

Situation at the Gremikha base

Main problems and general plan for remediation of the site

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The coastal technical base (CTB) in Gremikha settlement located in the Kola Peninsula in the area of the Svyatonossky Bay of the Barents Sea (see Fig. 1) was constructed in 1961-1966 for providing operation of Russian nuclear submarines (NS), receipt and storage of spent nuclear fuel (SNF) unloaded from reactors, as well as for storage of solid and liquid radioactive wastes (SRW and LRW).

The facility site features a cross-country relief with elevations from 0 to 25 meters, the territory area making up approximately 150 thousand sq. m.

In 1961-1965 the site was built up by 1-3-storeyed buildings and structures of special and industrial designation. There is no railway and motor road communications with the base. The nearest seaport with a railway terminal is Murmansk, situated 400 km to the North-West.

The base also integrates the SD-10 dry dock built in 1961 for NS docking on a solid base for SNF unloading from reactors.

The roadstead of the Svyatonossky Bay hosting the base is protected from sea by a number of islands forming navigable narrow waters.

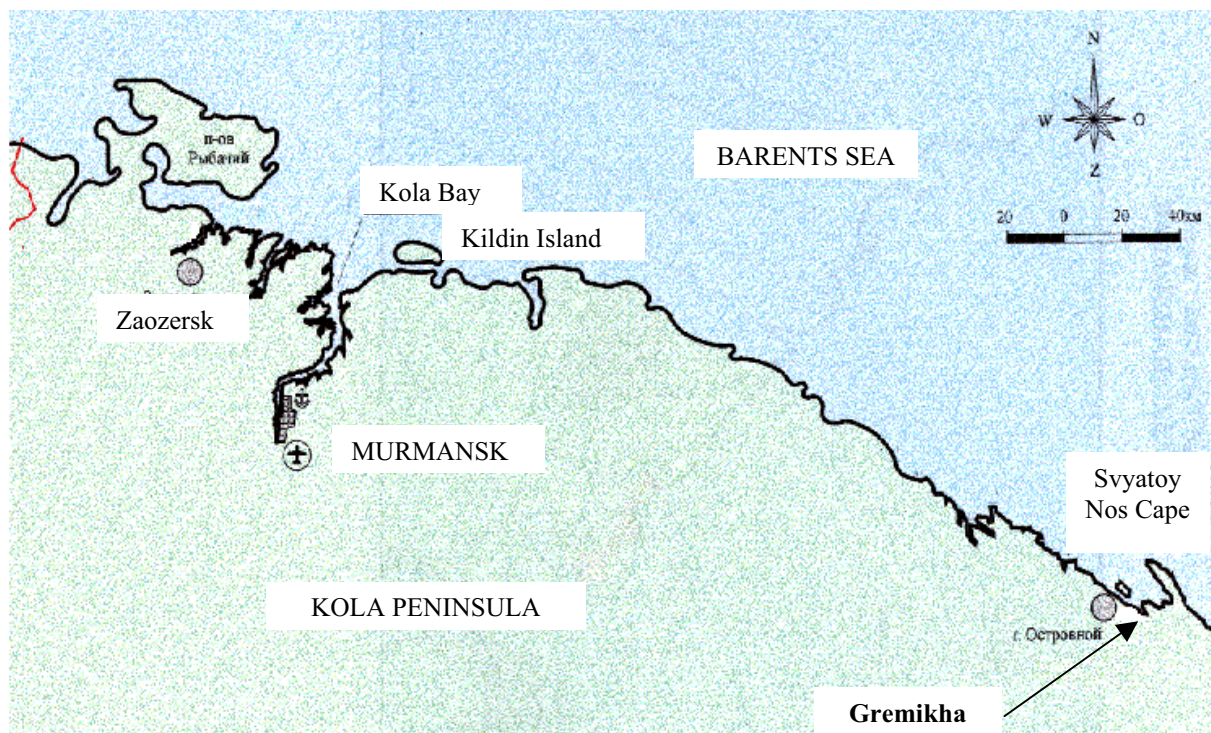


Fig. 1. Gremikha settlement site plan

A special infrastructure for refueling the Alpha-class NS equipped with liquid metal cooled (LMC) reactors was also constructed at the base, i.e. Building 1A (built in 1989) and Building 1B (built in 1961 and upgraded in 1988).

The base was not used for reactor refueling since 1993, SNF and radioactive waste (RW) receipt for storage was discontinued.

In 2001 the CTB in Gremikha was transferred to the jurisdiction of Minatom of Russia for its environmental remediation, being incorporated into the newly setup enterprise SevRAO as affiliated branch No. 2.

About 30 Buildings are located on the base territory, 19 of them of technological designation, the rest were designed for providing the facility functioning (power supply, transport, guards, etc.).

The layout of the buildings and structures is shown schematically in Fig. 2.

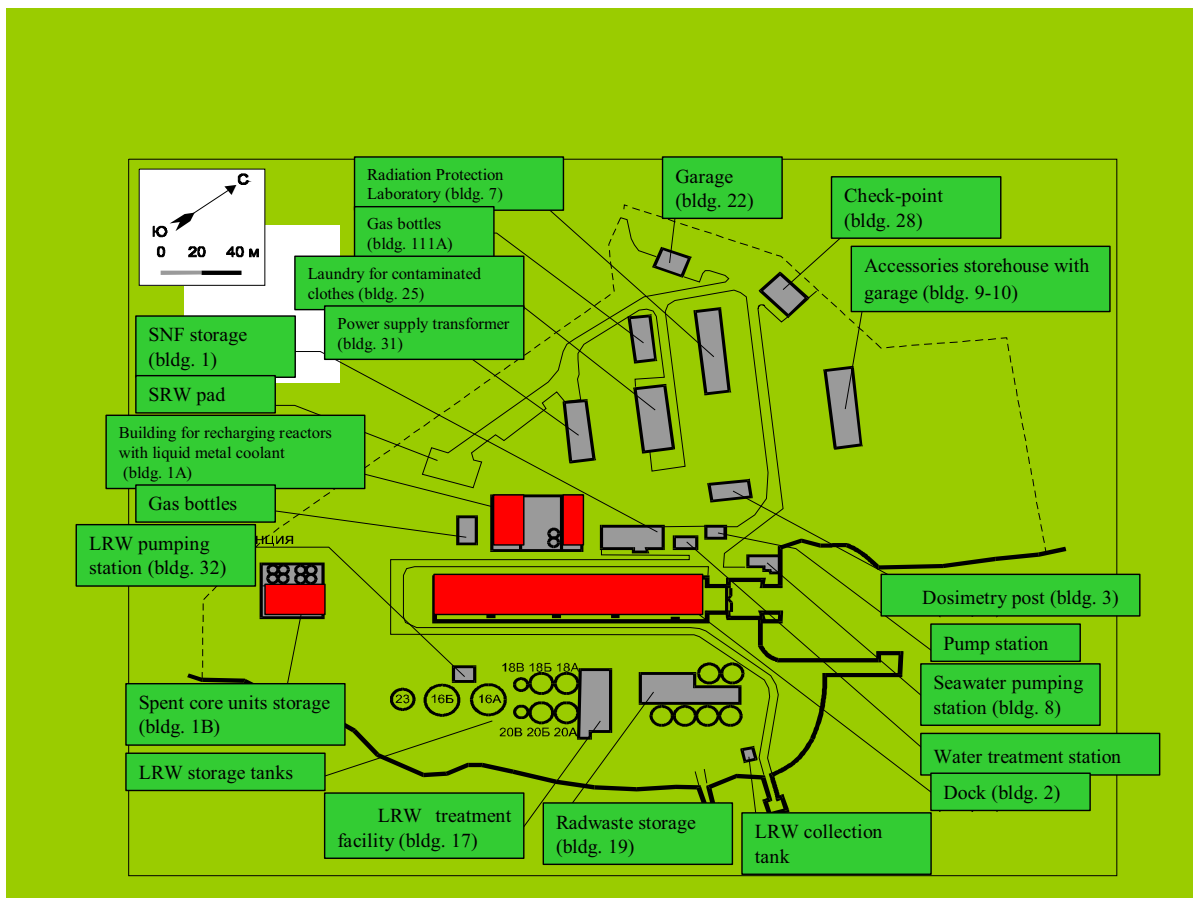


Fig. 2. Layout of the buildings and structures on the territory of the base in Gremikha

At present SNF unloaded from NS water-cooled reactors, SRW (about 740 m³), LRW (water and silt-like sediments in the pools), canisters with absorber rods of the reactor control and protection system (6 pieces), as well as six spent reactor cores containing SNF unloaded from the Alpha-class NS, are stored at the base in Gremikha.

Building 1 was built for storage of spent fuel assemblies (SFA) from NS water-cooled reactors. Structurally it is made up of 4 autonomous ferroconcrete pools (each of 68 m³ holding capacity), their inner surface lined with carbon steel.

The storage facility operation was discontinued in 1986 due to pool No. 1 leak. Storage facility for SNF (Building 1) is one of major sources of radioecological hazard posed

by the object. The steel liner of the pools features a high corrosion wear. The pools in Building 1 are drained, their walls covered with precipitates and the bottoms – with silt sediments containing radionuclides.

The radiation situation in Building 1 is generally characterized as a dangerous one. Check measurements indicated that gamma radiation dose rates in all the pools within the storage facility are similar, amounting to approximately 1 mSv/h.

Maximum values reaching 16 mSv/h were registered in pool No. 4. Average level of dose rate in the storage facility hall makes up 0.075 mSv/h (in some points up to 1-2 mSv/h). Average beta contamination value amounts to nearly 15000 particles/(cm²·min).

Radiation survey of the pools is to be made for defining nuclide composition of the remaining radioactivity, and feasibility study of options for localization (or removal) of radioactivity is to be conducted on the basis of the results obtained for developing Building 1 remediation project. The issue will be covered in greater detail in the paper by Mr. A.P. Vasiliev.

Building 1A was designed for refueling NS with LMC reactors. The state of building structures is assessed as a satisfactory one. The radiation situation inside the building as such is generally characterized as a normal one. Insignificant excess of the radiation background values was registered in some points. Building 1A was not used for its direct purpose in recent 10 years.

Spent nuclear fuel (spent reactor cores – SRC) of LMC reactors is stored in Building 1B which hosts 8 concrete cells intended for long-term storage of SRC. Natural air convection is provided in the cells to remove heat released by SRC.

Altogether six SRP are stored now in Building 1B now. The radiation situation (gamma radiation exposure dose rate, beta contamination) falls within the permissible limits.

As for SRW management at the base in Gremikha, it is noteworthy that there is no special intended storage facility for SRW. An open pad located in the elevated part of the relief, its size 20×15 m (see photo in Fig.3) is used for SRW storage. The pad is protected on its three sides by a 3 m high concrete wall, being fenced with barbed wire over its perimeter. There is no intercepting drainage from the pad.

SRW in form of metalwork, containers (traps) with ion-exchange resins of activity filter from the primary and third circuits of NS reactor installations, containers with instrumentation isotope sources, SFA fragments, etc. is stored on the pad. According to preliminary data about 290 containers with SRW are stored at the base in Gremikha; 220 containers out of the total number are stored on the open pad (the rest – in the storage facility of Building 19). About 370 m³ of SRW without any package are stored on the same pad.

In addition to SRW, old type casks (type 6 and type 11) with SNF unloaded from pools of Building 1 are stored on the pad too. Total number of casks with SNF according to preliminary estimates is about 100 pieces. Since they were stored in the open pad, the casks could have lost tightness of joints, therefore, moisture ingress inside the containers and, accordingly, SNF degradation are not ruled out.



Fig. 3. SRW storage pad

Check survey of the radiation situation on the pad and around it indicated that SRW stored in the pad, is a high-level source of external gamma radiation and at the same time is a source of radioactive substances (radionuclides) spreading to the ground beyond the pad boundaries.

On the concrete wall outer side the gamma radiation level reaches 500-900 $\mu\text{Sv/h}$, near the entrance to the pad – from 300 to 3000 $\mu\text{Sv/h}$. Specific activity of soil samples near the pad is 5×10^7 Bq/kg for cesium-137 and 6×10^6 Bq/kg for strontium-90.

The technical state of the SRW pad is characterized by the following shortcomings:

- there is no concreted ditch, which prevents water penetration from terrain, no collector for melted snow and rain water, no concrete flanging (border) for contamination localization within the pad;
- containers with SRW and casks with SNF arranged on the pad are not protected against atmospheric precipitation;
- there is no special cover of the SRW pad ground.

The following Buildings were envisaged for handling LRW:

- Building 17 for LRW treatment;
- Building 19 for storage of LRW treatment concentrates (never used for the purpose). At present the building hosts containers with SRW. Sorbents of activity filters from primary and third circuits (SRW volume making up about 150 m^3) are stored within one of 6 tanks (its volume being 400 m^3). The storage facility is partially filled with LRW;
- Buildings 16, 18, 20, 23 – LRW storage facilities (their total volume is 3200 m^3);
- Building 32 – pumping station for LRW pumping to a tanker. Service lines for feeding LRW from the object to a tanker have not been used for their direct purpose since 1992.

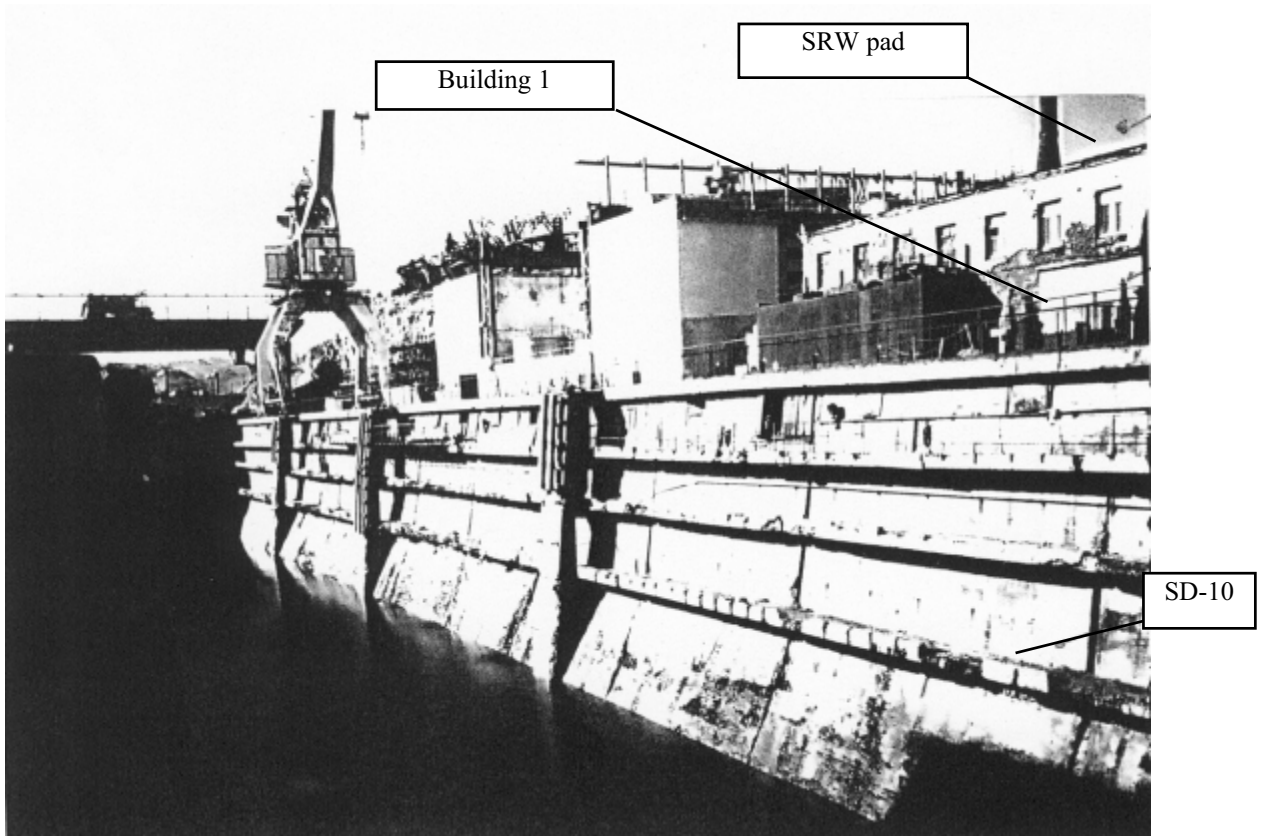


Fig. 4. View of the SD-10 dock, Building 1A and SRW pad

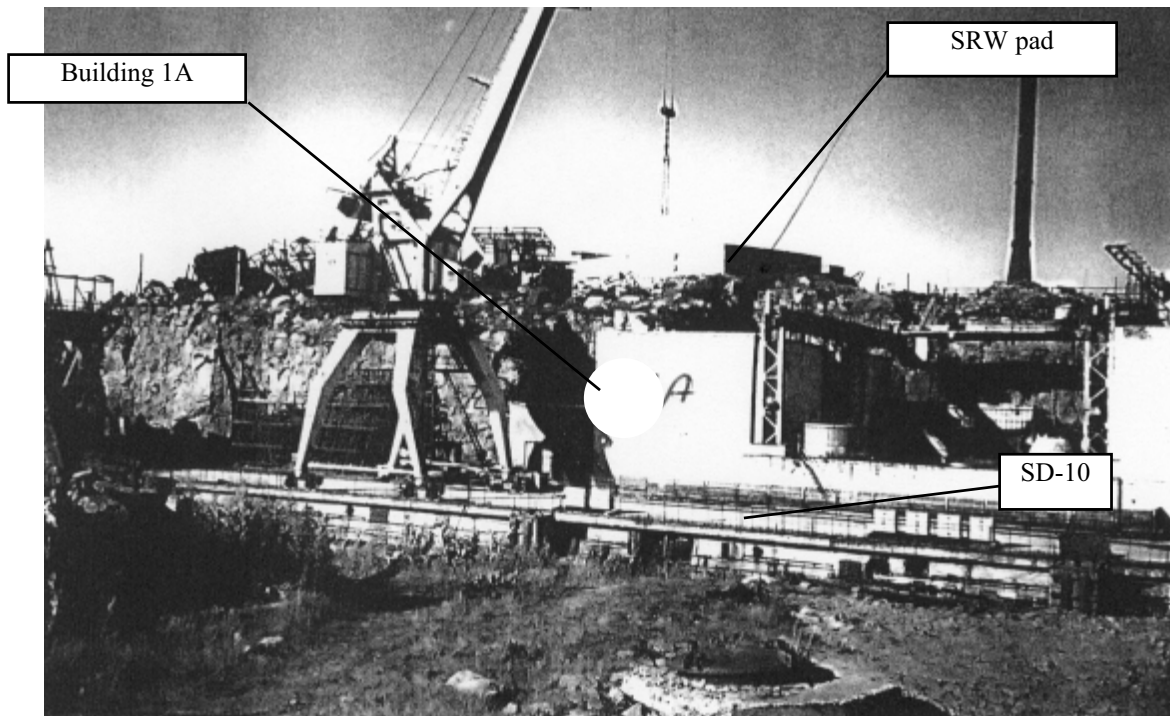


Fig. 5. View of the SD-10 dock, Building 1A and SRW pad

Strontium-90 is a prevailing radionuclide in LRW within most of the tanks. Volumetric activity of cesium-137 in different tanks varies from 2 to 10% of its total activity. The existing system for collection and storage of LRW does not comply with requirements set by current regulatory documents, i.e. NRB-99, OSPORB-99, specifically. Elevated gamma radiation levels (up to 300 $\mu\text{Sv/h}$) are observed on the territory near the tanks containing LRW.

At present major portion of LRW has been processed in the “Potok” facility. In greater detail information relevant to LRW is provided in the paper by Mr. A.P. Vasiliev.

The radiation situation for the most part (80%) of the CTB territory in Gremikha is assessed as a normal one (ionizing radiation is close to the background values). The area of the open-air pad for SRW storage, as well as the area between LRW storage facility and SD-10 dry dock should be referred to unsafe areas. Hence, gamma radiation levels at a distance of 40-60 m from the SRW pad make up from 10 to 60 $\mu\text{Sv/h}$, whereas in the vicinity of LRW tanks – up to 260 $\mu\text{Sv/h}$. Contamination of the soil upper level in the points of maximum gamma radiation amounts to about 10^6 Bq/kg (in terms of cesium-137) and about 4×10^5 Bq/kg (in terms of strontium-90).

According to the Russian State Concept of Comprehensive NS Dismantling (Minatom of Russia, 2001) the coastal technical base in Gremikha will not be used in future in line with its direct (design) purpose, being subject to the environmental remediation.

In the course of the base operation the protective barriers of the facilities have degraded, some of them partially (others utterly) lost their ability to perform the assigned functions, giving rise to sources of the environment radioactive contamination, which shall be localized and eliminated. Solution of the Gremikha base remediation problem is aggravated by the fact that the actual state of its infrastructure elements does not meet today's requirements specified in the regulatory documents in reference to functioning of the facilities, while conduct of nuclear and radiation-hazardous remediation necessitates the development and introduction of engineering approaches and technologies aimed at the infrastructure improvement for assuring nuclear and radiation safety. Allowance should be made for specific features of the Gremikha base related to its remoteness from main transport routes and industrial centers of the country, as well as for the fact that it is only at this base that infrastructure elements are available, which are necessary for unloading, handling and storing of SRP of LMC reactors.

Moreover, it should be noted that further operation of the Gremikha base should be limited to SNF unloading from the Alpha-class NS reactors and remediation efforts. Renovation at the base should be performed only in the scope required for completion of its functioning. By and large, it is assumed that accomplishment of the entire complex of work pertinent to the base remediation is to be completed by 2010.

The problem of the Gremikha base remediation will consist generally in coping with the following specific tasks:

- management of SNF (from the PWR and LMC reactors);
- management of RW (SRW and LRW);
- environmental remediation of buildings and structures;
- environmental remediation of the base territory.

Facilities providing normal working and life conditions for the personnel assuring the appropriate safety, as well as energy and technical support of the remediation are among top-priority elements in the re-establishment of the infrastructure operation.

Environmental remediation of the base shall be accomplished in line with the design documentation developed, coordinated and approved in compliance with the order established in Russia.

Detailed engineering and radiation survey of the site with ascertaining quantitative and radiation characteristics of the storage facilities, buildings, containers, as well as the technical state of the infrastructure equipment and auxiliary elements, is necessary for obtaining the initial data required for comparing options and subsequent development of design documentation for the option chosen.

Design approaches to radio nuclides isolation and prevention of their migration to the environment from the open pad for SRW storage, as well as to procedures for handling the canisters and casks with SNF, shall be developed and implemented as priority measures.

It is appropriate to consider the option of using some tanks available for receipt and temporary storage of newly generated LRW (as a result of decontamination, from special laundry and decontamination center) after preliminary repair and recovery (fitting out with isolation valves, monitoring systems, devices for LRW pumping) in support of the base remediation.

Bearing in mind that regional SRW repository has not been constructed yet, it is advisable to consider the option of SRW temporary isolation within the existing structures of the base, i.e. buildings 1, 19, etc.

In our opinion, it seems reasonable to prepare and implement a single comprehensive project of Gremikha CTB remediation, consisting of the following rather stand-alone components (projects):

1. Complex engineering and radiation survey of the buildings, structures, territory and water area of the base, that will permit obtaining the actual initial data required for development of the feasibility study of different options and specific programs in each area.

2. Preparation of the base infrastructure for remediation activities, including conditions for safe work of the personnel at elevated ionizing radiation levels and acceptable sanitary and life conditions.

3. Handling of spent nuclear fuel from water-cooled reactors stored at the coastal base in Gremikha. Inventory taking of the cask contents and canisters with SNF is to be performed, feasibility studies are to be made for options of further SNF handling, design documentation on the option chosen is to be developed, the necessary rigs are to be manufactured, the relevant handling operations flowsheet is to be prepared and SNF is to be removed from the territory for reprocessing.

4. Handling of spent nuclear fuel from the Alpha-class NS reactors. The stage of feasibility study (FS) shall precede the direct implementation of the project, which will permit choosing the optimal option of the spent reactor cores (SRC) handling operations flowsheet. Specific feature of the project consists in the fact that already today, without waiting for FS results, some specific tasks (projects) can be formulated and their implementation can be started without delay. They are:

- bringing SRP storage facilities (Building 1B) in compliance with the requirements stipulated by currently effective standards and regulations;
- development and manufacture of a shipping cask for SRC transportation by sea and by railway;
- development of design documentation and additional equipment for Mayak plant infrastructure providing the capabilities for reprocessing SNF from LMC reactors;
- substantiation and choice of the optimal option of the handling operations flowsheet for disassembling SRC and for handling the SRW produced.

5. Handling of radioactive waste and environmental remediation of the buildings, structures and territory. The project can also be subdivided into the following components:

- liquidation of the open pad for temporary storage of SNF and SRW;
- inventory taking, conditioning and further management of SRW;
- remediation of the buildings and structures;
- remediation of the site territory.

Proposals on the projects mentioned above are presented in greater detail in the papers by V.A. Shishkin, V.A. Mazokin, A.P. Vasiliev).

According to our estimates the major efforts aimed at the site remediation can be implemented in the period of 2004-2010. Urgency of remediation activities in Gremikha shall be pointed out, being dictated by the following factors:

- the scope and cost of the work to be carried out, as well as its complexity and hazards, increase as the buildings and structures become dilapidated, SNF and protective barriers degrade.
- the requirements for safety assurance during the activities, for the processes and equipment used grow more stringent with time. Delay in the activities onset will add to the risks and costs of activities aimed at the remediation of the radiation-hazardous site.

Proposals pertinent to the general work schedule are provided in Tables 1 and 2.

Cost estimates by phases and by project as a whole are made by expert judgments. Design cost of the activities will be defined during feasibility study of the approved option of the remediation for each phase.

Schematic diagram of organizational management of the project aimed at remediation of the coastal center for temporary storage of SNF and RW in Gremikha settlement is shown in Fig. 6.

Executors of dismantling and remediation operations will be identified on a competitive basis after the development and approval of remediation projects by specific components of the general task (see Table 1).

Table 1

Phase	Activities	Implementation period (year)				
		2004	2005	2006	2007	2008-2010
1	Comprehensive engineering and radiation survey of the buildings, structures, territory and water area of the site					
2	Preparation of the site infrastructure for remediation activities					
3	Handling of SNF from NS water-cooled reactors					
4	Handling of SNF from the Alpha-class NS reactors					
5	Handling of radioactive waste					

Table 2

Phase	Activities	Approximate costs, \$ million
1	Comprehensive engineering and radiation survey of the buildings, structures, territory and water area of the object	3.8
2	Preparation of the object infrastructure for remediation activities	5.0
	Handling of SNF from NS water-cooled and water-moderated reactors	61.2
	Handling of SNF from the “Alpha” class NS reactors	36.0
	Handling of radioactive waste	196.0
	TOTAL	302.0

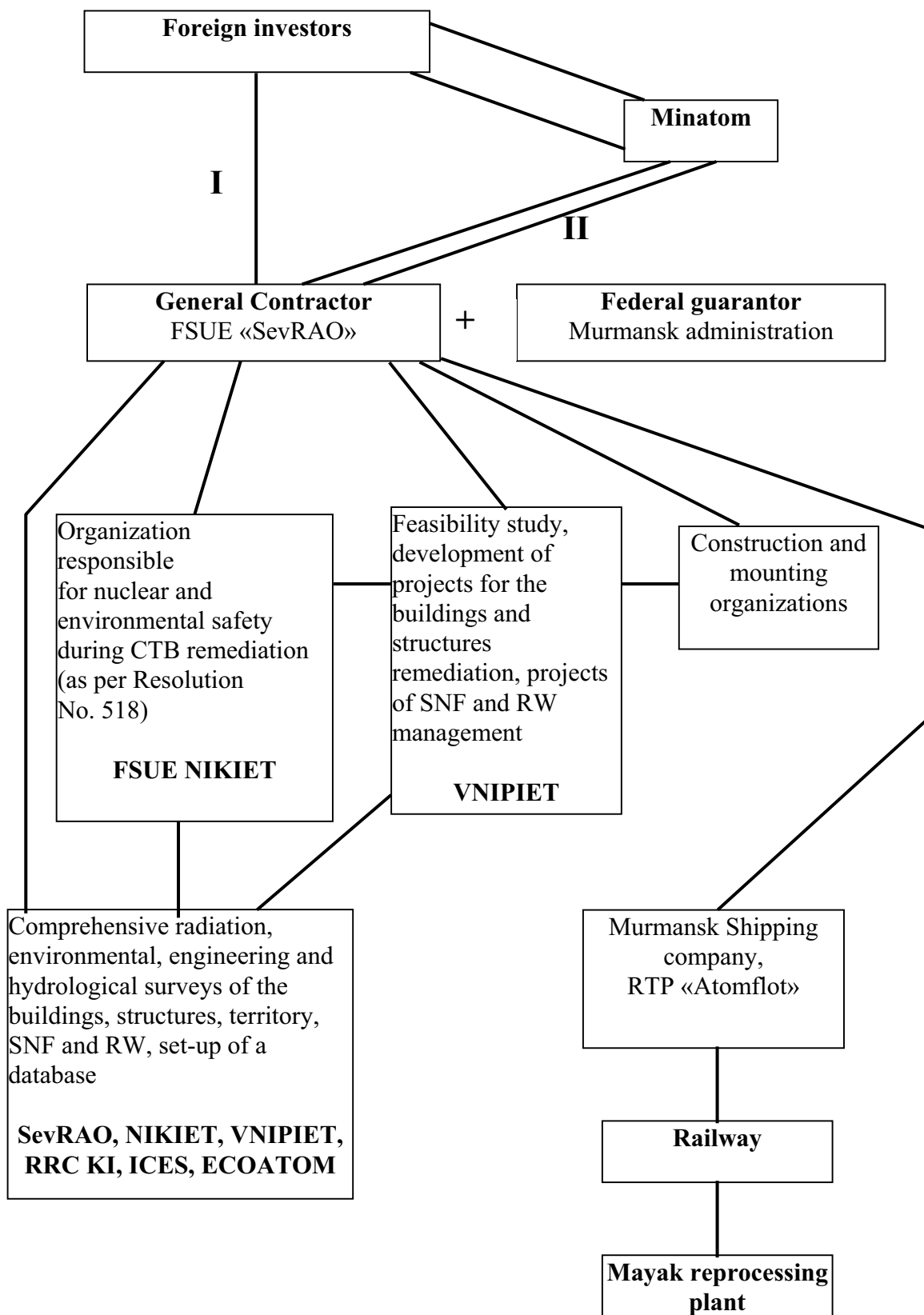


Fig. 6. Schematic diagram of organizational management of activities aimed at remediation of SNF and RW temporary storage center in Gremikha