

# **Radioactive Wastes Handling at Rosatom Enterprises during Establishment of Radioactive Waste Management System at North-West of Russia**

K.N. Kulikov, B.M. Ivanov NIPTB ONEGA Ltd, Severodvinsk,  
A.D. Anisimov Rosprom, Moscow,  
V.P. Struev FSUE SCN RF "Krylov CSRI", S.-Petersburg, Russia

## **Abstract**

This paper presents: the history of radioactive waste management in the North-West of Russia at Rosprom enterprises (FSUE PO "Sevmash", FSUE Ship Repair Centre (SRC) "Zvezdochka", Head Branch of FSUE SRC "Zvezdochka" "Ship Repair Yard (SY) "Nerpa"); the current radioactive waste management procedure; radioactive waste generation and accumulation data. The paper analyses measures to improve systems of radioactive waste management which are planned for the period up to 2015. Problem issues related to management of specific radioactive waste are also reviewed.

## **Background**

Since the time when Rosprom enterprises (FSUE "PO "Sevmash", FSUE "Shiprepairing Center (SRC) "Zvezdochka", Head Branch of FSUE "SRC "Zvezdochka" "Shiprepairing Yard (SY) "Nerpa") started repairs, modernization and dismantling nuclear powered submarines (NPS), radioactive waste (RW) have been continuously generated and accumulated at their premises.

Initially infrastructure of RW handling at the enterprises of the Shipbuilding Ministry (Minsudprom) was designed on the technical level achieved in 60s of 20<sup>th</sup> century.

The principle diagram of liquid radioactive wastes (LRW) and solid radioactive wastes (SRW) management at Minsudprom enterprises of Rosprom in North-West Russia according to the enterprise designs of 60's of 20<sup>th</sup> century is shown in Figure 1.

Due to political decisions on RW discharge in specific ocean areas, the construction of facilities for LRW and SRW handling at the enterprises was not finished and they were not commissioned.

Till 1976 RW discharge to the seas was performed according to the Temporary Sanitary Rules of RW Burial in Seas, approved by the USSR Ministry of Health

and the Navy Command in the end of 1966 [5]. Several reactor compartments and thousands of containers with SRW were buried in the seas [3, 4].

It is necessary to mention that the practice of RW discharge to the World Ocean was first applied by the USA. Such operations started on the Pacific coast in 1946 and were extended to the Atlantic coast in the 50s. During that period the UK and other European countries started LRW release and SRW burial in the North Atlantic, and then Japan and other Asian countries started these operations in the Pacific Ocean. So, RW discharge to sea was an accepted practice regulated by national rules [5].

Since 1976 the Navy put in force new Rules of Radioactive Wastes Discharge to the Seas, approved by the Navy Commander-in-Chief on 4 August 1983 and agreed with head of the USSR Hydromet [5].

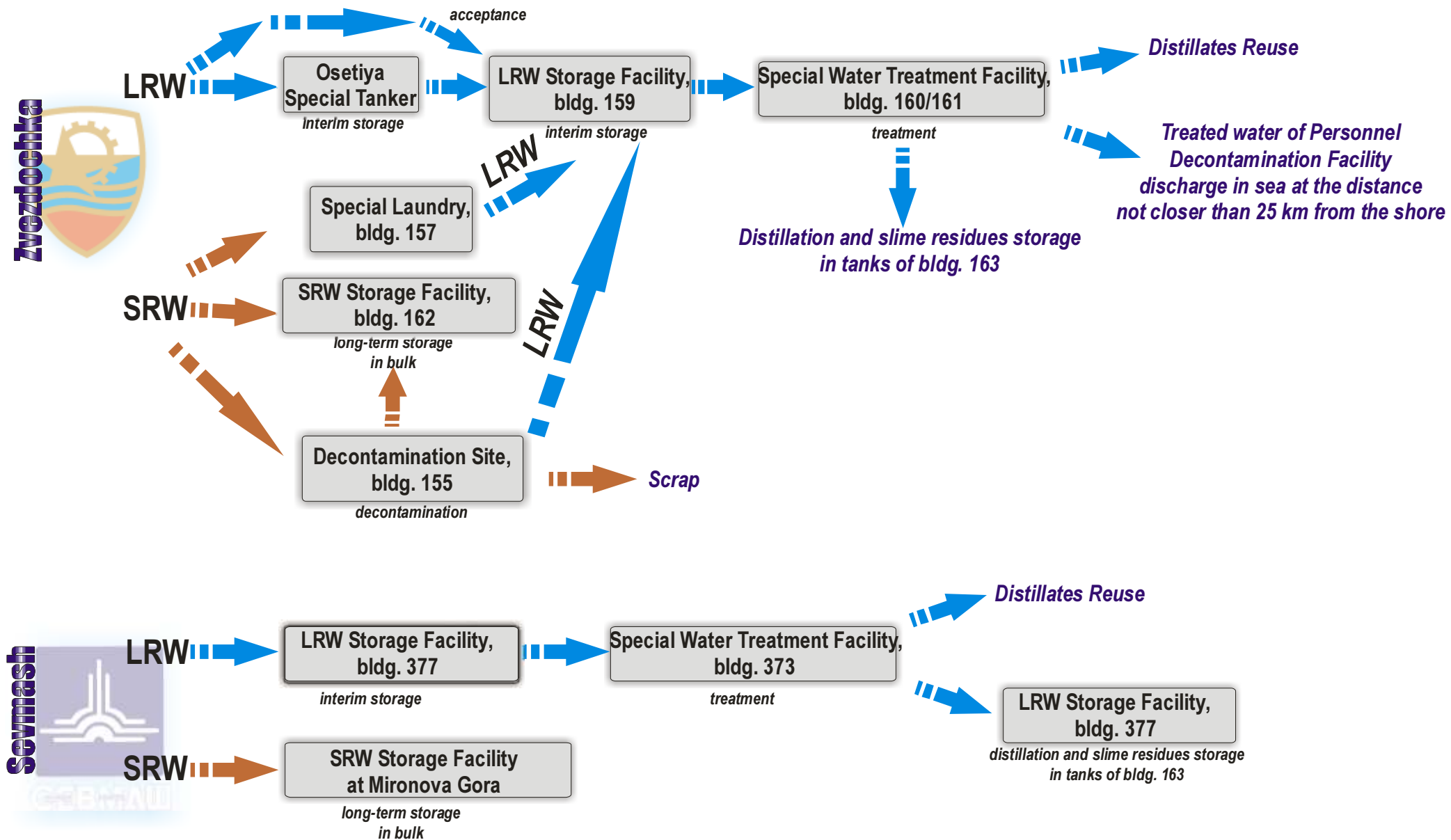


Figure 1 – Principle diagram of LRW and SRW management at Plants of Rosprom (North-West, Russia) taking into account the commissioning of RW management infrastructure facilities in accordance with Plants' design of 60-ties (XX century)

According to the Rules, RW discharge to the seas could be performed only from the Navy facilities. Principle diagram of RW handling during that period is shown in Figure 2.

In the end of 1991 a RF law on Environment Protection [1] was adopted. It introduced the prohibition of RW immersion, therefore the Navy stopped RW acceptance from Minsudprom enterprises. This resulted in LRW and SRW accumulation at the enterprises.

The problem of RW accumulation at the enterprises became acute in the beginning of 90s of the 20<sup>th</sup> century upon meeting of Russia's obligations on reduction of the strategic offensive weapons (SNV-1, SNV-2).

Constructed at that time the infrastructure of RW handling at Minsudprom enterprises did not correspond to the enterprises needs. This caused accumulation and temporary storage of the non-conditioned LRW and SRW.

Therefore, in 1996 at FSUE "SRC "Zvezdochka" (the main enterprise of NPS repair and dismantling) practically all facilities for LRW and SRW temporary storage have been filled. Implementation of the state plans of NPS dismantling was under threat. Simultaneously with such accumulation of large RW volumes there was a serious ecological risk for the population.

The situation and options for its improvement were discussed. Long-period correspondence with the Navy Command showed absence of funds and possibilities to solve this problem.

In the situation of increasing radioecological risks in Severodvinsk a company, MosNPO "Radon", was engaged to solve the problem of LRW accumulation.

By June 1997 a "Radon" facility "EKO-3" had ensured effective treatment of 407 m<sup>3</sup> of LRW at FSUE "SRC "Zvezdochka" MosNPO and by 2003 over 2100 m<sup>3</sup> had been additionally treated.

Alongside with solution of the problem of LRW volume reduction, the problems of SRW removal were solved, in particular SREB ONEGA prepared a MOM of a technical meeting on placement of SRW in the reactor compartments upon their preparation for long-term storage. It permitted SRW loading in the reactor compartments of the dismantled NPSs at FSUE "SRC "Zvezdochka". Later a leading document of the industry, 'Solid Radioactive Waste. Arrangement in Reactor Compartments of Dismantled Nuclear Powered Submarines' was developed.

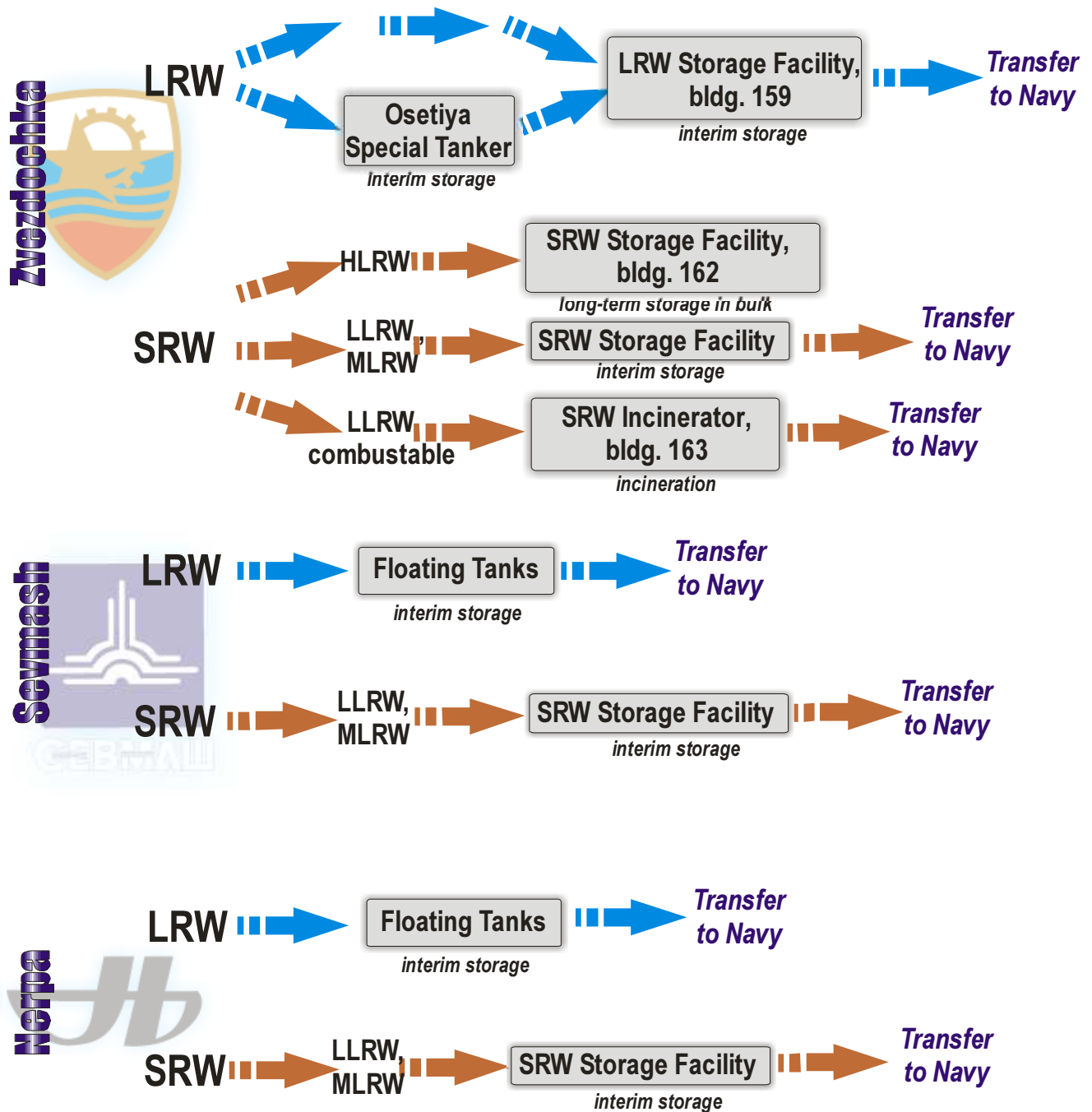


Figure 2 – Principle diagram of LRW and SRW management at Plants of Rosprom (North-West, Russia) before RW discharge in the sea prohibition in 90-ties (XX century)

HLRW – High-Level Radioactive Waste;  
 MLRW – Medium-Level Radioactive Waste;  
 LLRW – Low-Level Radioactive Waste

At that time the temporary storage facilities for LRW and SRW at FSUE "SRC "Zvezdochka" were morally and physically obsolete, so the decision was made and implemented in 1999 for the repair of LRW storage (facility 159), provision of special tanker "Osetiya" for LRW temporary storage and transportation, an open site for SRW temporary storage and construction of a new SRW storage (facility 165) commissioned in 1999.

For the principle reduction of RW volumes in storages and of generated volumes at the enterprise, the reconstruction of the facility 160\161 was completed in 2001 resulting in the creation of LRW and SRW treatment facility.

To solve problems of RW management at the industry enterprises in 1993 and in 1996 federal special programs on 'Radioactive Wastes and Spent Nuclear Materials Management, their disposal for 1993-1995 and 1996 – 2005 periods' were adopted ([6], [7]). Also a draft concept of RW handling was accepted, which specified principles of state system of RW management and control.

Here are the most important among them:

- Assurance of acceptable level of health protection against RW and spent nuclear fuel (SNF) radioactive effect;
- accounting of possible consequences for people and environment beyond Russia;
- exclusion of excessive economic burden for the future generations;
- presence of legal structure that ensures division of responsibilities between the State Authorities and Safety Supervision Authorities, which should be independent from the former;
- determination of clear responsibilities for SNF and RW management of government and organizations of various property, of commercial and non-commercial organizations;
- delineation of powers, determination of responsibility, rights and obligations of the federal centre and RF subjects relating to RW and SNF handling; and
- information transparency on the status of RW and SNF management for public and international monitoring according to the international agreements accepted by Russia.

Since 2001 a federal special program, Nuclear and Radiation Safety of Russia for 2000-2006, (approved by RF government decree dated 22, February 2000 No. 149, with revisions implemented by RF government decree dated 10, June 2005 No. 371) was put in force, RF Minatom is its State Customer. [9].

In 90s of 20<sup>th</sup> century and later, Russian cooperation with foreign countries in the area of RW handling expanded. Russia accepted some international obligations regarding the nuclear and radiation safety. In particular, in November 2005 Russia ratified the Comprehensive Convention of RW and SNF Safe Handling. [10].

In this context in 2003 it was decided to develop the Strategic Master Plan (SMP).

## **The Existing Infrastructure and Diagram of RW Management at Rosatom Enterprises and Aspects of its Improvement**

At Rosatom enterprises RW are generated as a result of dismantling of ships and vessels with nuclear propulsion plants (NPP), and maintenance of the infrastructure facilities designed for operations with radioactive substances (RS) and RW.

### *Processes entailing RW generation*

During NPS decommissioning and dismantling LRW are generated in following processes:

- first circuit setting for long-term storage, sampling;
- dismounting of gears of the reactor control rods;
- spent nuclear fuel (SNF) unloading;
- drainage of first and third circuits;
- drainage of biological protection tank (BPT);
- decontamination of the detachable equipment of NPS, reactor compartment, process outfitting accessories (POA), personal protection equipment (PPE) etc.;
- drainage of first circuit drain tanks and contaminated water tanks; and
- unloading of fillers of active filters of first and third circuits (this operation can be omitted upon agreement with the designer).

SRW generated during NPS decommissioning and dismantling include wastes that can not be used in future:

- large size equipment of NPP, fittings, first circuit pipelines;
- unloaded fillers of active filters of first and third circuits;
- radioactive contaminated metal structures, tools, cable sections etc.;
- PPE, isolating materials (plastic, polyethylene, rubber coatings etc.); and
- wastes generated during decontamination.

### *Facilities generating RW :*

During NPS decommissioning and dismantling LRW and SRW are generated at the following facilities:

- NPS NPP;
- floating technical bases designed for SNF unloading, and for temporary storage and transportation of fresh and spent nuclear fuel and RW;
- vessels for RW gathering and transportation;
- workshop sanitary passes;
- sites for repair and decontamination of the detachable equipment of NPP, reloading equipment for SNF unloading from NS, POA, PPE etc.;
- facilities for LRW and SRW temporary storage (floating tanks, special tankers, SRW storages, sites for SRW temporary storage);

- facilities for RW treatment (special laundry, floating stations for LRW treatment, shore objects for RW treatment, SRW burning plants, mobile SRW treatment units, etc.);
- laboratories of Nuclear and Radiation Safety Department (NRSD); and
- storage of radioisotope devices and radionuclides sources.

*The existing schemes of RW handling at enterprises and perspectives of its improvement*

Each enterprise has developed and is currently following its own scheme of RW management.

The principle diagram of LRW and SRW management at Rosprom enterprises in the North-West of Russia on 01.01.2008 is shown in figure 3.

Table 1 indicates the production possibilities of Rosprom enterprises in the North-West of Russia on RW management.

*Table 1 - Industrial capabilities of Rosprom shipbuilding and ship repair enterprises at Russia north-west.*

<b>Work performed by</b>	<b>Composition of main elements of used infrastructure</b>	<b>RW acceptance, treatment, m<sup>3</sup>/year</b>
Arkhangelsk region		
SRC "Zvezdochka"	- SRW storage 162; - SRW storage 165; - floating facilities; - facility for LRW treatment; - facility for SRW treatment.	Filled by 100%. Filled by 20%. Special tanker "Osetiya". Up to 4000 m <sup>3</sup> /year. Up to 200 m <sup>3</sup> /year.
PO "Sevmash"	- SRW storage; - SRW storage site; - floating tanks for LRW; - shore tanks for LRW.	Operation is prohibited. Area 290 m <sup>2</sup> . Volume 48 m <sup>3</sup> . Volume 27 m <sup>3</sup> .
Murmansk region		
SY "Nerpa"	- shore tanks for LRW; - SRW storage site; - floating tanks	Capacity 20 m <sup>3</sup> 500 m <sup>2</sup> , operation is prohibited. 2 PEK-50, will be subjected to dismantling

FSUE "SRC "Zvezdochka"

The existing scheme of LRW management at FSUE "SRC "Zvezdochka" includes:

- accumulation of low-salt LRW, BPT water, spent decontamination solutions at places of generation (except special laundry water) into the special tanks or, in case of large volumes, or pumping them to a special tanker "Osetiya" or to LRW storage (facility 159);
- transportation of RW to LRW storage (facility 159) or to the special tanker "Osetiya";
- temporary storage in LRW storage or special tanker;
- move of RW for treatment at LRW treatment facility (facility 160/161) from LRW storage;
- move of special laundry water directly from the special laundry to LRW treatment facility (facility 160/161).

LRW are treated at the treatment facility for low-level LRW and SRW (facility 160/161). The facility can treat every year up to 4000 m<sup>3</sup> of liquid wastes generating about 17 m<sup>3</sup> of SRW.

Additionally, the enterprise has the plant to treat the low-salt LRW with capacity up to 700 m<sup>3</sup>/year. The plant was rented at NPO "Radon".

According to the accepted diagram, at places of generation SRW are gathered in metal containers with capacity 1.5-3 m<sup>3</sup>, and large size equipment is preserved. Depending on wastes type and size SRW are transported to the following facilities:

- a. low-level wastes (LLW) - to site of SRW treatment at the treatment facility of low-level LRW and SRW (facility 160/161) or to the open site of SRW temporary storage; and
- b. medium-level and high-level wastes (MLW, HLW) - to temporary SRW storage (facility 165).

Currently we work to achieve the design capacity. Some components of the site for SRW treatment require modernization.

To improve the infrastructure of RW handling at FSUE "SRC "Zvezdochka", it is necessary to solve the following issues:

- modernization of SRW burning plant;
- rehabilitation of the temporary SRW storage (facility 162) and conditioning of the accumulated SRW (new project); and
- construction of the plant for re-melting of metal SRW (new project) or of the decontamination plant with transfer of decontaminated RW to transport rates for re-melting at the special enterprise.

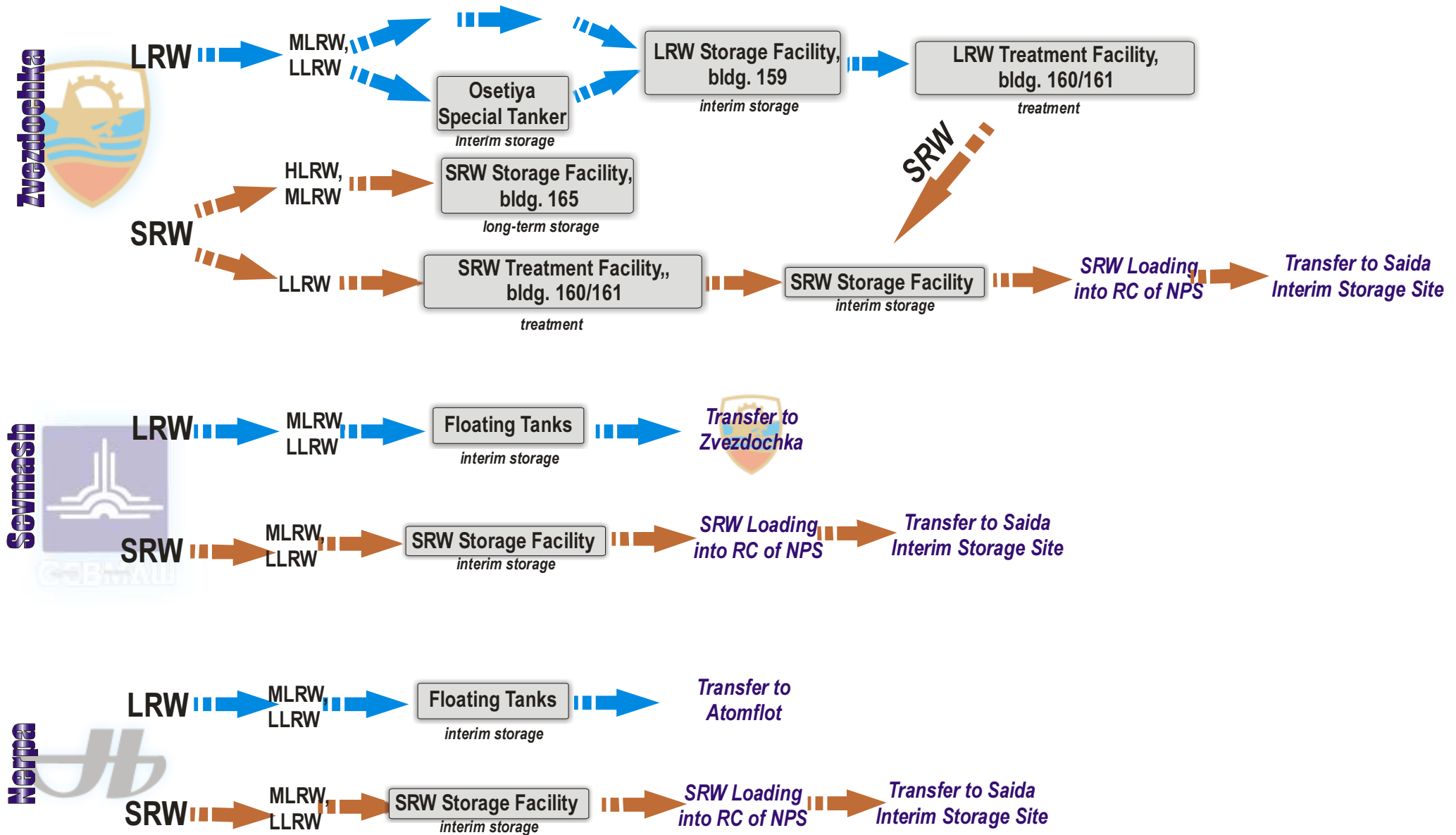


Figure 3 – Principle diagram of LRW and SRW management at Plants of Rosprom (North-West, Russia) for 01.01.2008

## FSUE "PO" Sevmash"

The enterprise has four floating tanks with the capacity of 12 m<sup>3</sup>, each for gathering, temporary storage and transfer for treatment of low-level LRW. Between operations the floating tanks are stored at the special pier.

Simultaneously the enterprise has 373 four metal tanks without the biological protection with the capacity of 6.3 m<sup>3</sup> each and two similar tanks with the capacity of 2.2 m<sup>3</sup> each to gather laboratory LRW.

According to the current scheme of RW handling all LRW generated at the enterprise are gathered to the floating tanks and transported by the special tanker "Osetiya" to FSUE "SRC "Zvezdochka".

SRW are gathered in containers with capacity 1.5-3 m<sup>3</sup>, and then are loaded in the reactor compartment of the dismantled NPS. Large size equipment is preserved and delivered to the temporary storage site with area 290 m<sup>2</sup>.

To improve the infrastructure of RW handling at FSUE "PO "Sevmash" it is necessary to solve the following issues:

- liquidation of SRW storage at Mironova hill;
- reconstruction of SRW temporary storage site;
- modernization of the object 377 for LRW gathering and storage between operations;
- modernization of the system for LRW intake and storage in the floating tanks.

## "SY "Nerpa" (Head Branch of FSUE "SRC "Zvezdochka")

Diagram of RW management at the enterprise was simplified: gathering, sorting, temporary storage and shipment for treatment at other enterprise or SRW loading in the reactor compartments.

The existing diagram of LRW gathering and temporary storage includes:

- tanks for LRW temporary storage in building adjacent to covered slipway;
- pipelines network in the covered slipway for LRW gathering from slipway places and further transfer to the floating tank PEK-50 or special vessel.

Further LRW are delivered for treatment at FSUE "Atomflot". Currently due to physical wear of the tanks, pipelines and fittings the tanks operation is prohibited by the Regulatory Authorities.

SRW are gathered in places of generation and are loaded in metal containers with capacity 1.5-3.0 m<sup>3</sup>. The containers are transported to the temporary storage site (area 500 m<sup>2</sup>), the large size equipment is also delivered to this site.

From the temporary storage site SRW are delivered for loading in the reactor compartments of the dismantled NPSs.

To improve the infrastructure of RW management at "SY "Nerpa" (Head Branch of FSUE "SRC "Zvezdochka") it is necessary to solve the following issues:

- reconstruction of the existing gathering and temporary system for LRW from slipway places and from the tanks;
- extension and reconstruction of temporary storage site for the containers with SRW;
- reconstruction and re-equipment of the decontamination site of the floating dosimetric station PKDP-6 and construction of the shore decontamination site.

Dynamics of LRW and SRW generation and accumulation at the enterprises is shown in Tables 2-5.

*Table 2 - Dynamics of LRW generation for 2004-2007 period, m<sup>3</sup>*

<b>Shipyard</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
FSUE "PO "Sevmash"	3.8	18.95	9.4	<b>12.05</b>
FSUE "SRC "Zvezdochka"	399.0	401.0	622.0	627.0
FSUE shipyard "Nerpa"	40.8	418.2	32.0	37.0

*Table 3 - Dynamics of SRW generation for 2004-2007 period, m<sup>3</sup>*

<b>Shipyard</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
FSUE "PO "Sevmash"	to SRW site 5 containers were delivered, weight 11.95 t (15 m <sup>3</sup> ) and large size equipment - 1 pc., weight 5.47 t	to SRW site 8 containers were delivered, weight 22.985 t (21.3 m <sup>3</sup> )	were not generated	to SRW site 2 containers were delivered, weight 9.98 t (m <sup>3</sup> ) and 3 montejeses, weight 16.75 t
FSUE "SRC "Zvezdochka"	198.0 m <sup>3</sup>	306.0 m <sup>3</sup>	227.0 m <sup>3</sup>	271.0 m <sup>3</sup>
FSUE shipyard "Nerpa"	164.0 m <sup>3</sup> (176.8 t)	511 m <sup>3</sup> (478.0 t)	475.0 m <sup>3</sup> (721.6 t)	338.3 m <sup>3</sup> (444.35 t)

*Table 4 - Dynamics of LRW accumulation for 2004-2007 period, m<sup>3</sup>*

<b>Shipyard</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
FSUE "PO "Sevmash"	3,8	no	1	11,65
FSUE "SRC "Zvezdochka"	1802	1362	1270	1092
FSUE shipyard "Nerpa"	N/A	N/A	N/A	N/A

*Table 5 - Dynamics of SRW accumulation for 2004-2007 period, m<sup>3</sup>*

<b>Shipyard</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
FSUE "PO "Sevmash"	delivered to 3 compartment blocks of NPS: containers - 61 pcs, weight 141.2 t (183 m <sup>3</sup> ), LSE - 3 pcs, weight 6.67 t;  stored at SRW site: containers – 56 pcs, weight 129.25 t (168 m <sup>3</sup> ), LSE - 2 pcs, weight 1.2 t (2 m <sup>3</sup> )	delivered to 6 compartment block of NPS: containers - 5 pcs, weight 19.165 t (15.0 m <sup>3</sup> )  stored at SRW site: containers – 3 pcs, weight 3.82 t (6.3 m <sup>3</sup> )	stored at SRW site: containers – 3 pcs, weight 3.82 t (6.3 m <sup>3</sup> )	delivered to 6 compartment blocks of NPS: containers - 43 pcs and 3 montejuses, total weight 113 t  stored at SRW site: 1 container, weight 120 kg
FSUE "SRC "Zvezdochka"	2286 m <sup>3</sup>	2322 m <sup>3</sup>	2403 m <sup>3</sup>	2454 m <sup>3</sup>
FSUE shipyard "Nerpa"	N/A	N/A	N/A	N/A

### **Federal Special Program, Assurance of Nuclear and Radiation Safety for 2008 and till 2015**

Implementation of the Federal special program on ‘Nuclear and Radiation Safety of Russia for 2000-2006’, ensured the definite progress in solution of the general problems of the nuclear and radiation safety in Russia, but it practically did not improve the situation with the accumulated problems and did not create the conditions for their effective solution in future.

The Federal special program ‘Assurance of Nuclear and Radiation Safety for 2008 and till 2015’, [11] is the logical continuation of the program for 2000-2006 period.

During the program development practical measures of improvement of the RW management system in the North-West of Russia were considered, such measures were specified in the Strategic Master Plan-2 (SMP-2).

The program contains five directions ensuring the nuclear and radiation safety including the following:

- 1 – construction of main infrastructure objects for SNF and RW handling;
- 2 – practical solution of the problems related to the previous activities;
- 3 – construction and improvement of the systems necessary to ensure and to control the nuclear and radiation safety under normal operation and under accidents;

- 4 – improvement of the personnel, population and environment protection against radiation effect;

- 5 – scientific, informative, analysis and organizational support of the activities supporting nuclear and radiation safety.

The principle diagram of LRW and SRW Management at Rosprom enterprises at North-West of Russia which shows commissioning of the infrastructure objects for RW handling under SMP-2 is shown in Figure 4.

The activities of the Federal special program for Rosprom enterprises in the North-West of Russia are shown in Table 6.

*Table 6 – Activities of the Federal special program, Assurance of Nuclear and Radiation Safety for 2008 and till 2015, related to Rosprom enterprises in the North-West of Russia*

<b>Measures</b>	<b>Beginning</b>	<b>End</b>
Preservation of RW storage "Mironova hill" (Severodvinsk). Storage transfer into ecologically safe object	01.01.2008	31.12.2010
Reconstruction the management system of accumulated RW at FSUE "PO "Sevmash"	01.01.2008	30.12.2015
Reconstruction of SRW temporary storage (object 162) FSUE "SRC "Zvezdochka" with conditioning of the accumulated RW	01.01.2008	30.12.2015
Reconstruction of the special facility for the accumulated RW management at FSUE "SRC "Zvezdochka", conditioning of the accumulated RW	01.01.2008	30.12.2015
Reconstruction of SRW storage site with conditioning of the accumulated RW at "SY "Nerpa" (Head Branch of FSUE "SRC "Zvezdochka")	01.01.2008	30.12.2015
Reconstruction of the management system for accumulated RW at "SY "Nerpa" (Head Branch of FSUE "SRC "Zvezdochka")	01.01.2008	30.12.2015
Reconstruction of the sanitary passage system for management of the accumulated RW at "SY "Nerpa" (Head Branch of FSUE "SRC "Zvezdochka")	01.01.2009	31.12.2010
Development of the processes and equipment to ensure measures on decommissioning, rehabilitation, reconstruction of the nuclear and radiation dangerous objects of shipbuilding industry and treatment of the accumulated RW	01.01.2008	30.12.2015

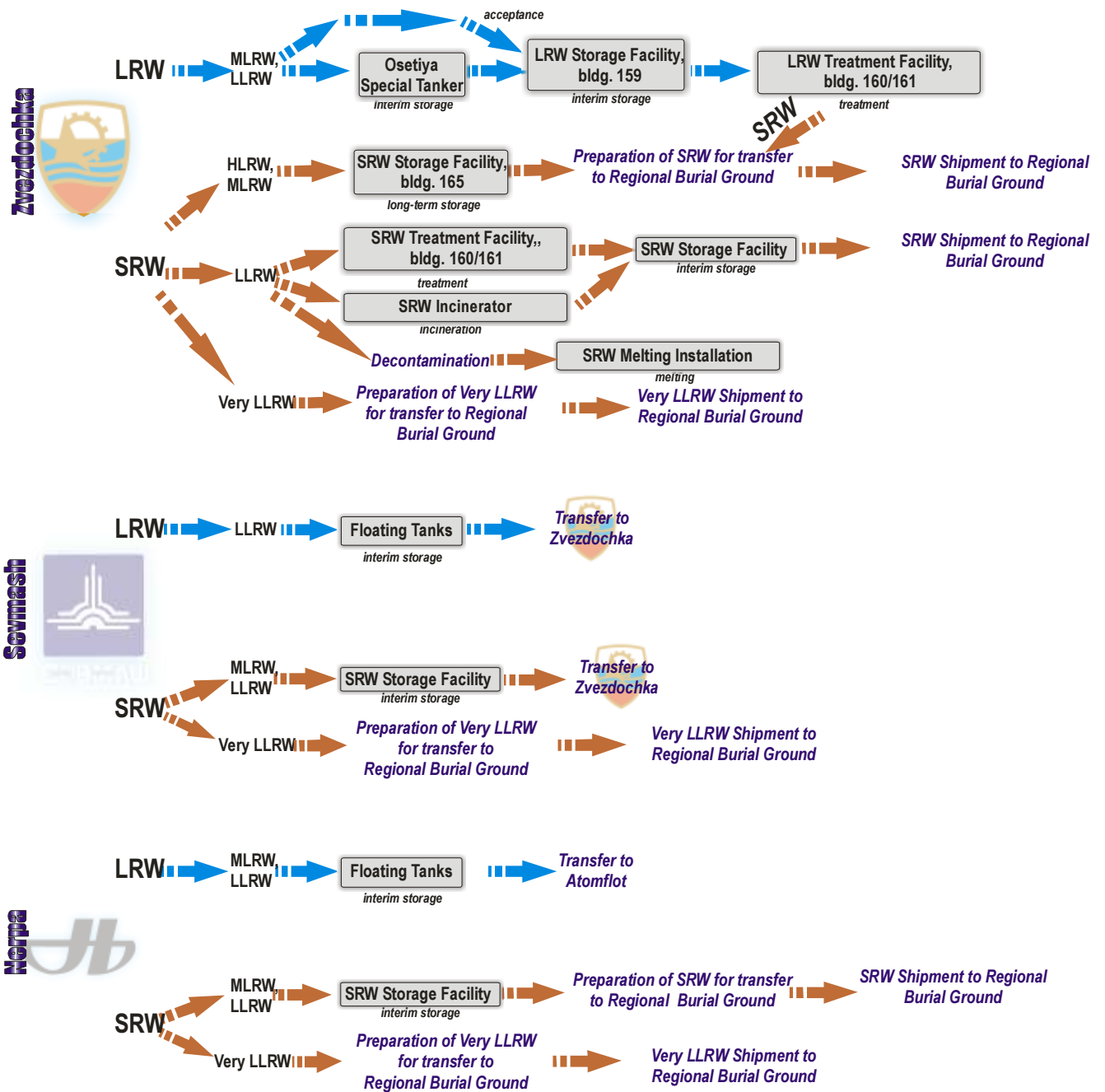


Figure 4 – Principle scheme of LRW and SRW management at Plants of Rosprom (North-West, Russia) taking into account the commissioning of RW management infrastructure facilities in accordance with Strategic Master-Plan-2 and Federal Task-Oriented Program “Nuclear and Radiation Safety in Russia” for the period of 2008-2015  
 Very LLRW – Very Low-Level Radioactive Waste.

## **Problems of RW Handling**

### *Nuclear service ships (NS ships)*

Dismantling NS ships is one of the most complicated objective of the program for comprehensive dismantling ships and vessels with NPP.

Currently 15 NS ships are decommissioned, which were used for NPS and nuclear powered ice-breakers (NPIB) servicing. In many cases serious radioactive contamination of rooms used for SNF and RW storage is recorded.

At the first stage of the decommissioning the ships are prepared for long-term storage afloat for at least five years. During further dismantlement of NS ships a large quantity of medium- and high-level SRW will be generated, which requires establishment of regional centers of RW management. After their creation it will be possible to start the NS ships dismantling.

### *FTB "Lepse"*

The floating technological base (FTB) "Lepse" is the most dangerous from nuclear and radiation points of view floating facility in Russia.

Currently the issue of financing of dismantling FTB "Lepse" at SY "Nerpa" is being discussed.

One of the problem issues of FTB "Lepse" dismantlement is insufficient infrastructure for RW management at SY "Nerpa", therefore its infrastructure is planned to be modernized.

### *Handling of control rods, high-level RW*

Currently during dismantling of NPS and surface ships with NPP the control rods in the course of SNF unloading are placed in the reactor hull and are delivered for long-term storage as part of the reactor plant.

Except for control rods of the dismantled NPSs, a significant number of control rods has been accumulated on NS ships and RW TSS. Approximate number of NPS control rods stored on NS ships, at shiprepairing enterprises and "SevRAO" and "DalRAO" TSSs is 2500. According to preliminary design estimations, the activity of one rod of 1st generation NPS reaches from  $7.4 \cdot 10^8$  kBq to  $3.7 \cdot 10^9$  kBq, so the accumulated activity of the control rods can be conservatively estimated as equal to  $1.0 \cdot 10^{12}$  kBq.

Development of TSS rehabilitation and NS ships projects requires the management of control rods, but due to absence of the accurate data on activity, radionuclides composition, quantity and type of rods, as well as absence of the standardised technical solutions for the rods handling, there are no available solutions for management of the control system elements.

To develop standardised technical solutions for the control rods management the following is suggested:

- research of inventory of the stored control rods (reactor compartment blocks, NS ships, RW TSS of "SevRAO", "DalRAO", FSUE "SRC "Zvezdochka", FSUE "DVZ "Zvezda", SY "Nerpa", SY Navy);
- development of process and standard equipment for control rods management;
- development of the standard (or adaptation of the existing) containers for the control rods loading;
- development of the standard transportation and processing scheme of the control rods management considering all involved enterprises.

The issue of high activity traps of ion-exchange resins (IER) requires a special solution.

In particular, it is suggested that during the storage rehabilitation (object 162 at FSUE "SRC "Zvezdochka") the IER trap vessels with the total volume of about 60 m<sup>3</sup> will be loaded into non-return shielding casks of type NZK-150, and then delivered to the SRW temporary storage. The same procedure can be applied to the control rods, ionization radiation sources, high-level equipment.

#### *Very low-level waste*

Introduction of a new category of wastes - very low-level wastes (VLLW) must be approved by law. This wastes category must have definite characteristics, which requires introduction of changes and amendments to the limits of total specific activity of VLLW into the Codes (OSPORB-99, SPORO-2002).

This will allow us to develop more effective strategies of wastes management and ecological rehabilitation of the sites, and reduction of expenses for both wastes treatment and construction of new ranges for wastes burial.

### **Conclusions**

The problem of the RW management and rehabilitation of the dangerous radioactive facilities at Rosprom enterprises in the North-West of Russia is comprehensive and multidisciplinary; it can not be solved completely in the near future due to economic, scientific and technical constraints.

Significant efforts in this area have been made in NPS dismantling, but only in the last years. The progress of works on NPS dismantling brought about aggravation of problems of RW management at Rosprom enterprises.

Considering the accumulated international experience and the measures specified in the Federal special program 'Nuclear and Radiation Safety of Russia for 2008 and till 2015', it is suggested to solve the accumulated problems by steps. This stipulates the following order of actions:

Stage 1 – a comprehensive engineering and radiation survey of the dangerous nuclear and radiation facilities and development of conceptual and technical solutions and action plans for safety assurance (in general - the programs of decommissioning) with the forecast of expenses for various time

scales of practical activities and conducting the most urgent works to bring nuclear power facilities to safe state.

Stage 2 - implementation of measures to bring facilities to the ecologically safe state, that excludes their negative impact on population and environment for long-term period (about several decades). Within this period the facility is to be protected against external and internal threats, and the required infrastructure for SNF and RW management is to be provided including the establishment of a regional centre (range) for RW final treatment and burial.

Stage 3 - rehabilitation of dangerous nuclear and radiation facilities according to a selected strategy; and rehabilitation of the adjacent areas, which would depend on their current and planned use; and placement of RW in the sites of final isolation.

The completion of works at stage 1 allows estimating the unavoidable expenses in future stages including RW management.

Upon implementation of the practical projects on improvement of RW management systems at Rosprom enterprises it is suggested to optimize the expenses for RW management and to ensure their transformation into the safe state for storage until the stage 3 is implemented. This is ensured by the following measures:

- use of standardised industrial package for generated, and conditioned SRW;
- use of modern power saving technologies and their standardisation within the industry during LRW and SRW treatment;
- use of modular means of sanitary passage and processes of RW management.

Special attention shall be paid to medium-level and high-level wastes management, which have been accumulated at the Rosprom enterprises and expected during rehabilitation of such facilities as NS ships.