 "Radiation monitoring of the environment in the enterprises engaged in construction, testing, repair, recycling of ships and vessels with nuclear installations and floating facilities for their support. Methodological guidelines.
12. RD5.IMYAN.107-2005 "Guide on the organization of certification of employees of enterprises and organizations of the shipbuilding industry working in the field of atomic energy use"/
13. SanPin 2.6.1.2.6.1.2523-09 Radiation Safety Standards (NRB-99/2009).
14. SP 2.6.1.799-99 Basic Sanitary Rules for Radiation Safety Provision (OSPORB-99).
15. SP 2.6.6.1168-02 Sanitary Regulations to Handle Radioactive Waste (SPORO-2002).

Section 1.6.

1. National standards. Indices. Volume 1,2,3. Federal Agency for Technical Regulation and Metrology, 2007 ISSN 0134-8752.
2. National standards. Indices. Volume 1,2,3. Federal Agency for Technical Regulation and Metrology, 2009, ISSN 0134-8752.
3. GOST "Dismantling of ships and vessels of the Navy. General Provisions ".

Chapter 2

Section 2.1.

1. "Concept of comprehensive dismantling of nuclear-powered submarines and surface ships with nuclear installations approved by the Ministry of the Russian Federation for Atomic Energy on Jan. 30, 2001.
2. "Dismantling of ships and vessels of the Navy. General Provisions " GOST RV 50811-2006
3. "General provisions for nuclear and radiation safety of shipboard nuclear power plants" (OPB-K-98/05).
4. "Nuclear Safety Regulations for ship nuclear propulsion plants" (PBYA-V.08-88/05).
5. "SGP of VM-A, OK-300, OK-350 OK-700 OK-650 types and their modifications of dismantled NPS. Potentially nuclear-hazardous works and technical requirements for their performance during decommissioning and storage of SGP, unloading of cores and works associated with discharge. Single list. »No. NYADI.000.0318.45.001.
6. "Temporary Regulations on nuclear-powered submarines decommissioned from the Navy and destined for scrapping, when stored afloat in the submarine military units" (approved by the Deputy Commander of the Navy's armament September 7, 1994).
7. "Situation with the organization, preparation and scrapping of decommissioned Naval submarines with nuclear propulsion plants " (approved by the Chief of Navy on 4th May, 1991 and by the First Deputy Minister of Shipbuilding Industry of the USSR on April 12, 1991).
8. "Procedure for transferring decommissioned nuclear-powered submarines and surface ships with nuclear installations to enterprises executing dismantling works No.NYADI.221.0701.
9. "Manual on the organization and maintenance of water chemistry regime of the first primary circuit of nuclear propulsion plant with unloaded cores on the ships retired from the Navy for dismantling No. I160-71-94.
10. "Dismantling of ships and vessels of the Navy. Terms and definitions " OST-97 V5R.0724
11. Manual for nuclear safety of facilities of the Navy (RBYA VMF-2001) enacted by the Order of Commander of the Navy on March 12, 2002 No. 115.
12. "Manual on radiation safety of the Naval ships with nuclear installations and facilities for their maintenance (NORB VMF-04) enacted by the Order of Commander of the Navy on December 16, 2004 No. 480.
13. "Regulations on the organization of transfers to the dismantling sites of NPS decommissioned from the Navy» No. 89.262.360070.001.

14. "Procedure to transfer nuclear-powered submarines and surface ships with nuclear installations ... and support vessels decommissioned from the Navy, and the facilities of the Ministry of Defense of the Russian Federation related to the temporary storage of spent nuclear fuel, solid and liquid radioactive waste" approved by the Instruction of the Ministry of Property of Russia on November 23, 1998 No. 1493-r.
15. "Radiation safety at comprehensive dismantling of nuclear-powered submarines" SP 2.6.1.2154-06.
16. "Civil crew of nuclear-powered submarines retired from the Navy and transferred to enterprises executing dismantling. Standard regulation "NYADI.0220.00.017.
17. "Relationship of the Navy and enterprises-executors of works on dismantling at temporary storage of dismantled NPS in naval bases» No.NYADI.0220.00.025.
18. Regulation "Procedure for the transfer of ships, marine vessels and floating vessels intended for nuclear maintenance decommissioned from the Navy to enterprises executing works. FSUE DaljRAO and FSUE SevRAO» No. LKIB.4130-015-2004.
19. Federal Law of 30 March 1999 No. 52-FZ "On the sanitary-epidemiological well-being of the population".
20. "Radiation Safety Standards (NRB-99/2009). SanPiN 2.6.1.2523-09.
21. "Basic Sanitary Rules for Radiation Safety (OSPORB 99/2010)" JV 2.6.1.2612-10.
22. "Sanitary Rules for Radioactive Waste Management (SPORO-2002)" SP 2.6.6.1168-02.
23. "Radiation safety at designing, construction, operation and dismantling of nuclear service ships (SSP-SATO-2001).
24. Federal Law of January 9, 1996 No. 3-FZ "On Radiation Safety".

Section 2.2.

1. Guide on technical supervision over ships in operation.
2. RBK-72 Guide for towing vessels, support vessels, floating equipment and facilities of the Navy.
3. No. 89.262.360070.001.Regulations on the organization of transfers to dismantling sites of NPS decommissioned from the Navy.
4. PPB UAPL Fire Safety ruled for dismantled nuclear-powered submarines.
5. RD31.52.22-88 Rules of technical operation of ship lift facilities.
6. NYADI.0220.00.019 On-duty and watch-keeping service for NPS decommissioned from the Navy and transferred enterprises executing dismantling.

Section 2.4.

1. NYADI.221.0701 Procedure to transfer to be dismantled nuclear-powered submarines and surface ships with nuclear installations to enterprises executing dismantling.
2. 89.262.360070.001. Regulations on the organization of transfers to the dismantling site of nuclear-powered submarines to be decommissioned from the Navy. Standard regulations.
3. RD5.IMYAN.105-2005. Guide to ensure nuclear safety at the facilities of the shipbuilding industry.
4. RD5.IMYAN.106-2005. Guide on radiation safety at the facilities of the shipbuilding industry.
5. PPB-UAPL-99 Fire Safety Regulations at dismantling NPS.
6. No.89-FZ of 12.1.003-83. Federal Law "On Industrial and Consumer Waste."
7. SP 2.6.1.2154-06 Radiation safety at comprehensive dismantling of nuclear-powered submarines. Sanitary Regulations.
8. Calculation methods and standards for determining costs in cutting decommissioned ships and vessels of the Navy.
9. V.A. Anitropov, N.I. Alexandrov, A.Ya. Rosina, I.N. Tarasov. Conducting dismantling of nuclear service vessels in shipyard conditions. "Ship Repair Technology, 2004.

Section 2.5.

1. RD5R.95108-94 Cutting hulls of ships and vessels for scrap. Standard process.
2. GOST RV 50811-2006.Dismantling of ships and vessels of the Navy. Basic regulations.
3. SP 2.6.1.799-99. Basic Sanitary Rules for Radiation Safety (OSPORB-99).
4. SP 2.6.6.1168-02. Sanitary Rules for Radioactive Waste Management (SPORO-2002).
5. SP 2.6.1.2154-06. Radiation safety at comprehensive dismantlement of nuclear-powered submarines. Sanitary Regulations.

6. San PiN 2.6.1.2523-09 Radiation Safety Standards. Sanitary rules and norms (NRB-99/2009).
7. San PiN 2.1.7.1322-03 Hygienic requirements for allocation and disposal of production and consumption waste.
8. RD 95.10594-2005 Single-compartment units of reactor compartments. Preparing for long-term storage. General technical requirements.
9. Anitropov V.A., Troshin E.P. et al. Basic technology for the organization for temporary storage of RC of decommissioned nuclear –powered submarines. "Life and Safety», No 2-3, 2000.

Section 2.6.

1. Concept of comprehensive dismantling of nuclear-powered submarines and surface ships with nuclear installations approved by Minatom on Jan. 30, 2001. Enacted by the resolutions of the First Deputy Prime Minister on 17.02.2001 No. IR-P7-02738.
2. RD 95 20594-2005. "Single-compartment units of reactor compartments. Preparing for long-term storage. General technical requirements ".
3. 2.3010 OP-07. "Fundamentals in preparation for storage and maintenance of reactor compartments of dismantled NPS at SLS in Sayda bay ".
4. BNIP.007-05. Process manual "Application of corrosion protection" Denber "to the outer hull structures of reactor compartments of decommissioned nuclear-powered submarines."
5. RD 95 10548-2000. "Solid radioactive waste . Accommodation in the reactor compartments of to be dismantled nuclear –powered submarines. General technical requirements. "
6. SP 2.6.6.1168-02. Sanitary Rules for Radioactive Waste Management (SPORO-2002).
7. No. 2.3096. "Technology of operating site for long-term storage of single-compartment units of reactor compartments in Sayda bay" (Regulations).
8. SP 2.6.1.799-99. Basic Sanitary Rules for Radiation Safety (OSPORB-99).
9. GOST ISO-10002-2007 "Organization management, customer satisfaction. Guidelines for claims management in organizations. "
10. Civil Code of the Russian Federation. Part Two.

Chapter 3

Section 3.1.

1. Administrative Regulations for exercising by the Federal Service for Environmental, Technological and Nuclear Supervision of the state function of licensing the activities in the field of atomic energy use that substantiate nuclear and radiation safety at decommissioning of facilities of atomic energy use (nuclear facilities). Registered with the Russian Ministry of Justice on December 17, 2008. No 12877.

Section 3.4.

1. "Dismantling ships and vessels of the Navy. Main regulations » GOST RV 50811-2006).
2. Guide for nuclear safety of facilities of the Navy "RBYA Navy-2001.
3. Guide for nuclear safety at the facilities shipbuilding industry "RD5.IMYAN.105-2005.
4. "Guide for radiation safety at the facilities of shipbuilding industry" RD5.IMYAN.106 -2005.
5. "Regulation of Radioactive Waste Management at enterprises and organizations in the shipbuilding industry" RD 5.IMYAN.092 -2009.

Section 3.6.

1. Federal Law of 26 December 2008 No. 294-FZ “On Protection of Rights of Legal Entities and Individual Entrepreneurs in the exercise of state control (supervision), and municipal control.”
2. Dobrov G.M. Prediction of science and technology.
3. S.M Bor et al. Methods of optimizing the characteristics of reactor installations.

APPENDIX

METHODOLOGY TO ASSESS THE COMPLIANCE BY LEGAL ENTITIES WITH REQUIREMENTS ON ENSURING NUCLEAR AND RADIATION SAFETY FOR DISMANTLING OF NUCLEAR-POWERED SUBMARINES, SURFACE SHIPS WITH NUCLEAR INSTALLATIONS AND NUCLEAR SERVICE VESSELS DECOMMISSIONED FROM THE NAVY

APPROVED BY

RF Defense Minister

A. Serdyukov

“ _____ ” _____ 2011

**METHODOLOGY TO ASSESS THE COMPLIANCE BY LEGAL
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2011

УТВЕРЖДАЮ

Министр обороны Российской Федерации


А.Сердюков

«15» марта 2011 г.

**Методика
оценки исполнения юридическими лицами
требований по ядерной и радиационной
безопасности при утилизации атомных подводных
лодок, надводных кораблей с ядерными
энергетическими установками и судов атомного
технологического обслуживания, выведенных
из состава Военно-Морского Флота**

2011 год

1. Developed by experts of the Directorate of State Supervision over Nuclear and Radiation Safety of the Ministry of Defense of the Russian Federation, 12th Main Directorate of the Ministry of Defense of the Russian Federation, Autonomous Non-profit Organization “International Center for Environmental Safety” of Minatom of Russia, Federal State Enterprise Burnazyan Federal Medical Biophysical Center, Federal State Enterprise Science & Technology Center for Nuclear and Radiation Safety, Open Joint Stock Company Dollezhai Research and Design Institute of Power Engineering decorated with Lenin order, Open Joint Stock Company Afrikantov Experimental Design Bureau, Open Joint Stock Company Onega Research and Technological Design Bureau.

2. Agreed with the Ministry of Education and Science of the Russian Federation, Ministry of Industry and Trade of the Russian Federation, Federal Space Agency and State Atomic Energy Corporation “Rosatom”.

3. This Methodology to Assess the Compliance by Legal Entities with Requirements on Ensuring Nuclear and Radiation Safety for Dismantling of Nuclear-Powered Submarines, Surface Ships with Nuclear Installations and Nuclear Service Vessels Decommissioned from the Nav (hereinafter - the Methodology) implements the norms of the Administrative Regulations of the Ministry of Defense of the Russian Federation for exercising the state functions of the state supervision over nuclear and radiation safety in the development, manufacture, testing, operation, storage and disposal of nuclear weapons and nuclear power plants intended for military purposes approved by the Order of the Minister of Defense of the Russian Federation dated July 9, 2009 No. 600 (registered in the Russian Ministry of Justice on Aug. 18, 2009, registration number 14560).

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1. Scope of Application.

This Methodology is an internal document of the Ministry of Defense of the Russian Federation and it sets forth the decision-making criteria to assess meeting by legal entities of the NRS requirements when dismantling nuclear-powered submarines (NPS) and surface ships (SS) with nuclear installations (NI) as well as nuclear service vessels and while managing spent nuclear fuel (SNF) and radioactive waste (RW).

The decision-making criteria to assess meeting by military units of NRS requirements when dismantling NPS and SS with NI and nuclear service vessels and while managing SNF and RW, are set forth by other official documents of the Ministry of Defense of the Russian Federation and do not fall within the scope hereof.

The Methodology statements shall be applied by the officials of the Directorate of State Supervision over Nuclear and Radiation Safety of the Ministry of Defense of the Russian Federation while making a decision to assess meeting the requirements for NRS when inspecting legal entities under the procedure prescribed by regulatory legal acts of the Ministry of Defense of the Russian Federation.

2. Terms, Definitions and Abbreviations.

2.1. This Methodology makes use of terms and definitions in compliance with GOST RV 50811 "Dismantling of Ships and Vessels of the Navy. Basic Provisions" and "General Provisions to Ensure Nuclear and Radiation Safety of Ship Nuclear Propulsion Plants" (OPB-K-98/05).

2.2. The following abbreviations are used in this Methodology:

BST	- Biological shielding tank
CPS	- Control and protection system
DB	-Data base
DC	- Departmental Center
DSS NRS	- Directorate of State Supervision over Nuclear and Radiation Safety
FE	- Fuel element
FMB	-Floating maintenance base
FMBA	- Federal Medical Biological Agency (Center)
FS	-Feasibility Study
IE CAMS	-Integrated Equipment Control, Alarm and Monitoring System
IRS	- Ionizing radiation source
MPI	- Main power installation
MPP CP	-Main power plant control panel
NI	- Nuclear (power) installation
NPS	-Nuclear-powered submarine
NS	-Nuclear service
NSR	- Nuclear and radiation safety
PD	- Personal dosimetry
PHO	-Potentially hazardous operations
PPE	- Personal protective equipment

RC	-Reactor compartment
RadSafety	- Radiation safety
RI	-Reactor installation
RM	-Radiation monitoring & control
RS	-Radioactive substances
RSp	-Reactor space
RSS	-Radiation Safety Service
RT	-Repair team
RW	-Radioactive waste
SGP	-Steam-generating plant
SLS	-Site for long-term storage
TC	-Transport container (In Russian- TK)

3. Decision-making Criteria to Assess by Legal Entities the Compliance with Requirements on Ensuring NRS at Dismantling of NPS, SS with NI and NSV Decommissioned from the Navy

To make a decision concerning assessment of meeting by legal entities of requirements for NRS at dismantling of NPS, SS with NI and NSV decommissioned from the Navy, one needs to estimate the value of the parameter of compliance of the activities of the legal entity associated with dismantling of NPS, SS with NI and NSV decommissioned from the Navy (hereinafter - the object of validation) with the NRS (P_s).

P_s parameter represents the degree of deviation of the estimated (actual) level of compliance of the object of validation with the NRS requirements characterized by P_s (estim) parameter from the baseline (desired) level of compliance (full compliance) of the object of validation with the NRS requirements characterized by P_s (bas) parameter. In this case, the formula for the P_s calculation looks as follows:

$$P_s = \frac{P_s(\text{estim})}{P_s(\text{bas})} \quad (1).$$

In order to assess compliance of the object of validation with the NRS requirements, a quantitative assessment of the P_s parameter is transformed to a qualitative one (score assessment, or scoring), which implies the existence of criteria.

The criteria listed in Appendix 1 to the Methodology are adopted as the criteria of compliance. The chosen assessment scale is from 0 to 1. Here the value of P_s (bas) parameter that characterizes full compliance of the object of validation with the NRS requirements is assumed to be 1.

To make an objective assessment of conformity of the object of validation with the NRS requirements, the factors (of Level 1) that most significantly affect compliance of the object of validation with the mentioned requirements are specified.

These include:

Factor D (*document*) describing the impact on the P_s (estim) parameter of the completeness and quality of data contained in the documents of the legal entity that substantiate ensuring NRS while performing works (rendering services) in the specified field of activity;

Factor P (*personal*) characterizing the impact on the P_s (estim) parameter of the level of compliance of the personnel involved in the execution of works (rendering services) in the specified field of activity, the level of special training set by federal executive bodies, State Corporation Rosatom that administer the inspected legal entities (to whose field of activity they belong)*;

Factor O (*object*) that characterizes the impact on the P_s (estim) parameter of the condition of sites, buildings, structures, spaces, equipment, transport vehicles used while conducting works (rendering services) in the specified field of activities;

* The impact of Factor P on the value of P_s (estim) parameter is assessed under the criteria specified in the document that defines the procedure and program of training (advanced training) of the personnel engaged in dismantling of NPS, SS with NI and NSV decommissioned from the Navy in the field of NSR, this document being agreed with the Ministry of Industry and Trade of Russia and State Corporation "Rosatom".

Factor T (*technology*) that characterizes the impact on the Ps (estim) parameter of the conducted works (rendered services) in the specified field of activity;

Factor A (*administration*) that characterizes the impact on the Ps (estim) parameter of actions undertaken by the administration of the entity (senior officials in charge) to meet NRS requirements.

Thus, the target function of the calculated level of compliance of the object of validation with the NRS requirements is as follows:

$$Ps(estim) = F\{D, P, O, T, A\} \quad (2).$$

The requirements set out in the legislation and regulations related to ensuring NRS are considered as factors of the 2nd level directly characterizing the factors of the 1st level.

The impact of Level 2 factors on Level 1 factors is taken into account through classification of violations of NRS requirements: by degree of their significance (the magnitude of risk of negative consequences of the violation) - into critical and non-critical, as well as by the form of manifestation – into actual and potential.

An actual critical violation of the NRS requirements (Category 1A) is a discrepancy with the NRS requirements related to inflicting harm to life, health, environment, and hazard of natural and manmade emergencies.

The necessary and sufficient condition for the classification of a violation of Category 1A is the identification of the fact of implementation of:

- An event corresponding to Level A1-A3 (accident) under the scale listed in Appendix 2 of the Methodology;
- An event corresponding to Level P1-P5 (an incident or a severe incident) under the scale listed in Appendix 2 to the Methodology.

In case of identification of violations of the NRS requirements of Category 1A the officials of the DSS NRS of the RF Ministry of Defense shall take immediate actions to stop inflicting harm to life, health, environment up to a temporary ban of activities of the legal entity, its branch office, representation, structural unit in the manner prescribed by the Code of the Russian Federation on Administrative Violations, and inform citizens as well as other legal entities in any practical manner about the fact of inflicting harm and methods to prevent its consequences.

In case of identification of violations of the NRS requirements of Category 1A containing features of crimes in accordance with the Russian legislation, that information is forwarded to the law enforcement bodies.

In case of identification of violations of the NRS requirements of Category 1A associated with the violation of licensing requirements and conditions for ensuring NRS in the specified field of activity, the respective information is sent in the prescribed manner to the licensing authority (State Corporation “Rosatom”).

In case of identification of violations of the NRS requirements of Category 1A, officials of the DSS NRS of the Ministry of Defense shall in the prescribed manner:
- Issue an instruction to the legal entity for elimination of the identified violations with the indication of the time frame for their elimination;

-Undertake actions to monitor and control the elimination of the violations, their prevention, prevention of possible harm to life or health of citizens, harm to animals, plants, environment, prevention of natural and man-made emergencies..

A potential critical violation of the NRS requirements (Category 1B) is the disparity between the NRS requirements that poses direct hazard of harm to life, health of the public, environment, as well as hazard of natural and man-made emergencies, but the necessary and sufficient conditions for the violation classification as that of Category 1A are actually not implemented.

Category 1B covers violations of the NRS requirements the failure to meet which makes performance of works in the specified field of activity illegal, including violations of the NRS requirements set out by:

- Federal laws;
- Acts of President of the Russian Federation, the Government of the Russian Federation;
- Regulatory legal acts of federal executive authorities and State Corporation “Rosatom” that exercise state management of activities related to the dismantlement of nuclear installations intended for military purposes, and (or) exercise the functions of State Customer (Customer -Coordinator) of the Program for comprehensive dismantling of NPS, SS with NI, NSV and remediation of coastal maintenance bases;
- State health regulations that specify the requirements for radiation safety at dismantlement (sanitary-hygienic aspects);
- NRS rules and regulations that do not have the status of regulatory legal acts, whose application in the works is required in compliance with the resolutions of federal executive authorities and State Corporation “Rosatom” that exercise state management of the activities related to the dismantlement of nuclear installations intended for military purposes, and (or) exercise the functions of the State Customer (Customer -coordinator) of the Program for comprehensive dismantling of NPS, SS with NI, NSV and remediation of coastal maintenance bases.

Category 1B also covers violations of the NRS requirements related to the implementation of events corresponding to Level P6 (anomaly) under the scale given in Appendix 2 of the Methodology.

In case of identification of violations of the NRS requirements of Category 1B the officials of the DSS NRS of the MOD shall undertake immediate steps to prevent inflicting harm to life, health, environment up to a temporary ban of activities of the legal entity, its branch offices, representation, structural unit in the manner prescribed by the Code of the Russian Federation on Administrative Violations, and inform citizens as well as other legal entities in any way practical way about the hazard of inflicting harm and methods of its prevention.

In case of identification of violations of the NRS requirements of Category 1B containing features of crimes in accordance with the Russian legislation, that information is forwarded to the law enforcement bodies.

In case of identification of violations of the NRS requirements of Category 1B related to violation of licensing requirements and conditions ensuring NRS in the specified field of activity, the respective information is forwarded in the prescribed manner to the licensing body (State Corporation “Rosatom”).

In case of identification of violations of the NRS requirements of Category 1B the officials of the DSS NRS of the MOD shall in the prescribed manner:

Issue an instruction to the legal entity for elimination of the violations with specification of the time frame for their elimination;

Undertake actions to monitor and control elimination of the violations, their prevention, prevention of inflicting possible harm to the life or health of citizens, harm to animals, plants, the environment, prevention of natural and man-made emergencies.

An actual non-critical violation of the NRS requirements (Category 2A) is the non-compliance with the NRS requirements that does not pose a direct hazard of inflicting harm to life, health, environment, and the hazard of natural and man-made emergencies.

Violations of Category 2A are accompanied by reduced effectiveness of the activities of structural units of legal entities participating in the work in the specified field of activity, the functioning of core processes at the stages of performing works in the specified field of activity. In this case, the direct hazard of inflicting harm to life, health, environment, and the hazard of natural and man-made emergencies is absent.

Category 2A includes violations of the NRS requirements set forth by standardization documents, Terms of Reference (otherwise called Statements of Work or Technical Assignments) of the State Customer, engineering documentation (design, process and software documentation, technical specifications, instructions, manuals, guides and regulations), if their application is envisaged by the terms of the state contract (agreement) for performance of specific works in the specified field of activity.

In case of identification of violations of the NRS requirements of Category 2A the officials of the DSS NRS of the MOD in the prescribed manner shall undertake measures to monitor and control the elimination of the violations and their prevention, prevention of inflicting possible harm to the life or health of citizens, harm to animals, plants, environment, prevention of natural and man-made emergencies.

The pre-requisite for the classification of a violation of the NRS requirements as that of Category 2A is a non-systematic nature of the identified violation.

If the violation of Category 2A becomes systematic, or a steady decrease in effectiveness of the structural units involved in the execution of works in the specified field of activity and functioning of key processes at the work stages essentially impacting meeting by the legal entity of NRS requirements is observed, the violation is classified as potentially critical (Category 1B). In this case the actions appropriate for Category 1B are undertaken in relation to the facts of identified violations.

A potential non-critical violation (Category 2B) is an incompliance between the NRS requirements that does not pose a direct hazard of inflicting harm to life, health, environment, and the hazard of natural and man-made emergencies the likelihood of occurrence of which in future can only be predicted with some degree of accuracy.

Category 2B is assigned to violations of the requirements set forth in the regulatory documents governing the procedure of implementing mandatory requirements (guidelines, guide for monitoring, etc.).

In case of identification of violations of the NRS requirements of Category 2B the officials of the DSS NRS of the MOD shall in the prescribed manner undertake measures to monitor and control the elimination of the violations and their prevention, prevention of inflicting possible harm to life or health of citizens, harm to animals, plants, environment, prevention of natural and man-made emergencies.

The list of regulatory legal acts and regulatory documents that contain requirements for NRS considered as factors in Level 2 is presented in Appendix 3 to the Methodology.

According to Section 5 of GOST RV 50811-2006 "Dismantling of Ships and Vessels of the Navy. Basic Provisions" there are 8 stages of dismantling (Appendix 4 of the Method). Each of these stages is characterized by a set of NRS requirements to be applied by legal entities while conducting the work (Appendix 5 of the Method). At the stage of direct preparation for validation of the legal entity specific NRS requirements subject to application are updated in due course by the validation group members while developing check lists.

The estimated parameter of conformity of the object of validation with the NRS requirements is defined under the formula:

$$\begin{aligned}
 Ps(\text{estim}) = & 1 - [W_{N1A}(A1 \dots A3) \times N_{1A}(A1 \dots A3) + W_{N1A}(\Pi1 \dots \Pi5) \times N_{1A}(\Pi1 \dots \Pi5)] - \\
 & W(D) \times [W_{N1B} \times N_{1B}(D) + W_{N2A} \times N_{2A}(D) + W_{N2B} \times N_{2B}(D)] - W(P) \times [W_{N1B} \times N_{1B}(P) + \\
 & W_{N2A} \times N_{2A}(P) + W_{N2B} \times N_{2B}(P)] - W(O) \times [W_{N1B} \times N_{1B}(O) + W_{N2A} \times N_{2A}(O) + W_{N2B} \times \\
 & N_{2B}(O)] - W(T) \times [W_{N1B} \times N_{1B}(T) + W_{N2A} \times N_{2A}(T) + W_{N2B} \times N_{2B}(T)] - W(A) \times \\
 & [W_{N1B} \times N_{1B}(A) + W_{N2A} \times N_{2A}(A) + W_{N2B} \times N_{2B}(A)],
 \end{aligned} \tag{3}$$

where:

$Ps(\text{estim})$ – calculated parameter of compliance of the object of validation with the NRS requirements;

$W_{N1A}(A1 \dots A3)$ - weight (importance) of actual critical violations of Level A1 ...A3 (accident) as per Appendix 2;

$N_{1A}(A1 \dots A3)$ - number of implementations of actual critical violations of Level A1 ...A3 (accident) in accordance with Appendix 2;

$W_{N1A}(P1 \dots P5)$ - weight (importance) of actual critical violations of Level P1 ... P5 (accidents and severe incidents) in accordance with Appendix 2;

$N_{1A}(P1 \dots P5)$ - number of implementations of actual critical violations of Level P1 ...P5 (accidents and severe incidents) in accordance with Appendix 2;

$W(D), W(P), W(O), W(T), W(A)$ - weights (importance) of Level 1 factors;
 $N_{1B}(D), N_{2A}(D), N_{2B}(D)$ - number of violations of the NRS requirements of Categories 1B (potential critical), 2A (actual non-critical) and 2B (potential non-critical), identified through checking the Factor D, respectively;

$N_{1B}(P), N_{2A}(P), N_{2B}(P)$ - number of violations of the NRS requirements of Categories 1B (potential critical), 2A (the actual non-critical) and 2B (potential non-critical) identified while checking Factor P;

$N_{1B}(O), N_{2A}(O), N_{2B}(O)$ - number of violations of the NRS requirements of Categories 1B (potential critical), 2A (actual non-critical) and 2B (potential non-critical), respectively, identified while checking Factor O;

$N_{1B}(T), N_{2A}(T), N_{2B}(T)$ - number of violations of the NRS requirements of Categories 1B (potential critical), 2A (actual non-critical) and 2B (potential non-critical), respectively, identified while checking Factor T;

$N_{1B}(A), N_{2A}(A), N_{2B}(A)$ - number of violations of the NRS of Categories 1B (potential critical), 2A (actual non-critical) and 2B (potential non-critical), respectively, identified while checking Factor A;

$W_{N1B}, W_{N2A}, W_{N2B}$ - weights (importance) of the respective category of violations of the NRS requirements of Categories 1B (potential critical), 2A (actual non-critical) and 2B (potential non-critical), respectively.

To determine the weights (importance) of the relevant factors, the method of peer review (expert assessments) involving professional experts in conjunction with the method of the experts' qualimetry was applied.

Thus, the weights (importance) are as follows:

$$\begin{array}{ll}
 W_{N1A}(A1 \dots A3) = 0,8 & W(D) = 0,5; \\
 W_{N1A}(\Pi1 \dots \Pi5) = 0,6 & W(P) = 0,55; \\
 W_{N1B} = 0,4; & W(O) = 0,7; \\
 W_{N2A} = 0,04; & W(T) = 0,62; \\
 W_{N2B} = 0,01; & W(A) = 0,52.
 \end{array}$$

After substitution of weights the formula (3) looks as (4).

If the calculated value of the Ps (estim) parameter falls into the field of negative numbers, it is made zero.

Given that the value of the baseline level of compliance of the object of validation with the NRS requirements Ps (bas) taken as 1, the exponent of compliance of the object of validation with the NRS requirements Ps coincides with the value of the estimated parameter Ps (estim).

$$\begin{aligned}
 Ps(\text{estim}) = 1 - [0,8 \times N_{1A}(A1 \dots A3) + 0,6 \times N_{1A}(\Pi1 \dots \Pi5)] - 0,5 \times [0,4 \times N_{1B}(D) + 0,04 \times \\
 N_{2A}(D) + 0,01 \times N_{2B}(D)] - 0,55 \times [0,4 \times N_{1B}(P) + 0,08 \times N_{2A}(P) + 0,01 \times N_{2B}(P)] - \\
 0,7 \times [0,4 \times N_{1B}(O) + 0,04 \times N_{2A}(O) + 0,01 \times N_{2B}(O)] - 0,62 \times [0,4 \times N_{1B}(T) + 0,04 \times \\
 N_{2A}(T) + 0,01 \times N_{2B}(T)] - 0,52 \times [0,4 \times N_{1B}(A) + 0,04 \times N_{2A}(A) + 0,01 \times N_{2B}(A)].
 \end{aligned} \tag{4}$$

In case of implementation of at least one event classified as A1 ... A3 (accident), the Ps parameter falls in the range of values corresponding to the assessment "extremely unsatisfactory" (Appendix 1), characterizing an extremely low compliance of the object of validation with the NRS requirements.

In the case of implementation of at least one event classified as P1 ... P5 (incident, severe incident), the Ps parameter falls in the range of values corresponding to the "unsatisfactory" assessment that characterizes a low compliance of the object of validation with the NRS requirements. Later on a decision to assess meeting by legal entities of the NRS requirements in accordance with Appendix 1 to the Methodology shall be made.

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 SAFETY OF THE MINISTRY OF DEFENSE OF THE RUSSIAN FEDERATION- CHIEF
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 A.Tormishev**

Appendix 1 (Mandatory)

Criteria of compliance of the object of validation with NRS requirements

Ps value	Score assessment of actual compliance	Characteristics of actual assessment of compliance of the object of validation to NRS requirements	Conclusion about the nature of required actions
$0.95 < P_s \leq 1$	Excellent	Very high compliance	Further improvement of safety level is evidently unreasonable from economic viewpoint
$0.8 < P_s \leq 0.95$	Good	High compliance	Some elevation of safety level is possible when sufficient resources are available
$0.4 < P_s \leq 0.8$	Satisfactory	Satisfactory compliance	Planned improvement of safety level is required
$0.2 < P_s \leq 0.4$	Unsatisfactory	Low compliance	Urgent actions are required to be undertaken (<i>as a rule, administrative ones</i>) to improve safety level
$P_s \leq 0.2$	Extremely unsatisfactory (Bad)	Extremely low compliance	Urgent actions are required to be undertaken (<i>as a rule, administrative and engineering ones</i>) to improve safety level

Appendix 2 (Mandatory)

Scale of events significant for classification of violations of NRS requirements

Designation of violation category	Violation category under INES scale	Features and consequences of violations
ACCIDENTS		
A1	Level 5 Accident with risk for environment	Radioactive release (dumping) to the environment as a result of which excess of Level B* of criteria for undertaking urgent decisions in the initial period of a radiation accident beyond the organization control zone took place.
A2		Radioactive release (dumping) to the environment as a result of which excess of Level B of criteria for undertaking urgent decisions in the initial period of a radiation accident within the organization control zone took place.
A3	Level 4 Accident without essential risk for environment	<ol style="list-style-type: none"> 1. Radioactive release (dumping) to the environment as a result of which excess of Level A of criteria for undertaking urgent decisions in the initial period of a radiation accident beyond the organization sanitary protection (buffer) zone took place. 2. Personnel exposure with a lethal outcome.
INCIDENTS		
P1	Level 3 Severe incident	<ol style="list-style-type: none"> 1. Radioactive release (dumping) to the environment in the absence of consequences characteristic of violations of Categories A1 ... A3, population exposure below the admissible limit. 2. Personnel exposure corresponding to that in the effective dose exceeding 200 mSv a year (hypothetically hazardous exposure). 3. Plunder or loss of SFA, SNF in any form or of other highly active radiation source.
P2	Level 2 Incident	Personnel exposure corresponding to that in the effective dose exceeding 100 mSv a year, but not more than 200 mSv a year.
P3		Personnel exposure corresponding to that in the effective dose exceeding 50 mSv a year, but not more than 100 mSv a year.
P4		Personnel exposure exceeding check levels, but not exceeding the values regulated by norms of radiation safety (50 mSv a year).
P5		<ol style="list-style-type: none"> 1. Falling and (or) damage of SFA or fuel elements (while de-fuelling the reactor), unauthorized recovery of work bodies of Protection Control System (PCS) or development of uncontrollable circulation of the heat-carrier in the reactor or unauthorized gas supply from the HP gas system to the primary circuit (at temporary storage of the ship afloat, towage to the dismantling site and preparation for dismantling) not resulted in an accidents or violation of Category P1 ... P4 (a radiation incident). 2. Uncontrollable and unauthorized operations on processing, moving, transfer and transportation of SFA, SNF in any form (more than 300 g of a nuclear-hazardous fission material). 3. Severe damage of physical barriers at transport-process operations, unloading SNF from the reactor that have not resulted in an accident or violation of Category P1 ... P4 (radiation incident). 4. Identification of an unaccounted highly active radiation source, though signs of violation of Category P1 ... P4 are missing.
P6	Level 1 Anomaly	<ol style="list-style-type: none"> 1. Insignificant damage of physical barriers at transport-process operations, unloading SNF from the reactor, at preservation of the essential part of multi-barrier protection. 2. Plunder, loss or identification of an unaccounted low active radiation source.

* Levels A and B of criteria for undertaking urgent decisions in the initial period of a radiation accident correspond to those specified in Table 6.3 of Sanitary Rules SanPiN of 2.6.1.2523-09 Norms of Radiation Safety (NRB-99/2010).

Appendix 3 (Mandatory)

List of legal acts and regulatory documents that specify NRS requirements

#	Title of document that specifies NRS requirements	Document requisites	Category (According to the Methodology) ¹
Federal laws			
1.	On Radiation Safety of the Population.	January 9, 1996 No. 3-FZ	1B
2.	On Sanitary-Epidemiologic Well-being of the Population.	March 30, 1999 No. 52-FZ	1B
3.	On Preservation of the Environment.	January 10, 2002 No. 7-FZ	1B
4.	On Unity of Measurements.	June 26, 2008 No. 102-FZ	1B
Acts of President of the Russian Federation and Government of the Russian Federation			
5.	On approval of Regulations on licensing of activities involving the use of radioactive materials during the work on the use of atomic energy for defense purposes.	June 20, 2000 No. 471	1B
6.	On the Procedure to develop radiation-hygienic passports of the organizations and territories.	January 28, 1997 No. 93	1B
Regulatory legal acts of federal executive authorities and State Corporation Rosatom			
7.	On approval of administrative regulations of the Ministry of Defense of the Russian Federation on exercising the state function of state supervision over nuclear and radiation safety at development, manufacture, testing, operation, storage and dismantlement of nuclear weapons and nuclear power military-oriented installations.	July, 9th, 2009 No. 600дсп	1B
State sanitary-epidemiologic rules that specify requirements to radiation safety at dismantling			
8.	Norms of Radiation Safety (NRB-99/2009).	SanPin 2.6.1.2523-09 July 7, 2009 No. 47	1B
9.	Basic Sanitary Rules for Radiation Safety (OSPORB-99/2010);	SP 2.6.1.2612-10 April 26, 2010 No. 40	1B
10.	Hygienic requirements to designing and operation of nuclear industry enterprises (SPP PUAN-03).	SanPin 2.6.1.07-03 February 4, 2003 No. 6	1B
11.	Radiation safety at comprehensive dismantling of nuclear-powered submarines	SP 2.6.1.2154-06 December 13, 2006 No. 33	1B
12.	Radiation safety at designing, construction, operation and dismantling of nuclear service vessels (SP -SATO-2001).	SP 2.6.1.11-02 April 16, 2002 No. 11-02	1B
13.	Sanitary Rules for Radioactive Waste Management (SPORO-2002)	SP 2.6.6.1168-02 October 23, 2002 No. 33	1B
14.	Radiation-hygienic requirements to cut out reactor compartments of NPS at preparation for storage ashore.	SP 2.6.5.12-02	1B

¹ In case of implementation as a result of any violation of NRS requirements of an accident or an incident corresponding to Level P1-P5 under the scale of Appendix 2 to Method, the specified violation is classified as that of Category 1A.

#	Title of document that specifies NRS requirements	Document requisites	Category (According to the Methodology) ¹
Interdepartmental norms and rules on the nuclear and radiation safety not having a regulatory legal status			
15.	General provisions for nuclear and radiation safety of ship nuclear installations.	OPB-K-98/05	1B
16.	Rules of nuclear safety of ship nuclear installations.	PBYA-V 08-88/05	1B
Documents on standardization			
17.	Dismantling of Naval ships and vessels. Basic provisions.	GOST RV 50811-2006	2A
Departmental regulatory documents defining administrative & engineering aspects of radiation safety at dismantling			
18.	Guide for nuclear safety at the facilities of shipbuilding industry	RD5.IMYAN.105-2005	2A
19.	Guide for radiation safety at the facilities of shipbuilding industry	RD5.IMYAN.106-2005	2A
20.	Guide for the organization of personnel certification at the enterprises and organizations of the shipbuilding industry operating in the field of atomic energy.	RD5.IMYAN.107-2005	2A
21.	Rules of radioactive waste management in the enterprises and organizations of the shipbuilding industry	RD5.IMYAN.092-2009	2A
22.	Civil crew of NPS retired from the Navy and transferred to enterprises executing dismantling. Standard regulations	NYADI.0220.00.017	2A
23.	On-duty and watch-keeping service for NPS retired from the Navy and transferred to enterprises executing dismantling. Standard regulations	NYADI.0220.00.019	2A
24.	Mixed crew of NPS retired from the Navy and transferred to the enterprises executing dismantling. Temporary regulations	NYADI.0220.00.020	2A
25.	Organization of unloading spent nuclear fuel at enterprises of Russian shipbuilding industry (Rossudostroeniye). Temporary regulations	NYADI.0220.00.021	2A
26.	Organization of unloading spent nuclear fuel at the onshore facilities of Rossudostroeniye enterprises. Regulations	NYADI.0220.00.027	2A
27.	Organization of unloading spent nuclear fuel at the onshore facilities of Rossudostroeniye enterprise with the crew of the Navy at the to be dismantled NPS NPS. Provisions	NYADI.0220.00.031	2A
28.	Procedure for transferring decommissioned NPS and SS with NI to the enterprises executing dismantling. Temporary regulations	NYADI.221.0701	2A

#	Title of document that specifies NRS requirements	Document requisites	Category (According to the Methodology) ¹
29.	Nuclear safety at nuclear-powered submarines decommissioned from the Navy and transferred to the enterprises executing dismantling. Provisions	NYADI.000.0230.00.001	2A
30.	Radiation Safety at nuclear-powered submarines decommissioned from the Navy and transferred to the enterprises executing dismantling. Main organizational and technical requirements.	NYADI.000.0230.00.002	2A
31.	Organization of LRW and SRW management at Russian shipbuilding enterprises engaged in construction, repair, modernization and dismantling of nuclear-powered submarines. Methodical guidelines	NYADI.0312.00.035	2A
32.	Procedure for the transfer of ships, marine vessels and floating vessels intended for nuclear maintenance decommissioned from the Navy to enterprises executing works. FSUE DaljRAO and FSUE SevRAOЭ .	LKIB.4130-015-2004	2A
33.	Preparing for storing and keeping afloat of nuclear service vessels retired from the Navy.	LKIB.4130-019-2006	2A
Guides and guiding documents defining sanitary-hygienic aspects of radiation safety at dismantling			
34.	Radiation safety while unloading the irradiated fuel assemblies of decommissioned nuclear-powered submarines" (RBV-2002).	R2.6.1.35-02	2A
35.	Hygienic regulations set for dismantling NPS.	R2.6.6.37-02	2A
36.	Radiation-hygienic requirements for placement of solid waste in the reactor compartments of decommissioned nuclear-powered submarines	R2.6.1.42-02	2A
37.	Radiation and environmental safety at the sites for temporary storage afloat of reactor units from dismantled NPS	Guide R2.6.1.42-03	2A
38.	Organization of individual dosimetric monitoring of the personnel of the enterprises of nuclear shipbuilding and population in the surveillance zone	R2.6.1.55-04	2A
39.	Radiation-hygienic requirements for dismantling nuclear service vessels	R2.6.1.62-04	2A
40.	Radiation monitoring and control of scrapped metal formed at dismantling of nuclear –powered submarines of the 1 st , 2 nd and 3 rd generations and surface ships with nuclear installations.	RD 2.6.1.69-02	2A
41.	Radiation-hygienic requirements for long-term storage of single compartment reactor units of decommissioned nuclear-powered submarines.	R2.6.6.57-04	2A
Methodical instructions on implementation of sanitary-hygienic aspects of radiation safety at dismantling			
42.	Radiation Safety at dismantling nuclear-powered submarines.	MU2.6.1.04-05	2B
43.	Radiation-hygienic requirements to the system of radiation control of Sites for Long-term Storage of single-compartment units of reactor compartments.	MU 2.6.1.11-06	2B
44.	Sanitary-protective (buffer) zones and access control zones of the enterprises of nuclear shipbuilding. Operating conditions and substantiation of borderlines.	MU 2.6.1.36-02	2B

#	Title of document that specifies NRS requirements	Document requisites	Category (According to the Methodology) ¹
45.	Radiation Safety for dismantling of nuclear-powered submarines of the first generation.	MU2.6.1.38-05	2Б
46.	Radiation-hygienic zones of nuclear shipbuilding enterprises. Operating conditions and justification for the boundaries.	MU 2.6.1.52-03	2Б
47.	Assessing the impact of radiation-hazardous work performed by nuclear shipbuilding enterprises on the environment and population.	MU 2.6.1.56-04	2Б
48.	Identification of individual effective and equivalent doses and control of the personnel exposure at enterprises of nuclear shipbuilding and ship repair.	MU 2.6.1.61-04	2Б
49.	Radiation monitoring/control of scrap metal formed during the decommissioning of nuclear-powered submarines	MU 2.6.1.32-01	2Б
50.	Radiation-hygienic requirements to single-compartment units of reactor compartments intended for storage on coastal pads.	MU 2.6.6.10-06	2Б
51.	Provision of radiation safety when conducting remediation of territories of coastal maintenance bases.	MU 2.6.6.22-05	2Б

Appendix 4 (Reference)

Stages of dismantling NPS, SS with NI and NSV of Navy

I.	Decommissioning of the ship with NI from the Navy and its preparation for the temporary storage afloat at the Naval base is done in compliance with the documents of the MOD, the documentation and the ship and SGP designers with production of protocols of the performed works Temporary storage of the ship by the Naval crew afloat. Transfer of the ship to the enterprise-executor of work.
II.	Placement of the ship at the enterprise performing the work. Preparation of the ship for dismantling.
III.	SNF unloading with the implementation of related activities, transportation, reprocessing of SNF.
IV.	Cutting out the reactor compartment (RC) or the reactor unit, preparing it for storage. Cutting and dismantling of the ship hull and the ship hull structures, processing of equipment, cable products for sale and (or) the sale of equipment and cables. Launch of the reactor unit to water, transportation of the RC (RSp) or the reactor unit to a site of temporary storage.
V	Cutting out of the RC (RSp) from the reactor unit
VII	Long-term storage of the RC (RSp) after its cuttings from the reactor unit
VIII.	RW management
VIII.	Disposal of the reactor compartment (RC) of NPS or a reactor space (RSp) of SS with NI

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	compliance of documentation that justifies activities on dismantling NPS and SS with NI and management of SNF and radioactive waste with the requirements of environmental protection.	33, Part 1								
14.	Setting standards of permissible impact on the environment in the implementation by the organization of activities on dismantling NPS and SS with NI and management of SNF and RW.	No. 7-FZ, Article 22, Part 1	+	+	+	+	+	+	+	+
15.	Development of an action plan to protect the workers (personnel) and the population from a radiation accident and its consequences agreed with the local authorities, executive bodies exercising state supervision and control in the field of radiation safety	No. 3-FZ, Article 19	+	+	+	+	+	+	+	+
16.	Development of a list of potential radiation accidents with the prediction of their consequences and prognosis of the radiological situation.	No. 3-FZ, Article 19	+	+	+	+	+	+	+	+
17.	Defining criteria for decision-making at a radiation accident	No. 3-FZ, Article 19	+	+	+	+	+	+	+	+
18.	Availability of means of warning and elimination of consequences of radiation accidents	No. 3-FZ, Article 19	+	+	+	+	+	+	+	+
19.	Availability of medical means for prevention of radiation injuries and means of medical aid to victims of radiation accidents	No. 3-FZ, Article 19	+	+	+	+	+	+	+	+
20.	Organization of the preliminary (when applying for a job) and periodic medical examinations of workers (staff).	No. 3-FZ, Article 14 No. 52-FZ, Article 34, Part 3	+	+	+	+	+	+	+	+
21.	Entering data on a medical examination in individual medical records	No. 52-FZ, Article 34, Part 5	+	+	+	+	+	+	+	+
22.	Organization of regular information to the workers (personnel) on the levels of ionizing radiation in their workplaces and the magnitude of individual doses obtained by them	No. 3-FZ, Article 14	+	+	+	+	+	+	+	+
23.	Organization of timely information to the federal executive bodies authorized to carry out state management, government supervision and control of radiation safety, executive authorities of subjects of the Russian Federation of emergency situations, violations of manufacturing regulations that pose hazard to radiation safety.	No. 3-FZ, Article 14 No. 52-FZ, Article 11	+	+	+	+	+	+	+	+
24.	Availability of officially published sanitary rules, methods and techniques to control the environmental factors	No. 52-FZ, Article 11	+	+	+	+	+	+	+	+
II. REQUIREMENTS SET BY RF GOVERNMENT DECREES										
1.	Availability of a license for carrying out works on dismantling NPS and SS with NI, and management of SNF and RW.	Appendix to PPrNo. 471, para. 6	+	+	+	+	+	+	+	+
2.	Implementation of licensing requirements and conditions that may lead to the occurrence of accidents, damage to the rights, legitimate interests and health of citizens, as well as defense and national security	Appendix to PPrNo. 471, para. 26	+	+	+	+	+	+	+	+
3.	Absence of facts of repeated or gross violations of licensing requirements and conditions	Appendix to PPrNo. 471, para. 28 б)	+	+	+	+	+	+	+	+
4.	Inclusion in the radiation-hygienic passport of organizations and sites of information on areas and risk groups of the population (personnel) exposed to high levels of ionizing radiation; prediction of radiation situation in the organizations that use sources of ionizing radiation, and in the territories; recommendations for	Appendix to PPrNo. 93, para. 5	+	+	+	+	+	+	+	+

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	planning, carrying out activities and decision-making related to radiation safety of the population (personnel); effectiveness analysis of conducted activities related to ensuring the population (personnel) radiation safety; information needed for decision making									
III. REQUIREMENTS SET FORTH BY THE STATE SANITARY-AND-EPIDEMIOLOGIC RULES										
1.	Non-excess of the basic dose limits for the personnel (Group A) or the population.	NRB-99/2009, para. 3.1.2	+	+	+	+	+	+	+	+
2.	Establishment of reference levels of radiation impact in the organization and the sanitary-protection (buffer) zone	NRB-99/2009, para. 3.1.2, 7.4 OSPORB-99/2010, para. 2.5.1, 3.13.9	+	+	+	+	+	+	+	+
3.	Organization of radiation monitoring	NRB-99/2009, para. 7.1...7.3 OSPORB-99/2010, para. 3.13	+	+	+	+	+	+	+	+
4.	Specification (by the organization administration) of the category for existing radiation facilities (as agreed with the authorities responsible for state sanitary and epidemiological surveillance)	OSPORB-99/2010, para. 3.1.6	+	+	+	+	+	+	+	+
5.	Development and approval of radiation monitoring/control, tailored to the specific features and conditions of work performed.	OSPORB-99/2010, para. 2.4.6 SPORC-2002, para. 14.2	+	+	+	+	+	+	+	+
6.	Agreement of the order of radiation monitoring/control with the authorities responsible for state sanitary and epidemiological surveillance.	OSPORB-99/2010, para. 6.19	+	+	+	+	+	+	+	+
7.	Development of radiation safety manual.	OSPORB-99/2010, para. 2.5.1	+	+	+	+	+	+	+	+
8.	Development of manual for personnel actions in radiation accidents (emergency situations)	OSPORB-99/2010, para. 2.5.1, 6.5	+	+	+	+	+	+	+	+
9.	Development of manual on the prevention and elimination of accidents (fire).	SPORO-2002, para. 12.2	+	+	+	+	+	+	+	+
10.	Specification of a list of organizations relating to personnel of Groups A and B.	OSPORB-99/2010, para. 2.5.1	+	+	+	+	+	+	+	+
11.	Briefings and examination of personnel in the field of radiation safety.	OSPORB-99/2010, para. 2.5.1	+	+	+	+	+	+	+	+
12.	Development and approval of the list of persons allowed to work with radiation sources	OSPORB-99/2010, para. 3.1.6	+	+	+	+	+	+	+	+
13.	. Assign persons responsible for ensuring radiation safety, accounting and storage of radiation sources, for organization of collection, storage and delivery of radioactive waste, radiation monitoring	OSPORB-99/2010, para. 3.4.9	+	+	+	+	+	+	+	+
14.	Providing the personnel with certified clothes, footwear and other personal protective equipment in accordance with the type and class work	OSPORB-99/2010, para. 3.14	+	+	+	+	+	+	+	+
15.	Development, coordination with the authorities exercising the state sanitary and epidemiological supervision and approval of the action plan for the personnel protection in the event of a radiation accident	OSPORB-99/2010, para. 6.4	+	+	+	+	+	+	+	+
16.	Assigning a responsible person y for organizing the collection, storage and delivery of RW by the order in the organization.	SPORC-2002, para. 5.16	+	+	+	+	+	+	+	+
17.	Keeping the systematic monitoring and accounting for	SPORC-2002,	+	+	+	+	+	+	+	+

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	the collection, storage and preparation for the removal of radioactive waste generated in the process, the responsible person in the register of radioactive waste.	para. 5.16								
18.	Appointment of a commission to verify the accounting of radioactive waste, handed over to a specialized organization for burial, as well as that located in the organization.	SPORC-2002, para. 5.17	+	+	+	+	+	+	+	+
19.	Setting up (at least once a year) of the Commission to verify the accounting of radioactive waste, handed a specialized organization for burial, as well as being in the organization.	SPORC-2002, para. 5.17	+	+	+	+	+	+	+	+
20.	Availability of the NPS dismantling project, having sanitary-epidemiological conclusion of State Sanitary and Epidemiological Surveillance bodies.	SP 2.6.1.2154-06, para. 3.3	+	+	+	+	+	+	+	+
21.	Conducting zoning of radiation facilities of the organization, sites for temporary storage (STS), sites for long-term storage (SLS).	SP 2.6.1.2154-06, para. 4.1.3, 6.1.2, 6.2.3, 7.2, 11.2.5, 12.1	+	+	+	+	+	+	+	+
22.	Establishing categories of enterprises (STS, SLS) on the potential hazard in agreement with the state sanitary and epidemiological surveillance authorities.	SP 2.6.1.2154-06, para. 4.1.4, 11.2.11	+	+	+	+	+	+	+	+
23.	Delineation of the SCZ by the Department of Nuclear and Radiation Safety of the enterprise, their harmonization with the bodies of state sanitary-epidemiological supervision and approval of the chief engineer enterprise.	SP 2.6.1.2154-06, para. 4.1.5, 10.2.1	+	+						
24.	Planning of logistics and execution of work on registration of SCZ, agreement of the structure of shielding screens and the scheme of their installation with the department of NRS of the enterprise and authority of the state sanitary and epidemiological surveillance.	SP 2.6.1.2154-06, para. 4.1.9	+	+						
25.	Performance of joint radiation survey by the NPS crew and the Department of NRS of the enterprise with execution of the act.	SP 2.6.1.2154-06, para. 4.2.1, 10.2.1	+							
26.	Conducting repeated radiation survey of the reactor compartment after completion of the NPS preparation to unloading spent nuclear fuel.	SP 2.6.1.2154-06, para. 10.2.1		+						
27.	Conducting a joint (by the department of NRS and the Radiation Safety Service of FMB or ODF) of a radiation survey of the reactor compartment, Rubka shelter and the technological pad after unloading SNF from to be dismantled NPS with presentation of the results in the Work Completion Act for unloading SNF.	SP 2.6.1.2154-06, para. 10.2.7			+					
28.	Conducting (by the department of NRS) of radiation survey of premises, as well as of the non-pressure or pressure hull(in the absence of the non-pressure on) of NPS after unloading SNF from the NPS to be dismantled and the NPS placement to the building berth with execution of a proper act and cartograms of dose rates and levels of radioactive contamination of indoor surfaces and the surface of the reactor compartment.	SP 2.6.1.2154-06, para. 10.2.8			+					
29.	Acceptance from the RSS of the Navy by the enterprise (civil crew) of radiation monitoring and control at the NPS.	SP 2.6.1.2154-06, para. 4.2.2	+							
30.	Permit to work in the SCZ for Group A personnel.	SP 2.6.1.2154-06, para. 5.2	+	+	+	+	+	+	+	+
31.	Carrying out all work in the SCF under the control of	SP 2.6.1.2154-06,	+	+	+	+	+	+	+	+

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	NRS enterprise with mandatory individual monitoring.	para. 5.2								
32.	Implementation of the personnel entry (exit) to the premises of SCZ through the sanitary check point with the obligatory radiation monitoring/control.	SP 2.6.1.2154-06, para. 5.2, 11.2.7	+	+	+	+	+	+	+	+
33.	Provision of the personnel working in SCZ (visiting SCZ), including PVC (PDH) with personal protective equipment	SP 2.6.1.2154-06, para. 5.3, 6.1.2, 11.2.2	+	+	+	+	+	+	+	+
34.	Examination of SCZ readiness before performing work by relevant services of the enterprise jointly with the state sanitary and epidemiological surveillance bodies	SP 2.6.1.2154-06, para. 5.5	+	+	+	+	+	+	+	+
35.	Measurement by the department of NRS of parameters of the radiation situation and, if necessary, making recommendations about the permissible time of technological operations and the number of personnel required to start work in the SCZ on the basis of production schedules of work and analysis of the radiation conditions.	SP 2.6.1.2154-06, para. 5.6	+	+	+	+	+	+	+	+
36.	Execution of permits to conduct radiation-hazardous operations.	SP 2.6.1.2154-06, para. 5.8		+	+	+	+	+	+	+
37.	Definition and limitation of time of stay of the executors of radiation-hazardous works in the area of increased radiation hazard by the department of NRS (Radiation Safety Service - for STS, SLS).	SP 2.6.1.2154-06, para. 5.9, 6.1.7, 11.2.2		+	+	+	+	+	+	+
38.	Appointment by the enterprise of a responsible executor of radiation hazardous operations - shift production foreman or other person for direct supervision.	SP 2.6.1.2154-06, para. 5.9		+	+	+	+	+	+	+
39.	Determination of the department of NRS (based on a survey job) list of additional PPE and personal dosimeters operating and (or) emergency controls to ensure that staff for the duration of radiation-hazardous work.	SP 2.6.1.2154-06, para. 5.9		+	+	+	+	+	+	+
40.	Performance of an off-schedule briefing of the personnel performing work and carrying out radiation monitoring in the workplace and obtaining permit of the persons responsible for organizing work in the SCZ for the control of radiation safety, prior to the start of radiation hazardous operations.	SP 2.6.1.2154-06, para. 5.9		+	+	+	+	+	+	+
41.	Performance of industrial radiation monitoring at all stages of the comprehensive dismantling of NPS, including the performance of transport-technological operations for management of SNF, SNF storage containers on the site for temporary storage, cutting NPS (including control of metal formed during dismantling) and formation of the reactor unit.	SP 2.6.1.2154-06, para. 6.1.2, 6.1.7, 6.2.3, 10.1.1, 10.2.9, 10.4		+	+	+	+	+	+	+
42.	Agreement of the scope and frequency of radiation monitoring with the state sanitary and epidemiological supervision bodies	SP 2.6.1.2154-06, para. 10.1.1		+	+	+	+	+	+	+
43.	Accreditation for technical competence in the system of laboratories of radiation monitoring of nuclear and radiation safety, conducting radiation monitoring at the enterprise.	SP 2.6.1.2154-06, para. 10.1.3		+	+	+	+	+	+	+
44.	Certification of measurement techniques in the process radiation monitoring and control in the prescribed manner.	SP 2.6.1.2154-06, para. 10.1.3		+	+	+	+	+	+	+

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
45.	Calibration of instruments used in radiation monitoring.	SP 2.6.1.2154-06, para. 10.1.3		+	+	+	+	+	+	+
46.	Specification of reference levels for all monitored parameters of radiation conditions, including those at STS (SLS).	SP 2.6.1.2154-06, para. 10.1.4, 11.2.2		+	+	+	+	+	+	+
47.	Definition of the list, and the numerical values of reference levels (in accordance with the conditions of work) and agreement with the state sanitary and epidemiological surveillance bodies.	SP 2.6.1.2154-06, para. 10.1.4		+	+	+	+	+	+	+
48.	. Implementation of individual monitoring of Group A personnel	SP 2.6.1.2154-06, para. 10.1.5		+	+	+	+	+	+	+
49.	Identification of individual doses of Group B personnel by the methods of group control.	SP 2.6.1.2154-06, para. 10.1.5		+	+	+	+	+	+	+
50.	Assessment of results of radiation monitoring and decisions on the radiation safety measures based on specified acceptable and control levels.	SP 2.6.1.2154-06, para. 10.1.7		+	+	+	+	+	+	+
51.	Identification of the scope, nature and frequency of radiation monitoring, procedure of registration and accounting of its results by NRS department as agreed with the state sanitary-epidemiological supervision bodies and approved by the enterprise administration	SP 2.6.1.2154-06, para. 10.1.7		+	+	+	+	+	+	+
52.	Development of maps of the periodic radiation monitoring to verify the effectiveness of radiation safety provision and detection of unauthorized spread of radioactive substances (for special quay, FMB (ODF) and a pad temporary storage of containers).	SP 2.6.1.2154-06, para. 10.2.4			+					
53.	Check of the status of technical systems and equipment of the reactor compartment required for the process operations	SP 2.6.1.2154-06, para. 6.1.2			+					
54.	Availability of two-way loud speaking communication between the central control room, the reactor compartment and the crane	SP 2.6.1.2154-06, para. 6.1.2			+					
55.	Performance of radiation surveys of the reactor compartment and decontamination of surfaces in the SCZ till reference levels set at the enterprise, after unloading SFA	SP 2.6.1.2154-06, para. 6.1.5			+					
56.	Development of special manuals (manual section) for radiation safety provision at storage and transportation.	SP 2.6.1.2154-06, para. 6.2.1			+					
57.	Execution of sanitary-epidemiological conclusion for the site for temporary storage of containers with SNF.	SP 2.6.1.2154-06, para. 6.2.1			+					
58.	Availability of a list of design accidents with specific values of radiation parameters and the number of damaged containers with SNF with the criteria of the necessity to replace them (in the project for the pad).	SP 2.6.1.2154-06, para. 6.2.5			+					
59.	Laying the route for transportation of containers with SNF from the onshore de-fuelling facility to the site for temporary storage (if possible) at a distance from places of the enterprise personnel work, and administrative buildings..	SP 2.6.1.2154-06, para. 6.2.9			+					
60.	Execution of the Act of readiness of the strict control zone of the radiation-dangerous facility	SP 2.6.1.2154-06, para. 7.3				+				
61.	Drainage of the biological shielding tank upon the	SP 2.6.1.2154-06,				+				

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)									
			I	II	III	IV	V	VI	VII	VIII		
	results of radiochemical analysis (to a special tank for LRW or to the sewage system).	para. 7.3										
62.	Preparation of the reactor compartment to the temporary (long-term) storage in accordance with the documentation developed with the participation of the ship designer.	SP 2.6.1.2154-06, para. 7.3				+						
63.	Availability of the blank form for the three-compartment unit and the passport of the reactor compartment developed by the ship designer t (in preparation for the RC temporary storage within the three-compartment unit).	SP 2.6.1.2154-06, para. 7.4, 7.6				+						
64.	Availability of a list of SRW loaded into the reactor compartment agreed with the state sanitary and epidemiological surveillance bodies (when loading SRW to the reactor compartment).	SP 2.6.1.2154-06, para. 7.5				+						
65.	Availability of an act of radiation survey of the reactor unit prepared for temporary (long-term) storage..	SP 2.6.1.2154-06, para. 7.6				+						
66.	Execution of sanitary-epidemiological conclusion for the reactor unit	SP 2.6.1.2154-06, para. 7.6				+						
67.	Agreement of activity permissible for discharge of treated water.	SP 2.6.1.2154-06, para. 9.7								+		
68.	Availability of the section "Radiation Safety and Environmental Protection" in the manual for the transportation of the reactor unit.	SP 2.6.1.2154-06, para. 11.1.1				+						
69.	Agreement with the state sanitary and epidemiological surveillance authorities of the choice of locations for a site for temporary storage of reactor units afloat.	SP 2.6.1.2154-06, para. 11.1.3				+						
70.	Availability within STS (SLS) of radiation safety service.	SP 2.6.1.2154-06, para. 11.1.4, 11.2.2				+						
71.	Enabling to arrange within STS in case of emergency of sanitary- access mode with the delineation of the borderlines of the SCZ by the STS radiation safety service with account of the radiation conditions.	SP 2.6.1.2154-06, para. 11.1.7				+						
72.	Specification of the maximum total amount of activity for each SLS, permitted for store (taking into account the activity of the reactor compartment and the activity of additional SRW placed in the reactor compartment).	SP 2.6.1.2154-06, para. 11.1.9							+			
73.	Identification of radiation protection equipment of STS (SLS) personnel and population in the section "Measures to ensure the radiation safety" of design documentation.	SP 2.6.1.2154-06, para. 11.2.4							+			
74.	Identification of restrictions and control of radioactive releases and discharges of radionuclides to water during regular operation of f the enterprises-executors of works, STS (SLS).	SP 2.6.1.2154-06, para. 12.1, 12.2		+	+	+	+	+	+	+	+	+
75.	Prevention of unorganized discharges of RS to the atmosphere under regular operating conditions of the enterprise.	SP 2.6.1.2154-06, para. 12.3		+	+	+	+	+	+	+	+	+
76.	Development, agreement with the state sanitary and epidemiological surveillance bodies of the action plan for protection of the personnel and the population in the event of a radiological accident (for enterprises-executors	SP 2.6.1.2154-06, para. 13.6		+	+	+	+	+	+	+	+	+

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	of work)									
77.	Equipping the NRS department of the enterprise with the necessary equipment and methods for measuring emergency levels of the equivalent dose rate, individual doses of external and internal exposure, levels of radioactive contamination of surfaces, activity of samples from the environment (air, water, sediment, soil, vegetation, etc.).	SP 2.6.1.2154-06, para. 13.10		+	+	+	+	+	+	+
78.	Presence in design materials of special sections devoted to decommissioning and dismantling of nuclear service vessels and the contents of the specified section.	SP 2.6.1.11-02, Items 20.1, 20.2	+	+						
79.	Conducting integrated survey of radiation conditions and engineering status of hull structures, process systems and equipment of s service vessel for decision-making about decommissioning.	SP 2.6.1.11-02, Item 20.3	+							
80.	Availability of the resolution about decommissioning of the nuclear service vessel.	SP 2.6.1.11-02, Item 20.3	+							
81.	Availability of the detailed design for decommissioning, preparation for cutting and dismantling of the nuclear service vessel agreed with the enterprise conducting dismantling of the vessel.	SP 2.6.1.11-02, Items 20.3, 20.5	+	+						
82.	Availability of the necessary infrastructure and documentation at the enterprise that conducts dismantling of the nuclear service vessel.	SP 2.6.1.11-02, Item 20.6		+		+		+	+	
83.	Availability of proven technologies for RW storage, processing, preparation for shipment and RW shipment for disposal with the enterprise that conducts cutting and dismantling of the nuclear service vessel.	SP 2.6.1.11-02, Item 20.8								+
84.	Availability of design decisions to ensure radiation safety at dismantling of nuclear service vessels.	SP 2.6.1.11-02, Items 20.10, 20.11, 20.12		+	+	+	+	+	+	
85.	Availability and contents of working instructions for each type of works at dismantling of nuclear service vessels.	SP 2.6.1.11-02, Item 20.13		+	+	+	+	+	+	
86.	Presence of the order about the start and finish of works at dismantling of nuclear service vessels.	SP 2.6.1.11-02, Item 20.15		+	+	+	+	+	+	
87.	Conducting integrated survey of objects of the environment and definition of the degree of impact of decommissioning and dismantling of nuclear service vessels on the environment.	SP 2.6.1.11-02, Item 20.16								+
	IV . INTERDEPARTMENTAL NORMS AND RULES ON NUCLEAR AND RADIATION SAFETY THAT ARE NOT REGULATORY LEGAL ACTS.									
1.	Availability of a single list of potentially hazardous operations (PHO) and technical requirements for their implementation for stages of decommissioning and dismantling NI developed by the ship designer and agreed with the designers of reactors, ship equipment control system, scientific advisor of the reactor development and military representations to them, DSS NRS MOD.	OPB-È-98/05, para. 8.1 PBYA CENTURY 08-88/05, para. 3.8	+	+	+					
2.	Availability of manual on nuclear safety (manual on NS, according to ORV-K-98/05) agreed with the designers of reactors, ship equipment control system, scientific advisor of the reactor development and military representations to them, DSS NRS MOD	OPB-È-98/05, para. 8.3 PBYA CENTURY 08-88/05, para. 5.1, 11.5	+	+	+					
3.	Compliance with the NRS requirements when performing PHO	PBYA CENTURY 08-88/05, para. 5.3	+	+	+					
4.	Keeping PHO log book by a responsible executor of works with recording in it of each specific nuclear-	PBYA CENTURY 08-88/05, para. 5.5	+	+	+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	hazardous operation, indicating the nuclear safety measures, the initial and end state of the NI, composition of the executors' team.									
5.	Development of the ship decommissioning and dismantling projects (for each project of a ship with NI).	OPB-È-98/05, para. 13.1 PBYA CENTURY 08-88/05, para. 11.1	+							
6.	Conduct of integrated engineering and radiation survey of the ship by the interdepartmental commission with submission of proposals on measures to ensure NRS (before decommissioning) to the operating organization (Navy) and the authority of state supervision over nuclear and radiation safety	OPB-È-98/05, para. 13.4 PBYA CENTURY 08-88/05, para. 11.3	+							
7.	Availability of an act of commission of the Navy confirming compliance with the requirements of the ship decommissioning design and reflecting the actual status of a specific nuclear installation attached to the documentation on the transfer of the ship to the industry for dismantling.	OPB-È-98/05, para. 13.4	+							
8.	Execution of the passport of the prescribed form for the reactor unit	OPB-È-98/05, para. 13.8				+				
9.	Availability of an action plan to protect the personnel and the population in the event of a radiation accident with the NI that satisfies the requirements of OSPORB-99/2010	OPB-È-98/05, para. 15.1 PBYA CENTURY 08-88/05, para. 13.1		+	+	+	+	+	+	+
V. REQUIREMENTS SET FORTH BY DOCUMENTS ON STANDARDIZATION										
1.	Execution of the state ecological expert assessment of technical documentation to perform dismantling.	GOST RV 50811-2006, para. 4.15		+						
2.	Development of the ship dismantling program	GOST RV 50811-2006, para. 4.17		+						
3.	Development of Feasibility Study of the ship dismantling program	GOST RV 50811-2006, para. 4.18		+						
4.	Planning (while the ship dismantling program) of measures to reduce radiation risk to as low as possible	GOST RV 50811-2006, para. 7.3.8		+						
5.	Holding control radiometric survey of the prepared for the storage reactor unit (or RC (RSp)) under approved procedures with filling in of cartograms.	GOST RV 50811-2006, para. 6.3.3				+				
6.	Availability of a passport for the RC(RSp) prepared for storage	GOST RV 50811-2006, para. 6.3.4				+				
7.	Availability of the completed blank form for the RC (RSp) unit prepared for temporary storage.	GOST RV 50811-2006, para. 6.3.4				+				
8.	Development of technological schemes of managing RW formed during dismantling	GOST RV 50811-2006, para. 6.4.3							+	
9.	Development of technical requirements for the contents of cores prior to their discharge.	GOST RV 50811-2006, para. 7.1.2	+	+						
10.	Development of a list of PHO during the core unloading works associated with discharge and technical	GOST RV 50811-2006,			+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	requirements for their implementation.	para. 7.1.2								
11.	Development of a list of possible emergency situations, assessment of their consequences and recommendations for the personnel actions.	GOST RV 50811-2006, para. 7.1.2			+					
12.	Development of safety analysis during the PHO.	GOST RV 50811-2006, para. 7.1.2			+					
13.	Development of a radiation safety guide during RHO.	GOST RV 50811-2006, para. 7.1.2	+	+	+					
14.	Compliance of the enterprise performing PHO with the requirements of PBYA V.08-88/05	GOST RV 50811-2006, para. 7.1.3	+	+	+					
15.	Conduct of radiation survey of the ship and the reactor unit while preparing the ship for transmission enterprise-executor of works when placing the ship at the site of n the enterprise and before launch of the reactor unit to water.	GOST RV 50811-2006, para. 7.2.2		+		+				
16.	Ensuring Radiation Control (dosimetric and radiometric), and production control of radiation safety.	GOST RV 50811-2006, para. 7.2.3	+	+	+	+	+	+	+	+
17.	Determining the requirements for the radiation monitoring of organizational and technological documents of the enterprise-executor.	GOST RV 50811-2006, para. 7.2.3		+	+	+	+	+	+	+
18.	Planning measures to reduce radiation risk to as low as possible (optimization) while developing a program of the ship dismantling by the enterprise-executor of works.	GOST RV 50811-2006, para. 7.3.8		+						
VI. REQUIREMENTS SET FORTH BY DEPARTMENTAL REGULATORY DOCUMENTS, DEFINING ADMINISTRATIVE-PROCESS ASPECTS OF RADIATION SAFETY										
1.	Specification of responsibilities and duties of officials and personnel in accordance with the organizational scheme of quality assurance and control of NRS at the enterprise.	RD5.IMYAN.106-2005, para. 6.3.6 NYADI.0220.00.02 7, para. 5.66) NYADI.0220.00.03 1, para. 5.76)	+	+	+					
2.	Performance of work to prepare the ship for transfer to the enterprise-executor of works with bringing SGP to a nuclear-safe state.	NYADI.000.0230.0 0.001, para. 1.5, 3.4 NYADI.000.0230.0 0.002, para. 1.2 NYADI.221.0701, para. 2.1.1, прим. 2 RD5.IMYAN.105-2005, para. 9.8, 9.10	+							
3.	Holding a control radiation survey with execution of the Act of control radiation survey of NPS .	RD5.IMYAN.106-2005, para. 6.3.6 NYADI.221.0701, para. 6.1, Appendix 3 NYADI.0220.00.03 1, para. 5.8, 19.3	+	+						

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
4.	Availability with the enterprise of operational and technical documentation to ensure nuclear and radiation safety transferred from the Navy in accordance with an act of a package of technical documentation of the prescribed form.	NYADI.221.0701, para. 2.4, Appendix JI	+	+						
5.	Availability with the enterprise of the act on the state of the reactor with the date of the core discharge, remaining power resource and data of an extended radiochemical analysis of the primary circuit coolant.	NYADI.221.0701, para. 2.4	+	+						
6.	Availability with the enterprise of the act of the ship readiness ship to transfer for dismantling with the attached act of survey of technical condition, the act of bringing nuclear power into a safe state, the act of replacing water in the BST, the act of decontamination of spaces and equipment, the act of preliminary radiation survey of the ship.	NYADI.221.0701, para. 2.6, 2.7, приложения В, Г, К	+	+						
7.	Formalization of transfer of the ship maintenance by the Naval crew to the civil crew under a bilateral act signed by the commander of the ship and head of the civil crew.	NYADI.221.0701, para. 3.4	+	+						
8.	Determining the composition of the civilian crew of the to be dismantled NPS and its main tasks in the Statute of the civil crew developed by the enterprise executing the works.	NYADI.221.0701, para. 3.3 RD5.IMYAN.106-2005, para. 6.3.6	+	+	+					
9.	Availability of a specific list of categories of professions and positions of employees who are trained under the approved program and passed examination in terms of NRS with execution of a permit agreed with the Center NRS and approved by the head of the enterprise.	RD5.IMYAN.107-2005, para. 3.9	+	+	+	+	+	+	+	+
10.	Development of training programs for the personnel (heads of units, specialists and workers) for NRS based industry standard programs and the current list of regulatory and methodical documentation on safety.	RD5.IMYAN.107-2005, para. 3.14 NYADI.000.0230.0 0.001, para. 6.1 NYADI.0220.00.01 7, para. 1.9, 1.10 NYADI.0220.00.02 7, para. 4.4, 5.6x) NYADI.0220.00.03 1, para. 4.4, 5.7x)	+	+	+	+	+	+	+	+
11.	Availability of a list of regulatory and methodical documentation of safety developed in relation to the to be solved production problems, agreed with the Departmental Center of NRS and approved by the chief engineer of the enterprise.	RD5.IMYAN.107-2005, para. 3.14	+	+	+	+	+	+	+	+
12.	Training (refresher training) for the personnel (heads of units, specialists and workers) in the educational centers of the Navy or other academic or training centers that are licensed, depending on nuclear ship projects to obtain the relevant certificate in prescribed cases.	RD5.IMYAN.106-2005, para. 6.3.10 RD5.IMYAN.107-2005, para. 4.6, 4.9 NYADI.000.0230.0 0.001, para. 6.4 NYADI.0220.00.01 7, para. 1.14 NYADI.0220.00.02 7, para. 4.2, 4.3, 4.7 NYADI.0220.00.03 1,	+	+	+	+	+	+	+	+

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
		para. 4.2, 4.3, 4.7								
13.	Establishment of permanent commissions for certification of personnel: 1) Heads of units and specialists - Commission of the enterprise; 2) workers - the shop commission (with the addition of captain and chief engineer - along with certification of the civil crew).	RD5.IMYAN.107-2005, para. 6.3, 6.6 NYADI.0220.00.017, para. 1.12	+	+	+	+	+	+	+	+
14.	Frequency of certification for the knowledge of rules, norms and regulations on nuclear and radiation safety by the personnel (heads of units, specialists and workers): 1) Heads of units (including supervisory personnel of the civil crew, ODF) - at least once in 3 years; 2) specialists and workers (including civil (mixed) crew, ODF staff) - at least once a year.	RD5.IMYAN.107-2005, para. 5.6, 5.7 NYADI.0220.00.017, para. 1.15, NYADI.0220.00.020, para. 1.14 NYADI.000.0230.00.002, para. 1.7.2	+	+	+	+	+	+	+	+
15.	Registration of certification results by protocols.	RD5.IMYAN.107-2005, para. 7.6, приложения А, Б NYADI.000.0230.00.001, para. 6.12 NYADI.0220.00.017, para. 1.13	+	+	+	+	+	+	+	+
16.	Availability with the personnel (heads of departments, specialists and workers) that has passed certification of the certificates signed by the chairman of the commission and stamped by the enterprise seal (of a unit responsible for organizing the knowledge test).	RD5.IMYAN.107-2005, para. 7.8, Appendix C NYADI.000.0230.00.001, para. 4.8, 6.12 NYADI.000.0230.00.002, para. 1.7.2 б)	+	+	+	+	+	+	+	+
17.	Availability of orders of the head of the enterprise about the establishment of a civil crew on each NPS, appointment of the captain of NPS and all engineering and technical personnel.	NYADI.0220.00.017, para. 1.2, 1.6	+	+	+					
18.	Availability of licenses for operation of technical means as prescribed for each crew member.	NYADI.0220.00.017, para. 1.13	+	+	+					
19.	Training of NPS captain under the program for admission to independent control of the ship and his certification in the prescribed manner.	NYADI.0220.00.017, para. 1.14	+	+	+					
20.	Availability of a permit for independent maintenance of the main machinery with the ship mechanical engineer and mechanical engineers of main machinery control.	NYADI.000.0230.00.001, para. 6.5	+	+	+					
21.	Approval of the staffing of civil (mixed) crew for each specific NPS by the enterprise director.	NYADI.0220.00.017, para. 2.4, NYADI.0220.00.020, para. 1.10	+	+	+					
22.	Development of job descriptions for members of civil crew.	NYADI.0220.00.017, para. 3.1 RD5.IMYAN.106-2005, para. 6.3.9	+	+	+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
23.	Development of a list of documents (log books) for everyday use approved by the chief builder (Head of dismantling unit) that includes the NPS log book, the log book about the SGP condition during storage, log book 1 of visited equipment enclosures of the SGP compartment, a log book of RW accounting, a log book for accounting of dismantling, unloading equipment and system components.	NYADI.0220.00.01 7, para. 3.8, 6.4	+	+	+					
24.	Organization of control by the watch man of the power compartment in accordance with the job description (with an entry in the NPS log book), NPS condition, levels of radiation factors in the compartments and spaces – once a day; microclimate of the reactor compartment, the integrity of seals and stamps, lack of water in the holds - every 4hours.	NYADI.0220.00.01 7, para. 3.12, 3.13, 6.4	+	+	+					
25.	Organization of daily inspection of NPS, which verifies the implementation of measures to ensure nuclear and radiation safety with check of radiation monitoring/control system.	NYADI.0220.00.01 7, para. 4.4	+	+	+					
26.	Execution of all works carried out in the power compartment in the magazine work orders in the power compartment.	NYADI.0220.00.01 7, para. 6.4	+	+	+					
27.	Organization of a temporary NRS group at the enterprise to monitor nuclear and radiation safety at the NPS at the naval base (in case of the NPS temporary storage at the Naval base from the time of receiving the NPS by the enterprise NPS till the start of its transport to the enterprise water area).	NYADI.0220.00.02 5, para. 3.11	+							
28.	Providing of NS at NPS, when stored (including naval bases) and in tow, in accordance with the instructions of the reactor or NPS designer.	NYADI.0220.00.02 5, para. 7.3 NYADI.000.0230.0 0.001, para. 3.5	+	+						
29.	Availability of maps and charts of radiation monitoring at the NPS, jetties and buildings transferred to the enterprise developed by the NRS temporary group of the enterprise and agreed with the RSS of the naval base.	NYADI.0220.00.02 5, para. 9.8	+							
30.	Control of NRS at the NPS transferred to the enterprise, stored at a Naval base with civil crews, and the territories of the transferred to the enterprises berths and radiation monitoring points of the NRS temporary group of the enterprise.	NYADI.0220.00.02 5, para. 9.2, 9.4-9.6, 9.9-9.12	+							
31.	Control of SGP condition by the watch-keeping service.	NYADI.000.0230.0 0.001, para. 3.7, 3.8	+	+						
32.	Execution of the Act of NPS readiness to tow with the application of the Act to bring an nuclear installation to a safe condition "(before towing the NPS from the naval base to the dismantling site).	NYADI.000.0230.0 0.001, para. 3.9	+							
33.	Observance by officials of the enterprise of responsibilities to provide NS.	NYADI.000.0230.0 0.001, section 5 NYADI.0220.00.02 7, section 14 NYADI.0220.00.03 1, section 16	+	+	+					
34.	Observance by officials of the enterprise of responsibilities to provide radiation safety	NYADI.000.0230.0 0.002, para. 1.4.1, 1.4.2, 1.4.3 NYADI.0220.00.02 7, section 14	+	+	+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)									
			I	II	III	IV	V	VI	VII	VIII		
		NYADI.0220.00.03 1, section 16										
35.	Availability of an action plan to protect the personnel and population, localize and eliminate the consequences of nuclear and radiation accidents.	NYADI.000.0230.0 0.001, para. 4.8, 73 NYADI.0220.00.01 7, para. 6.5 NYADI.0220.00.02 7, para. 5.6a) NYADI.0220.00.03 1, para. 1.18a), 5.7a)	+	+	+							
36.	Availability of an action plan of specialized units of the enterprise for emergency response to accidents at dismantled NPS, developed on the basis of the manuals to ensure nuclear safety and radiation safety and an action plan for the personnel protection, localization and elimination of nuclear and radiation accidents.	NYADI.0220.00.02 5, para. 3.7, 3.9	+									
37.	Scheduling and selecting subjects for emergency response drills and exercises approved by the chief engineer.	NYADI.000.0230.0 0.001, para. 7.5	+	+	+							
38.	Compliance with the frequency of emergency response drills and exercises (emergency response exercise - at least once a month, class training - before unloading SNF from the reactors).	NYADI.000.0230.0 0.001, para. 7.6	+	+	+							
39.	Formation and training of emergency teams from NPS crews.	NYADI.000.0230.0 0.001, para. 7.10	+	+	+							
40.	Organization of the collection, processing and analysis of materials about all nuclear accidents at the NPS, as well as nuclear-risk situations that occurred at enterprises involved in dismantling NPS.	NYADI.000.0230.0 0.001, para. 7.13	+	+	+							
41.	Development of manuals for the personnel actions in emergency situations at the enterprise.	NYADI.0220.00.02 7, para. 5.6b) NYADI.0220.00.03 1, para. 5.6b)	+	+	+	+	+	+	+	+	+	+
42.	Development of a manual on the personnel actions in emergency situations at the onshore facility and NPS.	NYADI.0220.00.02 7, para. 5.6r) NYADI.0220.00.03 1, para. 5.6r)	+	+	+							
43.	Development of manuals to eliminate the consequences of accidents and malfunctions that lead to the deterioration of the radiological situation at the NPS.	NYADI.000.0230.0 0.002, para. 1.9 б), Appendix C NYADI.0220.00.02 7, para. 5.6ж), 10.6	+	+	+							
44.	Development of notification scheme at the enterprise and the personnel of the naval base in case of an accident at every NPS.	NYADI.0220.00.02 5, para. 6.3	+									
45.	Determination of the scope and means of radiation monitoring (RC) at the NPS and ODF and its implementation by the department of NRS of the enterprise.	RD5.IMYAN.106- 2005, para. 5.7.2, 5.7.4, 6.3.11 NYADI.000.0230.0 0.002, para. 1.3	+	+	+	+	+	+	+	+	+	+

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
		NYADI.0220.00.02 7, para. 10.116) NYADI.0220.00.03 1, para. 10.13a)								
46.	Accreditation of Nuclear and Radiation Safety department in the system of laboratories for conducting all types of radiation measurements during RC.	RD5.IMYAN.106-2005, para. 5.7.2	+	+	+	+	+	+	+	+
47.	Entry of revisions to the State register of RC measuring instruments.	RD5.IMYAN.106-2005, para. 5.7.2	+	+	+	+	+	+	+	+
48.	Certification of measurement techniques in the Russian State Metrological bodies (Rostechregulirovanie).	RD5.IMYAN.106-2005, para. 5.7.2	+	+	+	+	+	+	+	+
49.	Availability of RC guide for to be dismantled NPS agreed with the state sanitary and epidemiological surveillance bodies and approved by the administration of the enterprise.	RD5.IMYAN.106-2005, para. 5.7.2	+	+	+	+	+	+	+	+
50.	Conduct of personal dosimetric monitoring (PDM) of civil crew members by the decision of NRS department taken together with the NPS captain.	RD5.IMYAN.106-2005, para. 6.3.11	+	+	+	+	+	+	+	+
51.	Registration of individual doses in the log book and inserting it into individual cards and storage media (for creating a database on enterprise).	RD5.IMYAN.106-2005, para. 5.7.8	+	+	+	+	+	+	+	+
52.	Setting a list of values and reference levels for all radiation factors for each radiation-hazardous facility agreed with the regional administration of FMBA and approved by the administration of the enterprise.	RD5.IMYAN.106-2005, para. 5.7.10 NYADI.0220.00.02 7, para. 10.7 NYADI.0220.00.03 1, para. 10.4	+	+	+	+	+	+	+	+
53.	Keeping a log-book for recording the results of radiation monitoring at each radiation-hazardous facility.	RD5.IMYAN.106-2005, para. 5.7.12	+	+	+	+	+	+	+	+
54.	The organization of radiation monitoring stations, including the development of regulations governing the activities of NRS department in these stations.	RD5.IMYAN.106-2005, para. 5.7.13	+	+	+	+	+	+	+	+
55.	Setting of controlled zones at the NPS.	NYADI.000.0230.0 0.002, para. 1.7 a), 1.7.1 RD5.IMYAN.106-2005, para. 6.2.8	+	+	+	+				
56.	Organization of the medical examination of members of the NPS civil crew to obtain permits to work in an appropriate position and permits to work with radioactive materials and radiation sources.	NYADI.0220.00.01 7, para. 1.15 NYADI.000.0230.0 0.002, para. 1.7.2 a) RD5.IMYAN.106-2005, para. 5.2.5, 6.3.10	+	+	+					
57.	Approval of qualification requirements for the personnel of Group A allowed to work with the IRS and work in the SCZ.	RD5.IMYAN.106-2005, para. 5.2.2	+	+	+					
58.	Making permits for crew members to work with the IRS by the order of the enterprise head.	NYADI.000.0230.0 0.002, para. 1.7.2 RD5.IMYAN.106-2005, para. 5.2.2	+	+	+					
59.	Organization of coaching of Group A personnel.	RD5.IMYAN.106-2005,	+	+	+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
		para. 5.2.3								
60.	Use of personal protective equipment when working in the strict control zone.	NYADI.000.0230.0 0.002, para. 1.7.4 RD5.IMYAN.106-2005, para. 5.4	+	+	+					
61.	Organization sanitary treatment of the crew	NYADI.000.0230.0 0.002, para. 1.7.5 RD5.IMYAN.106-2005, para. 5.5	+	+	+					
62.	Drawing a passport for the transfer of radioactive waste.	NYADI.000.0230.0 0.002, para. 1.10	+	+	+					
63.	Keeping a log book for accounting RW at the NPS by the chief engineer.	NYADI.000.0230.0 0.002, para. 1.10	+	+	+					
64.	Organization of collection and temporary storage of radioactive waste by the workshop producing the dismantling and assembly (related) works.	NYADI.0220.00.02 7, para. 10.12			+				+	
65.	Development of a guide on radioactive waste management.	RD5.IMYAN.106-2005, para. 5.8.5 NYADI.0220.00.03 1, para. 5.7y), 10.15							+	
66.	Development of a guide for the radiation safety provision at the NPS.	RD5.IMYAN.106-2005, para. 6.3.14 NYADI.000.0230.0 0.002, para. 1.9 a), Appendix A NYADI.0220.00.02 7, para. 5.6e), 10.6	+	+	+					
67.	Availability at the NPS of : 1) institutional orders for the admission of a civil crew (to the duties as per the position, to be on-duty at the NPS, to monitor the implementation of PHO, at the control panel of main machinery and in the hardware enclosure, for the right to open hardware enclosures and premises of main machinery control desks); 2) Manuals as to how to ensure the NS to at the to be dismantled NPS during the dismantling and assembly (related) work, and when unloading SNF; 3) Log books (NPS log book – of the central control room, main machinery control room log book, log book of SGP condition during storage, the log work of inquires for works in the reactor compartment, log book of visits to the hardware enclosures of SGP compartment of PUR magazine briefing on safety with a dedicated section of instruction on NRS) ; 4) Job descriptions governing the composition of the civil crew and the watchman of the reactor compartment; 5) manual of SGP maintenance during prolonged storage developed by the NPS (SGP) designer; 6) Package of documents to prepare the crew for the NRS provision, buoyancy, explosion and fire safety (how to prevent accidents and fires and to eliminate their consequences, an action plan to protect workers and the public, to localize and eliminate the effects of nuclear and radiation accidents, a damage control plan (flooding and	RD5.IMYAN.105-2005, para. 9.12 NYADI.000.0230.0 0.001, para. 2.14 NYADI.0220.00.02 7, para. 5.6 г), д), и) NYADI.0220.00.03 1, para. 5.7 e), ж)	+	+	+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	explosion & fire safety of NPS), a plan of exercises to localize and eliminate the impacts of nuclear and radiation accident while unloading SNF from nuclear reactors of decommissioned NPS); 7) List of sealed premises, equipment, valves, plugs, instruments affecting the NS; 8) Provisions for an emergency repair brigade (ERB); 9) other documents specified in the NS guide , manual of SGP maintenance during prolonged storage, a collection of instructions for actions of the civil crew to ensure buoyancy, and explosion and fire safety while the NPS is afloat, a collection of naval exercises at the to be dismantled NPS in the struggle for buoyancy -keeping and explosion and fire safety.									
68.	Availability of provisions about a specialized unit of dismantled NPS	NYADI.000.0230.0 0.001, para. 2.16	+	+	+					
69.	Organization of opening and closing of hardware enclosures, which provides: 1) written permits for opening for NPS captain (in the logbook of NPS); 2) Presence at the opening of a senior engineer (shift mechanical engineer) and the on-duty dosimetrist of NRS department; 3) Entry in the NPS logbook by the NPS on-duty man and in the log book of visit to the hardware enclosures by the watchman of the reactor compartment (at whose instruction, for what purpose and in whose presence the hardware enclosure was opened, time of opening and closing the hardware enclosures, names and titles of people working in them) ; 4) Delivery of hardware enclosures under the protection of the NPS on-duty guide man, closed with a lock and sealed by the chief engineer and the NRS department after checking the availability and integrity of the seals on the plugs, the equipment in the hardware enclosure; 5) Storage of a set of keys at the chief engineer and NPS on-duty man.	NYADI.000.0230.0 0.001, para. 2.17.1...2.17.3, 2.17.5	+	+	+					
70.	Organization of opening and closing of hardware enclosures, which provides: 1) written permits for opening for NPS captain (in the logbook of NPS); 2) Presence at the opening of a senior engineer (shift mechanical engineer) and the on-duty dosimetrist of NRS department; 3) Entry in the NPS logbook by the NPS on-duty man and in the log book of visit to the hardware enclosures by the watchman of the reactor compartment (at whose instruction, for what purpose and in whose presence the hardware enclosure was opened, time of opening and closing the hardware enclosures, names and titles of people working in them) ; 4) Delivery of hardware enclosures under the protection of the NPS on-duty guide man, closed with a lock and sealed by the chief engineer and the NRS department after checking the availability and integrity of the seals on the plugs, the equipment in the hardware enclosure; 5) Storage of a set of keys at the chief engineer and NPS on-duty man.	NYADI.000.0230.0 0.001, para. 2.17.4, 2.17.5	+	+	+					
71.	Issue of an order of the enterprise head about admission of the personnel to conduct independent unloading of SNF after the training of specialists and workers of ODF in training centers.	NYADI.0220.00.02 7, para. 4.9 NYADI.0220.00.03			+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
		1, para. 4.9								
72.	Issue of an order of the enterprise head about admission of the personnel (ODF personnel and civil crew of to be dismantled ship) to conduct SNF unloading on a specific NPS as a result of the extraordinary knowledge test by the examination board.	RD5.IMYAN.105-2005, para. 9.14 NYADI.0220.00.02 7, para. 4.12 NYADI.0220.00.03 1, para. 4.13			+					
73.	Issue of an order of the enterprise head about the appointment of manager, responsible executives of PHO (of PHO phase) by the order of the enterprise head. Issuance of orders	NYADI.000.0230.0 0.001, para. 4.8 NYADI.0220.00.02 7, para. 5.10, 9.3 NYADI.0220.00.03 1, para. 9.3			+					
74.	Issue of orders (instructions) of heads executing units about the appointment of PHO executors	NYADI.0220.00.02 7, para. 5.10, 9.3 NYADI.0220.00.03 1, para. 9.3			+					
75.	Issue (based on the annual plan of SNF unloading) of an order of the enterprise head about the appointment of senior officials and determining the number of shifts and means to ensure the unloading of SNF	NYADI.0220.00.02 7, para. 5.3 NYADI.0220.00.03 1, para. 5.4			+					
76.	Development of institutional, organizational and administrative and technical documents for ODF preparation to unloading SNF: 1) manual to ensure NS when working with the SNF at the ODF; 2) manual for the radiation safety when working on the ODF; 3) processes of SNF unloading; 4) process manual to transport TC; 5) manual on operation of systems and components of SNF ODF; 6) manual for carrying out decontamination of hardware enclosures of the reactor compartment and ODF sites (para. 5.7t) NYADI.0220.00.031); 6) regulations for SNF ODF; 7) job descriptions for SNF ODF; 8) process schedule of SNF unloading from NPS reactors; 9) logistics plan for discharging SNF agreed with the sanitary and epidemiological surveillance agency(FMBA); 10) plan of administrative and engineering actions to ensure radiation safety (Appendix D NYADI.0220.00.027, Appendix D NYADI.0220.00.031); 11) plan of administrative and engineering actions to ensure radiation safety (Annex D NYADI.0220.00.027, Annex D NYADI.0220.00.031) agreed with the sanitary and epidemiological surveillance agency (FMBA); 12) check list of mandatory inspections and acceptances when unloading SNF from the reactors using ODF (Appendix G NYADI.0220.00.027, Appendix G NYADI.0220.00.031).	NYADI.0220.00.02 7, para. 5.6...5.9, Appendix И NYADI.0220.00.03 1, para. 5.7, 5.10..12, Appendix И			+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
77.	Development by the ODF (together with the senior builder of the enterprise, head of production, performing demolition (related) work, and captain (commander) of NPS) of the schedule of preparation and holding of SNF unloading from NPS reactors.	NYADI.0220.00.02 7, para. 5.7, Appendix C NYADI.0220.00.03 1, para. 5.9, Appendix C			+					
78.	Preparation of NPS for SNF unloading in compliance with the manual agreed with the NPS designer .	NYADI.0220.00.02 7, para. 5.12 NYADI.0220.00.03 1, para. 5.16			+					
79.	Issue of an order of the enterprise head about appointing a working commission to verify the readiness of the enterprise, systems and equipment, and NPS personnel to SNF discharge	NYADI.0220.00.02 7, para. 5.11 NYADI.0220.00.03 1, para. 5.15			+					
80.	Check of NPS readiness to unloading of SNF from the reactors with execution of the Act of NPS preparedness for SNF unloading from the reactors approved by the enterprise head.	RD5.IMYAN.105-2005, para. 9.16 NYADI.0220.00.02 7, para. 5.12, 5.13, 17.1.1a), Appendix M NYADI.0220.00.03 1, para. 5.17, Appendix H			+					
81.	Check of ODF readiness for SNF unloading from the reactors with the execution of the Act of preparedness of the onshore de-fuelling facility for SNF unloading from the reactors approved by the enterprise head.	RD5.IMYAN.105-2005, para. 9.16 NYADI.0220.00.02 7, para. 5.14, 5.15, 17.1.3a), Appendix H NYADI.0220.00.03 1, para. 5.18, 5.19, 19.1.2a), Appendix II			+					
82.	Check of readiness of the enterprise, systems and equipment, and NPS staff to unloading SNF from the reactors and execution of the Act to check readiness of the enterprise, systems and equipment, and NPS personnel for the unloading of SNF from the reactors agreed with the regional administration of FMBA.	RD5.IMYAN.105-2005, para. 9.15-9.18 RD5.IMYAN.106-2005, para. 6.4.4 NYADI.0220.00.02 7, para. 5.16...5.18, 17.1.16), Appendix II NYADI.0220.00.03 1, para. 5.20...5.22, 19.1.1a), Appendix II			+					
83.	Execution of a passport of readiness of the enterprise, ODF and NPS for SNF unloading.	NYADI.0220.00.02 7, para. 5.6ч) NYADI.0220.00.03 1, para. 5.7ч)			+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
84.	Check of the enterprise readiness to unloading SNF by the commission of the departmental center of scientific and methodological support of NRS (DC of NRS) with execution of the "Conclusion about readiness of the enterprise and NPS for SNF unloading from the reactors."	RD5.IMYAN.105-2005, para. 9.19, 9.20 RD5.IMYAN.106-2005, para. 6.4.4 NYADI.0220.00.027, para. 5.20, 5.21 NYADI.0220.00.031, para. 5.26			+					
85.	Issue of an order of the enterprise head about SNF unloading from NPS reactors with the indication of time and date of work start (based on the act of the enterprise readiness for discharge and conclusion of the IC NRS.	RD5.IMYAN.105-2005, para. 9.21 NYADI.0220.00.027, para. 5.22			+					
86.	Formalization of readiness of the reactor, transshipment equipment, ODF equipment and hoisting equipment to dismantle the cover and unload SNF from the reactors' Act on the audit of readiness to undermine the reactor cover and unload SNF from the reactor. "	RD5.IMYAN.105-2005, para. 9.16 NYADI.0220.00.027, para. 5.23, 7.10, 17.1.36), Appendix C NYADI.0220.00.031, para. 5.28, 19.1.26), Appendix T			+					
87.	Execution written permit to demolition and dismantling of the reactor cover (in the log book of SNF unloading) by an officer assigned the responsibility for performing unloading of SNF.	RD5.IMYAN.105-2005, para. 9.23 NYADI.0220.00.027, para. 5.23, 7.10 NYADI.0220.00.031, para. 5.30			+					
88.	Execution of an act of SCZ readiness for dismantling (related) works.	NYADI.0220.00.027, para. 7.1 a) NYADI.0220.00.031, para. 7.1a)			+					
89.	Execution of the Act of SCZF readiness for unloading SNF.	NYADI.0220.00.027, para. 7.1 6) NYADI.0220.00.031, para. 7.16)			+					
90.	Execution of the Act to transfer the BPS reactor compartment for f unloading SNF from the reactors. "	RD5.IMYAN.105-2005, para. 9.16 RD5.IMYAN.106-2005, para. 6.4.4 NYADI.000.0230.00.001, para. 2.11, NYADI.0220.00.027, para. 6.3, 17.1.26), Appendix P NYADI.000.0230.0			+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
		0.021, Appendix K								
91.	Execution of the Act to transfer the hardware enclosures of the NPS reactor compartment for unloading SNF from the reactors. "	NYADI.0220.00.03 1, para. 5.27, Appendix C			+					
92.	Permit for NPS crew, employees of the enterprise to the reactor compartment, hardware enclosure and SGP control desk based on a list approved (daily) by the NPS commander.	NYADI.000.0230.0 0.001, para. 4.10 NYADI.0220.00.02 7, para. 7.6 NYADI.0220.00.03 1, para. 7.8			+					
93.	Compliance with the administrative and engineering requirements stipulated by the radiation safety manual developed in accordance with the unified list of potentially hazardous operations, when performing the PHO accompanying SNF unloading (holding of the dismantling nuclear-hazardous operations under the regulations of unloading SNF), when unloading and handling of SNF at the ODF, agreed with the designers of the ship, reactor, and the submarine equipment control system, with the scientific advisor of the designs of the reactor, departmental center for NRS, DSS NRS of the RF MOD and approved by the head of the enterprise.	NYADI.000.0230.0 0.001, para. 2.10, 4.2 6) RD5.IMYAN.105- 2005, para. 9.12			+					
94.	Availability of specially developed technological processes (manuals) to execute the PHO.	NYADI.000.0230.0 0.001, para. 4.2 г), 4.8 NYADI.0220.00.02 7, para. 7.8 NYADI.0220.00.03 1, para. 7.10			+					
95.	Briefing the personnel on NS before each PHO with registration in the PHO log book or in the log book of SNF unloading.	NYADI.0220.00.02 7, para. 9.5 NYADI.0220.00.03 1, para. 9.6			+					
96.	Registration of all orders and actions of the personnel (when performing work related to unloading SNF) in the log book of PHO and the NPS watch log book.	NYADI.000.0230.0 0.001, para. 4.2 д), 4.9 NYADI.0220.00.02 7, para. 9.5			+					
97.	Registration for all orders and actions of staff (after the approval of the Act on the audit of the readiness of the enterprise, systems and equipment, and NPS personnel to SNF unloading from reactors) in the log book of SNF unloading from NPS reactors (by a shift head of SNF unloading).	NYADI.0220.00.02 7, para. 5.7.1, 7.8, 9.5 Appendix E NYADI.0220.00.03 1, para. 7.10, 9.6, Appendix E			+					
98.	Execution of a written permit to perform PHO by the NPS captain in the PHO log book in agreement with a senior builder of the to be dismantled NPS, Department of NRS of the enterprise.	NYADI.000.0230.0 0.001, para. 4.2 a), 4.6, 4.8			+					
99.	Execution (by the head of unloading operation) of the daily work plan for SNF unloading and its coordination with the NPS captain (commander).	NYADI.0220.00.02 7, para. 7.8 NYADI.0220.00.03 1,			+					

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
		para. 7.10								
100	Execution of a permit to conduct PHO.	NYADI.000.0230.0 0.001, para. 4.8			+					
101	Ensuring a reliable two-way communication of the reactor compartment with the NPS central control room and other places of PHO execution.	NYADI.000.0230.0 0.001, para. 4.8			+					
102	Monitoring of the PHO implementation, state of the reactor in accordance with technical requirements for implementation of PHO and radiation conditions in the reactor compartment.	NYADI.000.0230.0 0.001, para. 4.7, 4.8 NYADI.0220.00.02 7, para. 9.6 NYADI.0220.00.03 1, para. 9.7			+					
103	Execution of the "Act on completion of SNF unloading from the reactors, SNF loading to a TK-18 container (TK-108 / 1), installation of reactor rovers and transfer of the reactor compartment to the civil crew for further dismantling of NPS».	NYADI.000.0230.0 0.001, para. 2.11 NYADI.000.0230.0 0.021, Appendix H NYADI.0220.00.02 7, para. 7.12, 17.1.3r), Appendix Y NYADI.0220.00.03 1, para. 7.11, 9.11.2r), Appendix Ф			+					
104	Execution of a report on unloading SNF approved by the head of the enterprise.	NYADI.0220.00.02 7, para. 17.2, Appendix Ф NYADI.0220.00.03 1, para. 19.4, Appendix II			+					
105	Registration after unloading SNF from the NPS reactors by the NPS chief engineer of the passport of the nuclear installation and its dispatch to DSS NRS of MOD.	NYADI.0220.00.02 7, para. 17.3			+					
106	Development of the manual for the radiation safety provision while storing SNF at the ODF.	RD5.IMYAN.106- 2005, para. 6.4.5			+				+	
107	Registration of accompanying documentation, according to OST 95 957-93 to send SNF for reprocessing.	NYADI.0220.00.02 7, para. 7.15 NYADI.0220.00.03 1, para. 7.14			+				+	
108	Development of the manual for radiation safety when performing loading SNF to a special train from a temporary storage site of the ODF.	RD5.IMYAN.106- 2005, para. 6.4.6			+				+	
109	Development of administrative and engineering regulations to overload SNF from the FMB of the Navy to a support vessel in the water area of the enterprise agreed with the department of NRS	RD5.IMYAN.106- 2005, para. 6.4.6							+	
110	Development of administrative and engineering regulations to load SNF from storage spaces of the FMB o(belonging to the Navy or t or enterprise) to a special train agreed with the department of NRS.	RD5.IMYAN.106- 2005, para. 6.4.6							+	
111	Availability of an act of transfer the NPS from the crew	NYADI.0220.00.01				+				

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)							
			I	II	III	IV	V	VI	VII	VIII
	to the responsible person (workshop) designated as responsible for NPS dismantling.	7, para. 3.16								
112	Organization of placing in to the reactor compartment of additional bulky equipment and containers with SRW in accordance with R 2.6.6.42-02.	RD5.IMYAN.106-2005, para. 6.3.12				+				
113	Registration of sanitary-epidemiological conclusion on the reactor compartment.	RD5.IMYAN.106-2005, para. 6.3.12				+				
114	Conducting a radiation of survey outside surfaces of the SGP unit and premises of the reactor compartment to the extent determined by the ship designers.	RD5.IMYAN.106-2005, para. 6.3.13				+				
115	Conducting radiation survey of scrap produced when dismantling the ship.	RD5.IMYAN.106-2005, para. 6.3.13				+				
116	Transfer of nuclear service vessels having SNF storage spaces from the Navy to the enterprises-executors of works in nuclear-safe condition with SFA unloaded from their storage spaces, supported by respective certificates.	LKIB.4130-019-2006, Items 4.1.1, 5.1.1 LKIB.4130-015-2004, The appendix In	+							
117	Availability of the data card of a nuclear service vessel prepared for temporary storage, containing the results of works on conversion of the nuclear service vessel and preparation of the hull package for temporary storage afloat.	LKIB.4130-019-2006, Item 1.1.3		+				+		
118	Performance of actions for preparation of the nuclear service vessel to conversion.	LKIB.4130-019-2006, Section 2.2		+						
119	Design development (a set of design, process and administrative documentation) for conversion and preparations of the nuclear service vessel for temporary storage afloat according to the specified requirements. Presence as part of the project of the list of emergencies that may occur during the temporary storages afloat.	LKIB.4130-019-2006, Section 2.4, item 5.5.1		+						
120	Performance of actions for conversion of the nuclear service vessel.	LKIB.4130-019-2006, Section 3		+						
121	Provision of radiation safety during preparation of the nuclear service vessel for temporary storage afloat and during storage afloat according to Federal laws and effective rules and norms of radiation safety provision.	LKIB.4130-019-2006, Item 5.1.2	+	+		+		+	+	
122	Setting of a sanitary-protective (buffer) zone round the site and water area of the enterprise that conducts preparation of the nuclear service vessel for temporary storage afloat and carries out storage afloat of the hull package.	LKIB.4130-019-2006, Item 5.1.3	+	+		+		+	+	
123	Setting of a controlled access zone, provision of sanitary/permit-based access mode and radiation monitoring and control while conducting works on the nuclear service vessels with open radiation sources.	LKIB.4130-019-2006, Item 5.1.3	+	+		+		+	+	
124	Performance of actions to provide radiation safety when placing a nuclear service vessel to the pontoon-deck (building berth deck) of the dock or dock-chamber.	LKIB.4130-019-2006, Item 5.1.4		+						
125	Performance of actions to ensure radiation safety when conducting works in the controlled access zone of the nuclear service vessel or the hull package when the hull package is in the dock at which the release and migration of radioactive substances are possible.	LKIB.4130-019-2006, Item 5.1.5		+				+	+	
126	Conformity of the dose rate of gamma radiation of the prepared for storage hull packing in any point of its outer surface and at a distance of 1 m from the outer surface, as well as unstable radioactive contamination of the outer surfaces specified by norms.	LKIB.4130-019-2006, Item 5.1.6		+				+	+	
127	Development of radiation safety manuals and other documentation to ensure and monitor radiation safety in compliance with the effective guiding documents.	LKIB.4130-019-2006, Items 5.1.11, 5.5.3		+				+	+	

No.	Type and contents of requirement	Legal basis	Dismantling stages (under GOST RV 50811)								
			I	II	III	IV	V	VI	VII	VIII	
128	Holding of specified surveys and maintenance of the hull package at temporary storage afloat.	LKIB.4130-019-2006, Sections 4.2 ... 4.6							+	+	
129	Planning of actions, preparation and actions of the personnel of the enterprise-executors of works on preparation of the nuclear service vessel for storage and of the enterprise that exercises storage of the hull package afloat, in case of accident occurrence according to OSPORB-99/2010.	LKIB.4130-019-2006, Item 5.5.2		+					+	+	
130	Organization of prophylactics to prevent accidents and conducting of special training and exercise of the personnel of the enterprise-executor of the works on preparation of the nuclear service vessels for storage and of the enterprise that conducts storage of the hull package afloat.	LKIB.4130-019-2006, Item 5.5.4		+					+	+	



Statens strålevern
Norwegian Radiation Protection Authority

StrålevernRapport 2013:1

Virksomhetsplan 2013

StrålevernRapport 2013:2

Ultrafiolett stråling, solskader og forebygging

StrålevernRapport 2013:3

Dismantlement of nuclear facilities decommissioned from the russian navy: Enhancing regulatory supervision of nuclear and radiation safety