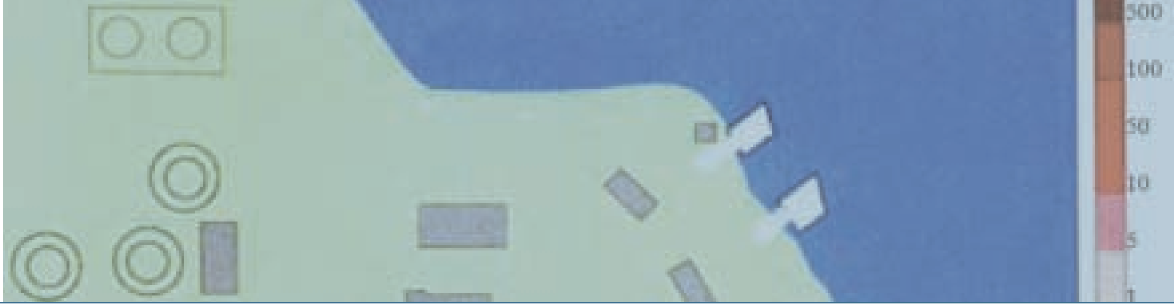

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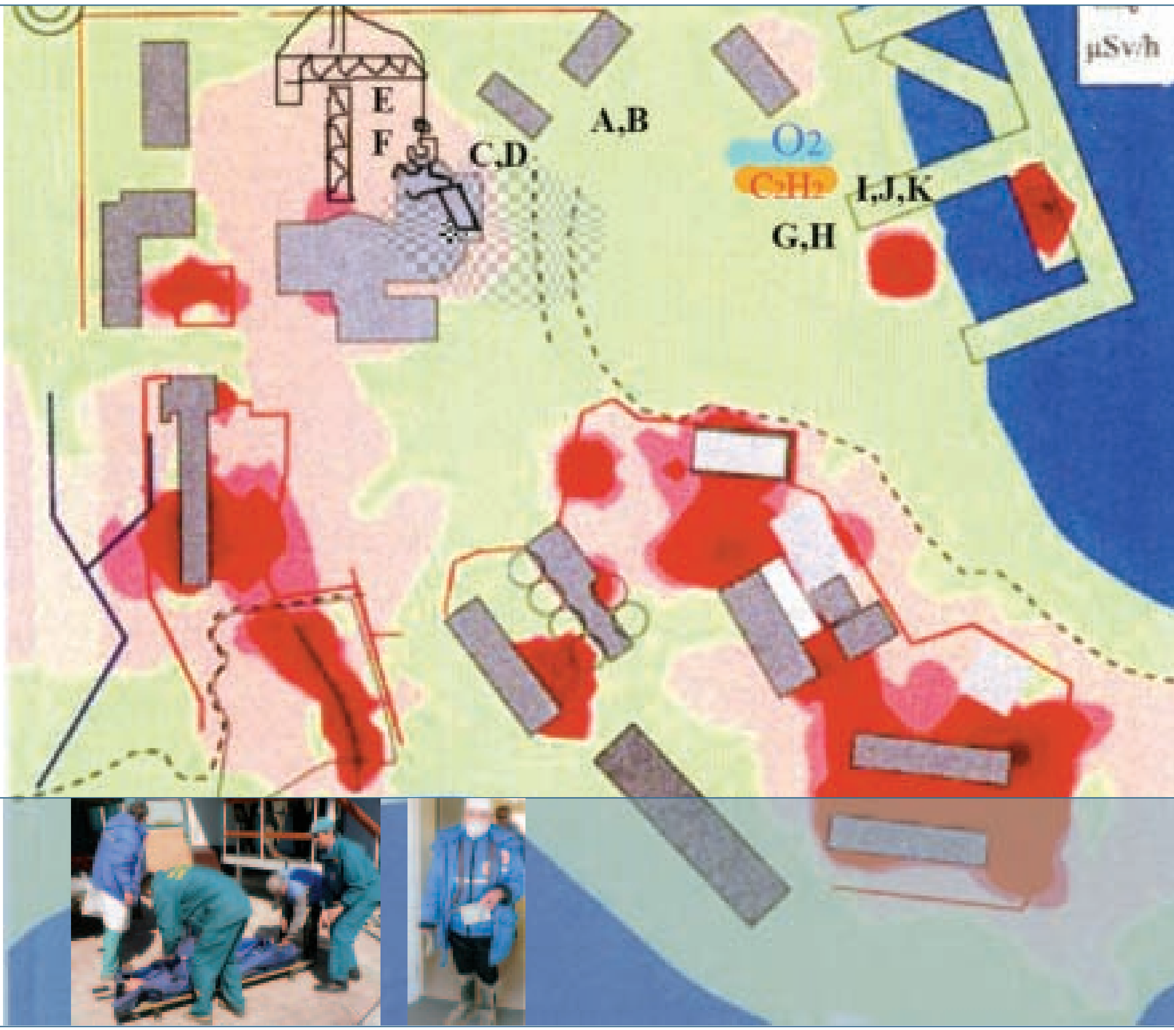

Radiological regulatory improvements related to the remediation of the nuclear legacy sites in Northwest Russia

Final Report of work completed by FMBA and NRPA to the end of 2006

Statens strålevern
Norwegian Radiation Protection Authority

Reference:
Sneve M K, Kiselev M, Kochetkov O. Radiological regulatory improvements related to the remediation of the nuclear legacy sites in Northwest Russia. StrålevernRapport 2007:11. Østerås: Norwegian Radiation Protection Authority 2007.

Key words:
Site of temporary storage, spent nuclear fuel, radioactive waste, sanitary shielding zone, surveillance area, radiation-hygienic monitoring, radionuclides, personal radiation monitoring, personal protective equipment, effective exposure doses, emergency preparedness and response.

Abstract:
This report describes work carried in 2006 under the NRPA – Federal Medical-Biological Agency regulatory support program. It focuses on development of improved regulatory documents and supervision of remediation activities due to be carried out at Andreeva Bay and Gremikha in Northwest Russia. The work program for 2007 is also introduced.

Referanse:
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Emneord:
Mellomlagringssted, brukt kjernebrensel, radioaktivt avfall, kontrollert og beskyttelses soner, radiologisk overvåking, radionuklider, strålevern av personale, beskyttelsesutstyr, effektive stråledoser, beredskap.

Resymé:
Rapporten beskriver arbeid som ble gjennomført i 2006 som en del av Strålevernets og FMBAs myndighetssamarbeid. Arbeidet fokuserer på utvikling av normative dokumenter og tilsynsprosedyrer under opprydning av anleggene i Andreeva og Gremikha i Nordvest Russland. Rapporten beskriver også arbeidsprogrammet for 2007.

Head of project: Malgorzata K. Sneve
Approved:

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Per Strand, Director, Department for Emergency Preparedness and Environmental Radioactivity

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Radiological regulatory improvements related to the remediation of the nuclear legacy sites in Northwest Russia

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Østerås, 2007

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Executive Summary

By the Russian Federation (RF) Government Order No. 220-p of 09 February 2000, the Federal State Unitary Enterprise (FSUE) SevRAO was established with the purpose to conduct work on nuclear legacy sites in the Northwest Russia. This includes management of the spent nuclear fuel and radioactive waste accumulated in the course of Naval activities and that generated as a result of dismantling of nuclear submarines and surface ships with nuclear powered installations. The scope also includes work on environmental rehabilitation of radiation-hazardous objects in the above region.

To increase the efficiency of the aforementioned operations the assistance rendered within international cooperation frameworks is especially important. The Norwegian Government, through a Plan of Action implemented by the Ministry of Foreign Affairs (MFA) is promoting improvements in radiation protection and nuclear safety in the Northwest region of Russia. The strategy of the MFA of Norway includes not only support to industrial projects but also support to RF regulatory bodies in order to increase the efficiency of the work on implementation of the industrial projects in compliance with RF law. MFA also assists with consideration of international recommendations on practical methods of operation as relevant in the RF conditions. Accordingly, MFA, through the Norwegian Radiation Protection Authority (NRPA) has set up a program of cooperation with the Federal Medical-Biological Agency (FMBA of Russia). The overall objective of the cooperation is to promote effective and efficient regulatory supervision of the activity carried out at SevRAO facilities within the scope of responsibilities of FMBA of Russia. The cooperation is being implemented in three directions related to sanitary-epidemiological supervision: radiation safety of personnel, radiation safety of the public, and regulatory aspects of emergency preparedness and response. Accordingly three projects were developed and set up for implementation in 2005/06.

Project 1. Development of regulatory guidance for improvement of radiation protection in non-standard situations using radiological risk assessment. This project centers on the development of criteria and regulatory guidance for improvement of radiation working conditions for personnel at SevRAO facilities, including at Andreeva Bay.

Project 2. Development of criteria and instructions for rehabilitation of radioactively contaminated territory and de-licensing of nuclear enterprises. This project centers on the development of the norms and standards for the Regulatory Guidance during rehabilitation of the territory of the sites of temporary storage (STS) at Andreeva Bay and Gremikha. The project covers the course of principal operations on removal of spent nuclear fuel (SNF) and radioactive waste (RW) and upon its completion.

Project 3. Improvement of medical and radiological aspects of emergency preparedness and response at SevRAO facilities. This project centers on the development of the regulatory aspects in planning of medical-sanitary measures in the emergency situations of radiological character at SevRAO facilities.

The first task carried out was an assessment of radiological threats currently existing and those that could occur during the work expected to be carried out. An analysis was made to identify priority issues from the point of view of FMBA of Russia‘s regulatory perspectives. This included a compilation of the necessary developments of regulatory documents required for effective supervision of the planned remediation work.

As part of this work, independent measurements were made of the radiation-hygienic situation at the objects of industrial sites, in sanitary shielding zone (SSZ) and surveillance area (SA) of STS of SNF and RW at Branch No. 1 (Andreeva Bay) and Branch No.2 (Gremikha). Experts from State Research Center Institute of Biophysics (SRC IBPh) made a series of investigation visits to SevRAO facilities. They also organized and carried out training in rendering complete medical aid during emergency situations at the industrial site of Branch No.1 FSUE “SevRAO”.

As a result of the work under these three projects, regulatory guidance was developed and drawn up under the title “Hygienic requirements for personnel and public radiation safety guaranteeing at the stage of designing the work with SNF and RW at FSUE SevRAO Branch No. 1.

In order to get a better knowledge of other national practices in the sphere of regulation of radiation safety, study visits were arranged by the NRPA for specialists from FMBA of Russia and technical support organizations to meet their counterparts in the UK and USA. Financial support for the visits was provided under the NATO program “Exchange of experience in the sphere of regulation to reduce the risks associated with operation of nuclear facilities”. These were designed to provide further improvement of FMBA of Russia’s regulatory functions at the SevRAO enterprise and following implementation of the 2 + 2 approach, in which Russian operators and regulators carry out the work jointly with western counterpart organizations.

Following the work in 2006, it was decided to fulfill a further series of projects dedicated to the most urgent issues of radiation safety control at SevRAO. These focus on issues relevant to the next stage of SevRAO work, i.e. implementation rather than design. Projects topics for work in 2007 include personnel radiation safety during SNF and RW management including:

- management of waste containing radionuclides with a level of activity lower than low level radioactive waste (LLW);
- development of the criteria for monitoring and control of the radio-ecological situation during STS rehabilitation activities; and
- development of operating and medical criteria for implementation of an emergency action plan and application of emergency protective measures at SevRAO enterprises.

In addition, a public information brochure is being prepared, describing Russian-Norwegian cooperation in the sphere of radiation safety in Northwest Russia.

1 Introduction

1.1 History of the problem of radiation safety assuranse in Northwest Russia

In the early 1960s, a broad program of ocean-going nuclear ship-building was started in the USSR. A total of 262 ships and vessels with nuclear powered installations, including 248 nuclear submarines (NS), five surface ships and one nuclear lighter, were built. Over 450 nuclear reactors, in total, were installed onboard the ships, their total power rate being compatible with the installed power of all the nuclear power plants operating in the former USSR (Atomic Energy, 2006).

Supporting infrastructure was built to support the nuclear fleet: shore technical bases (sites of temporary storage) - two of them in the Northwest region, and over 30 technological support vessels (Antipov et al, 2006a and b). In the late 1980's and during 1990's, a full-scale decommissioning of nuclear vessels was started, mainly due to the fact that specified service life of the ships and vessels had been exhausted and the obligations under the Treaty on Limitation of Strategic Offensive Arms signed between Russian Federation and USA, had to be met. At the present time, almost 200 nuclear submarines have been decommissioned and over 89 reactor units are being stored at the sites of temporary storage (Atomic Energy, 2006a).

By 2005, 42 submarines (30 of them with reactors still containing nuclear fuel) and 26 technological support ships were gathered in the water area of ship-repair plants and Navy bases awaiting dismantling. At the present, on-shore storage facilities hold about $1{,}5\text{-}10^{18}$ Bq of spent nuclear fuel, 18 thousand m^3 of solid (total activity $-1{,}5\text{-}10^{14}$ Bq) and 700 m^3 of liquid radioactive waste (total activity $-2{,}5\text{-}10^{11}$ Bq) (S.V. Antipov et al. 2006a).

Formerly effective infrastructure supporting transportation, storage and treatment of spent nuclear fuel at the enterprises of Rossudostroenie, the Navy and Rosatom was predominantly orientated to wards construction, repair and operation of nuclear submarines. The existing infrastructure proved to be insufficient to ensure timely and environmentally safe decommissioning and dismantling activities. The above problem in combination with national economical reforms led to a rapid growth of decommissioned submarines and other hazardous objects gathered at STS.

In connection to this, the assistance provided within the international cooperation framework is especially important. So, in particular the Norwegian Government, through a Plan of Action implemented by the Ministry of Foreign Affairs (MFA) is promoting improvements in radiation protection and nuclear safety in Northwest Russia. The initial stage of the Plan has been fulfilled through work carried out at radiation-hazardous facilities of Northwest Russia.

Today, we can name the following most important projects carried out within the framework of bilateral international agreements:

- renewal of infrastructure at the former shore technical base in Andreeva Bay (Norway);
- increase of production capacities of transport-technological system for spent nuclear fuel unloading and management (Norway, USA);
- dismantling of multi-purposed nuclear submarines (Norway, UK, Canada);
- development of innovative technologies aimed to improve spent nuclear fuel storage, treatment of solid waste, development of technical facilities for radiological environmental monitoring (Norway, U.K.);
- improvement of industrial infrastructure at ship-repair plant for dismantling of strategic nuclear submarines (USA);
- building of on-shore site facility for storage of reactor compartments in Saida Bay (Germany);
- search for optimal ways of safe management of spent nuclear fuel and solid radioactive waste (UK, Sweden).

The complex dismantling of nuclear submarines is one of the key objectives in the program of the Global Partnership against the Spread of Weapons and Materials of Mass Destruction. At the present time, the most important issue in cooperative work is the legal support and accompanying legal documentation to the above program. To solve this problem, Russia and 10 other countries, including Norway, the European Union and Euratom signed in Stockholm an "Agreement on the Multilateral Nuclear-Ecological Program in the Russian Federation" (MNEPR, 2003).

1.2 Solving the problem of radiation safety assurance in Northwest Russia

Already, the end goals and technological schemes of complex dismantling of NS and remediation of territories have been identified, developed and coordinated (Antipov et al, 2006c) taking account of the following principles and agreements in the sphere of nuclear power use (Antipov et al, 2006a):

- strict nuclear, radiation and environmental safety guaranties based on existing laws;
- arrangement of a closed cycle in handling of spent nuclear fuel and conditions for possible temporary storage of SNF in dry containers till the time of removal or treatment,
- postponed dismantling of the radiation-hazardous equipment forming part of ships with nuclear installations
- postponed burial of the equipment not subject to dismantling after long-term cooling as part of NS reactor compartments and reactor rooms, and surface ships with nuclear installations specially prepared for long time storage;
- maximum use of the vacant space in reactor compartments (rooms) for placement, in accordance with specially developed normative documents, of the solid waste obtained during unloading of spent nuclear fuel from reactors or during repair, modernization of the nuclear installations being in operator's temporary storage;
- all operators must follow the principles of non-proliferation of nuclear materials and technology;
- development of a governmental legal structure for distribution of duties among the state organizations responsible for state management and safety regulation at the state level;
- the information on the work performed and future work should be open and available to the residents in the regions.

The end goals of the activity on NS complex dismantling and rehabilitation of territories are, as follows:

- complete dismantling of decom-missioned submarines, surface vessels with nuclear powered installations and technological support ships
- the removal and disposal of spent nuclear fuel unloaded from the reactors;
- resulting waste must be brought to a suitable form for final reliable and safe isolation from the environment;
- buildings, structures and territories of technical service bases must be brought to ecologically safe condition, while access to and use of the facilities must be restricted.

In such conditions, the principal factor determining priorities in the work performance is the safety factor. Keeping in mind that spent nuclear fuel is the major radioactive source and term, the facilities holding large amounts of SNF are the most hazardous ones. In the comparative analysis of the level of safety at the facilities it is noted that, taking account of their hazardous radiation potentials, the base at Andreeva Bay is the most hazardous site. The Lepse floating spent nuclear fuel and radioactive waste (SNF and RW) storage ship is the second, and the base in Gremikha is the third. The vessels for nuclear-technological support and surface vessels with nuclear powered installations occupy the fourth and fifth places, respectively. (Antipov et al, 2006a)

To solve the above problems in Northwest Russia, the enterprise FSUE SevRAO was established to unite under its management the most nuclear-hazardous and radiation-hazardous facilities. This included a series of the industrial sites (Andreeva Bay, Gremikha, Saida Bay), named as the sites of temporary storage of SNF and RW. The primary function of these sites consists in safe storage of spent nuclear fuel, the preparation of RW for its removal from the territories and subsequent rehabilitation of buildings, structures and territories (Panteleev et al, 2001).

The following aspects were taken into consideration for environmental rehabilitation of FSUE SevRAO facilities, bearing in mind the results of preliminary consultations with the public in Murmansk, Severodvinsk and Moscow in November and December 2004:

- STS of SNF and RW at Andreeva Bay are not intended for use in the future by their original purpose. Only the operations related to preparation and removal of SNF, solid and liquid radioactive waste from the territory, rehabilitation (liquidation or conser-vation) of buildings and structures, and remediation (decontamination) of the territory will be performed;
- at the STS of SNF and RW in Gremikha, it is necessary to perform, besides environmental rehabilitation operations, a remediation and renewal of the infrastructure required for unloading and subsequent temporary storage of the reactor cores removed from submarines of 705 and 705K designs (liquid-metal cooled reactors);
- industrial sites for long-term storage of reactor compartments and dismantled NS was arranged at the STS of SNF and RW in Saida Bay.

However, the work on rehabilitation of the STS of SNF and RW of SevRAO enterprise is complicated due to the fact that in the course of operation significant deviations from the design were allowed in the technological processes related to SNF and RW management at the above STS. Abnormal and emergency situations at the sites aggravated the aforementioned problem. Taking into account the lack of sufficient information available on SNF conditions and the state of nuclear and the radiation safety guaranteeing system, we can note that conditions at the enterprise cause uncertainty in the work and the work itself is to be carried out in non-standard radiological conditions.

According to internationally accepted practice in solving the problem of radiation safety guaranteeing, under such conditions, the entire rehabilitation process is to be subdivided into technologically effective stages where each next step is a result of a previous one. The prime purpose is to lower the risk gradually, as an approach to the problem such as this, even if in some particular situation risks might increase.

Considering the above approach in dealing with the problems of rehabilitation of the STS's of SNF and RW at SevRAO enterprise, we can specify a series of steps where prime priority is given to renewal of supply lines and development of infrastructure for safe work of personnel. Measures are taken to remove the environmental contamination sources and minimize the risk associated with dismantling of facilities and environmental rehabilitation (Vasiliev et al, 2006; Pavlov, 2006).

1.3 Regulation in non-standard conditions

The existing extreme radiological conditions at the STS's of SNF and RW at Andreeva Bay and Gremikha create difficulties for regulatory supervision of the activity at the above facilities. The existing norms and rules were developed for normal conditions of SNF and RW management. However, the situation at the facilities is such that the existing regulatory documents cannot be applied in full, and operations on rehabilitation of territories present difficulties. It is necessary to improve the regulatory process including development of specific norms and rules taking account of the current non-typical situation.

The strategy of the Norwegian Ministry of Foreign Affairs includes both support to industrial projects and to Russian regulatory bodies with the aim to enhance the effective implementation of the industrial projects in compliance with the Russian Federation law. This was done taking account of international recommendations on practical work methods acceptable in the RF conditions. The Norwegian Ministry of Foreign Affairs with assistance from the Norwegian Radiation Protection Authority has set up a program of cooperation with the Federal Medical-Biological Agency.

The overall objective of cooperation is to promote effective and efficient regulatory supervision by FMBA of Russia of the activities at SevRAO facilities. To achieve this overall objective the following cooperative steps are planned:

- Regulatory supervision of radiation safety of personnel and public;
- Environmental monitoring on-site and off-site to guarantee the personnel and public health safety;
- Radiation-hygienic monitoring;
- Cooperation with local organizations;
- Identification of risk-reducing preventive measures;
- Medical service in extreme and emergency situations; and
- Research work oriented to study the conditions associated with non-standard situations, assessments of their impact to public health and development of recommendations to reduce such impact, as well as development of the requirements for rehabilitated territories.

The cooperation has been implemented during 2005/06 through three projects addressing regulatory supervision issues in the following areas:

1. Radiation exposure of personnel;
2. Radiation exposure of public; and
3. Emergency preparedness and response.

1.4 Radiological threats

To identify the regulatory priorities which are to be set for the sake of effective performance of the work in compliance with the law. An assessment of the radiological threats currently existing and those that could occur through future operations at SevRAO enterprise, was also made. As a result, a review was prepared and analysis of the current situation was made, from the perspective of FMBA of Russia's regulatory responsibilities. This included special focus on identifying requirements for additional regulatory supervision documents.

The following issues were identified, in approximate order of their priority.

At the industrial sites:

1. At both industrial STS sites there are storage areas containing highly active materials. Dose rates in parts of the territory around the facilities exceed 1 mSv/h, and the SNF storage facilities themselves are particularly hazardous;
2. The locations for solid radioactive waste storage where an equivalent dose rate is in the range 3 - 8 mSv/h;
3. Partially below ground nuclear-technology facilities can cause contamination of the water of the coastal strip.

In the territories adjacent to the industrial sites:

1. The territory and water near the STS at Andreeva Bay are contaminated by ^{90}Sr, ^{137}Cs and ^{60}Co from the local sources of radiactive contamination. However, in samples of soil taken in Zaozersk concentrations of ^{137}Cs were not higher than 50 Bq/kg, much lower than at industrial of the site and decreasing with the distance from the site. The local concentration of ^{137}Cs in soil in Gremikha village, reaches 2400 Bq/kg.
2. The concentration of ^{137}Cs in bottom sediments of the coastal strip in the STS areas of Andreeva Bay varies from <20 to 600 Bq/kg depending on the distance from the former brook outflow. The content of ^{137}Cs in the brook also varies from less than <20 to 500 Bq/l near Building 5. Local contamination of seaweeds and periphyton in the area of vessel anchorage is more than a factor of ten higher (>2500-4600 Bq/kg) than in seaweeds collected at

other STS sectors, while contamination of bottom sediments differs only by three times (600 Bq/kg in the area of anchorage). Similar levels of contamination are observed near Gremikha village.

3. Average annual concentrations of ^{90}Sr and ^{137}Cs in the atmosphere at Andreeva Bay are ten times lower than the acceptable levels, however, they are much higher than background levels of the Murmansk region.
4. Activity concentrations of ^{137}Cs in sea water at Andreeva Bay are close to background levels. Nevertheless, traces of radioactive contamination of sea water in the area of berth in Andreeva bay are noted. Concentrations of ^{137}Cs in the sea water at STS in Gremikha village are approximately double that of the values for the open sea.
5. Realistic assessment of public radiation doses on the basis of available data is difficult because many parameters of radiation-hygienic situations have not been established yet. In particular, reliable data on the level of radionuclides in drinking water and foods, including local food (venison, fish and wild plants) are lacking.
6. Data on the existence of radionuclides in the soil and their migration in the environment of Andreeva Bay and Gremikha are limited.

Threats associated with medical consequences of nuclear and radiological accidents:

In parallel to the existing sources of hazard, potential sources were taken into consideration as well, i.e. those which can be described as nuclear and radiological accidents with significant release of radionuclides into the environment. The following threats are realistic in such case:

- occurrence of determined exposure effects;
- occurrence of delayed after-effects;
- traumatic injuries.

Threats are aggravated by the drawbacks in organization of the first aid service and by poor condition of the facilities, making their subsequent disposal very challenging, due to semi-submerged position, non-transportability, etc.

1.5 Improvement of FMBA of Russia's regulatory functions in supervision of activities at SevRAO facilities

To minimize the threats described in the section above and to improve the FMBA of Russia's regulatory functions it was recognized as necessary to develop corresponding normative-legal documents. For this purpose, the NRPA and the FMBA of Russia agreed to implement the following three Projects:

Project 1. Development of a regulatory guidance for improvement of radiological protection in non-standard situations using radiological risk assessment

The objective of the project was to develop criteria and regulatory guidance to improve the radiological conditions for personnel working at SevRAO facilities at Andreeva Bay.

The tasks and related deliverables included the following:

- Preparation of a list and substantiation of status of technological process operations in the course of SNF and RW management at Andreeva Bay.
- Development of guidance on hygienic norms for exposure doses to personnel during routine, abnormal and emergency/ remediation operations in management of spent nuclear fuel and radioactive waste. This included taking account of the existing general requirements and site specific working and radiation conditions at Andreeva Bay.
- Guidance on application of indi-vidual and collective means of protection of personnel at SevRAO facilities.

- Final Guidance document “Hygienic rules for personnel and public radiation safety guaranteeing in designing the work process on SNF and RW management at FSUE SevRAO Branch No. 1” (R-GTP SevRAO-07) prepared basing on above tasks’ results and analysis of the findings obtained in management of spent nuclear fuel and radioactive waste.

Project 2. Development of criteria and guidance for rehabilitation of contaminated territory and de-licensing of nuclear enterprises.

The primary objective of the project was to set the norms and standards, as well as the regulatory Guidance in support of the above, to be used during and after rehabilitation activities at the STS's territory at Andreeva Bay and Gremikha. These standards were to be applied in the course of main operations on SNF removal and further management.

Tasks and related deliverables of the project include:

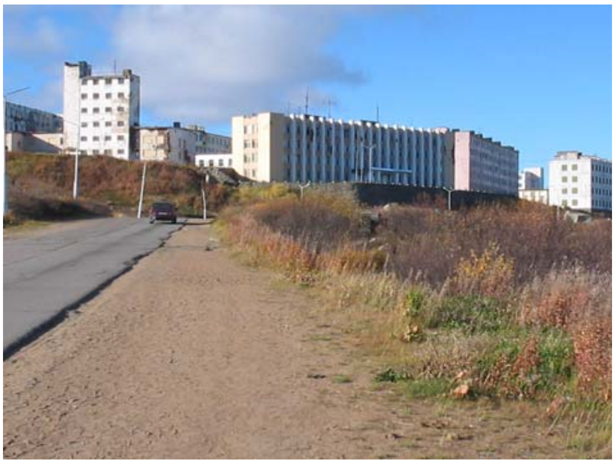
- Review and comparative study of independent data on radiological situation and radiation control on-site and off-site;
- Reports on the ‘Methods for conducting radiological assessments during rehabilitation activities” and on “Methods for organization of radiation control”.
- Development of radiation criteria and norms providing socially acceptable guarantees of public radiation safety during and after rehabilitation of the facility.

Project 3. Improvement of medical and radiological emergency and response management at SevRAO facilities

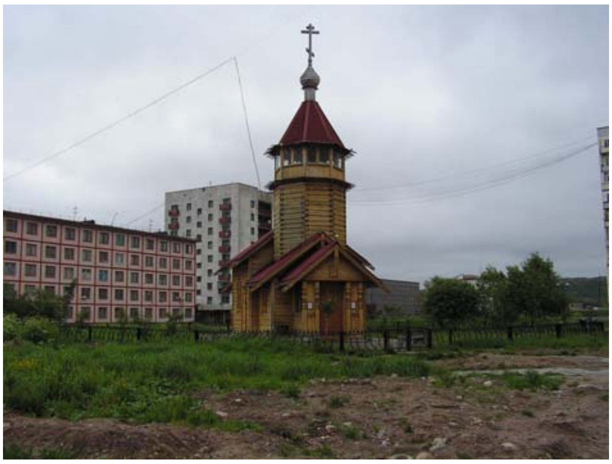
The primary objective of this project was to provide regulatory Guidance for planning the work with regards to medical and radiological emergency and response management at SevRAO facilities.

Tasks and related deliverables include development of:

- Review of international and nationally-accepted methods;
- Transparent explanation of organizational responsibilities with regards to emergency preparedness, for operators and regulators;
- Regulatory basis for requirements to emergency preparedness;
- Guidance on medical and sanitary plan in emergency situations;
- Training in the sphere of radiation-medical response to emergency situations.

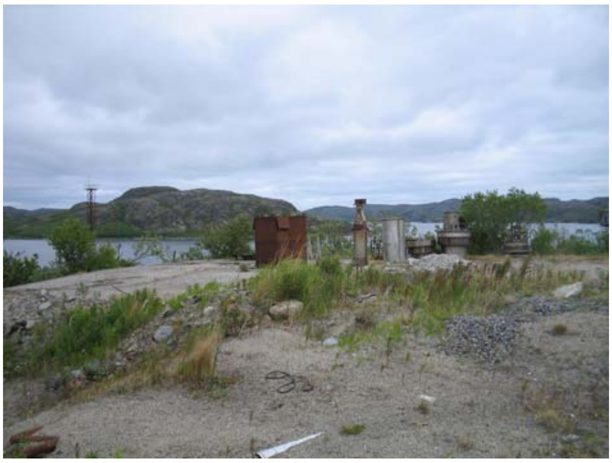


Supervised Area (SA) of SevRAO facility no. 2 at Gremikha – Ostrovnoy. The nearest city in 1 km from the site

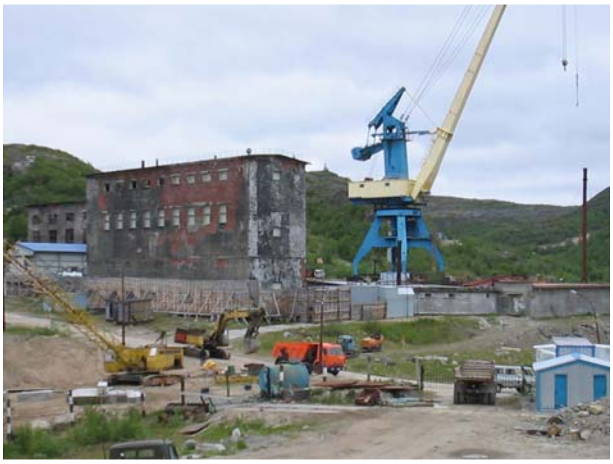


Zaozersk, the nearest town to SevRAO facility no. 1 at Andreeva bay

SevRAO facility nr 1 in Andreeva Bay - view of two tanks with SNF and building nr 5

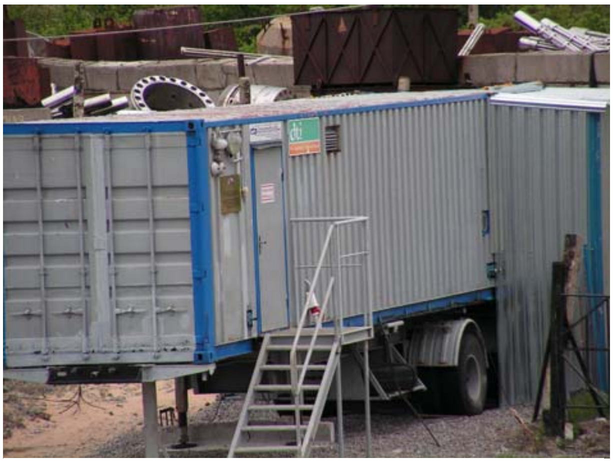


SevRAO facility nr 2 at Gremikha – view of the radioactive waste and SNF



General view of SevRAO facility no. 1 at Andreeva bay.

View of SevRAO facility no. 1 at Andreeva Bay: Health Protection Zone; the area of radiation hazard begins at the left (decontamination facilities (sanitary passes/check points)).



Mobile decontamination facility (sanitary pass/check point) on the industrial site SevRAO facility no. 1 at Andreeva Bay.

New check point at the SevRAO facility no. 1 Andreeva Bay.

2 Summary of the Work Fulfilled under Projects in 2005 - 2006

2.1 Project 1. Development of regulatory guidance for improvement of radiological protection in non-standard situations using radiological risk assessment

2.1.1 Measurement of radiation parameters in the industrial buildings and rooms at STS of SNF and RW at Andreeva Bay and development of normative-methodical documents to ensure efficient supervision of radiation safety guaranteeing

Radiation parameters in the rooms at the STS of SNF and RW at Andreeva Bay.

1. The obtained values of an Effective Dose Rate (EDR) in the production rooms of Building No. 5 and Block Dry Storage showed that the effective dose rates of external gamma-radiation are ten and hundred times, respectively, higher than those in the production rooms at currently operating enterprises of nuclear industry and power engineering in Russia.

The permissible working time calculated based on the conservative approach (subject to full-shift working time if no measures of protection are taken) for the personnel working in production rooms of Building No.5 and Block Dry Storage (BDS), is strictly limited. So, for example, permissible working time in the transport corridor of Building No. 5 should not exceed 104 working shifts at the average EDR levels and 52 working shifts at the maximum EDR levels, before reaching the annual exposure dose of 50 mSv for personnel. Permissible working time for the personnel operating in the room of Building No.5 and in BDS rooms is even more limited.

The factor limiting and determining the permissible working time for personnel in the rooms of Building No.5 and Block Dry Storage is the effective dose. This allows us to design criteria for protection measures during planning and organization of the work on SNF and RW management in the above rooms.

Gamma radiation is the prime factor contributing to the effective dose in BDS rooms. The portion of neutron radiation is negligibly small if no work on opening the cells and unloading the SNF is carried out.

2. In dry storage area 3A, the cells are covered with concrete slabs, so practically no beta-radiation affecting skin and crystalline lens of an eye has been registered. The total exposure dose is determined by gamma radiation only. In dry storage areas 2A and 2B, cells are covered with metal caps failing to reduce the radiation impact, as can be seen from measurements results, and so the sites are contaminated with beta-emitting radio nuclides.

The summarized beta and gamma dose rates affecting skin exceed the gamma dose rate by 12 times (average value for areas 2A and 2B is equal to 5.6 ± 1.3 mSv per hour), while the maximal coefficient value affecting crystalline lens of an eye is equal to 16 (average value for 2A area is 6.0 ± 3.0 mSv per hour).

Analysis of obtained data shows that:

- variation in surface contamination values is wide. The contamination of gamma-emitting radio nuclides contamination is dominated by Cs-137;
- the most contaminated parts are those at inner surfaces of cells and plugs (water in the cells was up to 2050 Bq/cm^3).
- lower levels of contamination are noted at the surface of shielding containers and on the floor; however, variation in values at those surfaces is high: from several Bq/cm^2 to 620 Bq/cm^2. In such cases the ratio of Cs-137 to Co-60 concentration also varies within a wide range from 3 to 2170.

When studying gammaradiation field characteristics, the researchers could subdivide the above into three groups:

1. the sources that are generating a gamma-radiation field are buried below the floor or located directly at the floor surface. Wide or narrow parallel beam directed upwards corresponds to above geometry; while the field itself is anisotropic;
2. the sources generating the radiation field in the rooms are either located at sufficiently large distance (when change in dosimeter position on the body is not significant) or where the radiation field is generated by multiple sources evenly distributed over the room area. Therefore the change in dosimeter position does not cause any significant change in radiation rate values. The field in such space is isotropic, as a rule;
3. the gamma-radiation field is generated by multiple sources unevenly distributed over the area. A change in dosimeter position in the room space correspond to its drawing near or moving away from a source, thus, causing changes in dosimeter readings. The field in such a space is anisotropic and presents a superposition of all its constituent fields.

The aforementioned sub-categories allows us to calculate the conversion factor of transition from personal dosimeter readings to an effective dose from external exposure, taking due account of the occupational routes.

The obtained results of radiation field approximation with one extended source (disc or cylindrical volume non-absorbing) satisfy the limited amount of points. Taking into consideration that to build a physical model of an extended source adequately reflecting the existing radiation fields generated by the multiple sources unevenly distributed over the area is an extremely complicated task, it is preferable to apply a statistical approach in personnel exposure simulation.

Modeling of production activity at BDS and in Building No. 5.

Radioactive aerosols characteristics obtained by the results of production activity simulation at BDS and in Building No. 5 showed that:

- The active median aerodynamic diameter (AMAD) of radioactive aerosols at intensive work can vary from 2.5 to 30 µm when β_g is from 1.5 to 5.7; in this case the 95% confidence interval for the AMAD is 0.3 – 80 µm;
- The nuclide composition of gamma-radiating radioactive aerosols is determined, predominantly, with Cs-137 dominating over Co-60 by 150 times;
- Activity concentration of gamma-radiating aerosols can reach significant values. Values up to 2000-4500 Bq/m^3 were registered. This exceeds the permissible activity concentration for personnel ($PAC_{pers)}$ by Cs-137 (1700 Bq/m^3) and requires: obligatory use of personal protective equipment for protection of respiration organs; application of dust suppression means; decontamination of contaminated surfaces or bringing the removed radioactively contaminated matters to a fixed position in a form not intended for further removal; and individual monitoring of intake of radioactive material by a humans;
- The AMAD values will be used to define the dose coefficients necessary in determination of admissible annual inhalation intake and PAC_{pers} values for different radionuclides combinations.

The above work has formed the basis for a series of measures to be taken in order to guarantee the efficient individual protection of SevRAO personnel.

To ensure the personnel radiation safety during the work on SNF removal from BDS cells and occasional work in Building No. 5, an entire complex of protective measures should be envisaged already at the stage of design and organization of the work. The above measures should include:

- Remote handling methods;

- Shielding against external gamma-radiation;
- Application of personal protection equipment;
- Use of remote control equipment;
- Decontamination of radioactively contaminated surfaces, etc.

2.1.2 Documents developed in the course of the work under the Project

1. As part of Task 1 and in conjunction with the other projects, a Threat Assessment report was prepared and published by the NRPA (Ilyin et al, 2005a).
2. Under Tasks 2, 3 and 4 the following documents were developed:
   - Guidance document "Application of personal protective equipment for personnel at SevRAO facilities";
   - Report "List of principal technological operations in the work process of SNF management at FSUE SevRAO Branch No. 1";
   - Report «Radiation parameters in the Blocks Dry Storage of SNF and in Building No. 5 of FSUE "SevRAO Branch No.1".
3. The above documents found their place in the draft final regulatory guidance «Hygienic requirements for personnel and public radiation safety guaranteeing at the stage of designing the work with SNF and RW at FSUE SevRAO Branch No. 1 (R-GTP SevRAO-07) ››.

In addition, two scientific conference papers have been prepared and presented concerning the project work (Ilyin et al, 2005b; Sneve et al, 2006).

2.2 Project 2. Development of criteria and instructions for remediation of contaminated territory and de-licensing of nuclear enterprises

2.2.1 Analysis of the radiological situation in SSZ and SA followed by the development of criteria and norms for rehabilitation of facilities and territories at STS's of SNF and RW at the SevRAO enterprise

Analysis of radiological situation in SSZ and SA at STS's of SNF and RW at SevRAO enterprise.

STS's of SNF and RW in Andreeva Bay:

When studying the radiological situation in the Sanitary Shielding Zone (SSZ) and SA (Surveillance Area) of the STS of SNF and RW at Andreeva Bay in 2005-2006, the method of radiation-hygienic monitoring was applied as a basic tool. This allowed the use of the monitoring results for characterization of the radiation-hygienic situation in the SSZ and SA of the STS and the following conclusions were made:

1. Gamma dose rate within the SSZ of STS territory varies over a wide range. In the sub-zone of the controlled access area the dose rate is from 0.2 to 140 μSv/h. Maximum levels here were observed near the mouth of the former brook near Building 5. In the zone of possible contamination the dose rates are from 0.2 to 12 μSv/h. In the remaining SSZ and SA territory – the values range from 0.063 to 0.14 μSv/h with an average value of 0.12 μSv/h. Off-site gamma dose rate does not differ much from the typical levels for the territories of Northwest Russia and in the Murmansk region, in particular.
2. Maximum levels of soil contamination in the STS territory are observed near the old technological pier and also around the BDS where concentrations of ^{137}Cs reach $5.7 \cdot 10^{7}$ Bq/kg, while concentration of ^{90}Sr is one order of magnitude less. The concentration of ^{137}Cs and ^{90}Sr in the soil off-site in SSZ and SA, is within the background level typical for unpolluted

territories of the Russian North and does not exceed 36 Bq/kg by ^{137}Cs and 4 Bq/kg by ^{90}Sr.

3. The concentration of ^{137}Cs in vegetation in the territory of controlled access area is up to $4.7 \cdot 10^3$ Bq/kg. In the territory of SSZ and SA the maximum concentration of ^{137}Cs and ^{90}Sr in vegetation is 9 and 12.7 Bq/kg, respectively, and does not exceed the background values for these radionuclides.
4. The concentration of ^{137}Cs in bottom sediments of the coastal strip at the STS No 1 is 100 Bq/kg near the mouth of the former brook and 36 Bq/kg behind the SSZ barrier: this is up to 25 times greater than background values. The concentration of ^{90}Sr in the same bottom sediment samples is varying from 2 to 36.6 Bq/kg, exceeding the background by more than 20 times. The concentration of ^{137}Cs and ^{90}Sr in seaweeds only slightly exceeds the background values.
5. The concentration of ^{137}Cs and ^{90}Sr in the Barents Sea water is 0.04 and 0.03 Bq/l, respectively, which is an order of magnitude higher than the average background values.
6. The concentrations of ^{137}Cs and ^{90}Sr in the drinking water consumed in the territory of STS No 1 are 0,02 and 0.001 Bq/l, respectively. This is from 550 to 5000 times less than the intervention levels for ^{137}Cs and ^{90}Sr in drinking water.
7. Specific activities of ^{137}Cs and ^{90}Sr in local foodstuffs (wild berries, mushrooms, sea fish) collected in the territory of the SA, do not exceed the existing admissible radiation-hygienic norms at STS off-site.
8. In summary, the obtained results show that, presently, the STS industrial site has not caused any significant impact to the adjacent territory, except for sea environment in coastal areas (bottom sediments, seaweeds). The concentrations of ^{137}Cs and ^{90}Sr in the enviromental facilities of SA are generally found to be within background values.
9. The results of personal monitoring show that there is no statistically significant difference in exposure doses to public and personnel group B. The equivalent effective doses (EED) of external gamma-radiation are 0.77 and 0.87 mSv/year, respectively, while the input from man-made radiation at STS does no exceed 20% of this. The effective dose of internal gamma-radiation from intake of ^{137}Cs and ^{90}Sr with the diet is 14 μSv/year. The dose due to internal exposure of wild-growing foodstuffs in the diet does not exceed 8%. The total effective dose for the public living in the SA of the STS at Andreeva Bay is assessed to be under 0.8 – 0.9 mSv/year.
10. It is necessary to perform a detailed analysis of man-made radionuclide concentration in the air, both on-site and off-site territory because the available information is not sufficient for adequate assessment of its potential intake via inhalation.

STS of SNF and RW in Gremikha village:

When studying the radiological situation in SSZ and SA of the STS of SNF and RW in Gremikha village in 2005-2006, the methodology of radiation-hygienic monitoring was applied as a basic tool. The research check-points for such monitoring were selected taking into account the available monitoring base, perspectives in rehabilitation of the STS facilities and territory, as well as the preliminary threat assessment. The results of the work performed allowed the characterization of the radiation-hygienic situation in the SSZ and SA of STS in Gremikha and to make the following conclusions:

1. At the STS industrial site (in controlled access area) there are sections of the territory where gamma dose rate reaches 8500 μSv/h. Gamma dose rate within the industrial site area is generated by the radiation from contaminated soil and the radioactive substances that are inside the radiation-hazardous facilities.
2. In the major part of the territory of SSZ and SA, gamma dose rate does not exceed 0.23 μSv/h. Gamma dose rate within the industrial site area is generated by radiation from contaminated soil and radiation from the radioactive substances that are inside the radiation-hazardous facilities. Gamma dose rate in the SA is

within the limits of background radiation fluctuations and does not differ much from the rates typical for background ("clean") territories of the Murmansk region.

3. In the territory of the STS industrial site, man-made contamination of soil with ^{137}Cs, ^{90}Sr, ^{60}Co, ^{152}Eu, and ^{154}Eu was registered. The concentration of ^{137}Cs and ^{90}Sr in some parts exceed the background values for this particular region by more than 100 times. The levels of soil contamination with ^{137}Cs are 3-30 times higher than with ^{90}Sr. The concentration of ^{137}Cs and ^{90}Sr in the soil outside the SSZ, in the STS SA (Gremikha and Ostrovnoy villages) is, generally, at background level (1-50 Bq/kg). In some cases we noted values exceeding the background levels, with up to 100 Bq/kg ^{137}Cs.
4. The concentration of ^{137}Cs in vegetation in the territory of controlled access area reaches $3.2 \cdot 10^4$ Bq/kg. In the territory of SSZ and SA, the concentration of ^{137}Cs and ^{90}Sr in vegetation varies from 3 to 69 Bq/kg, and does not exceed the background values.
5. The concentration of ^{137}Cs in bottom sediments of the coastal strip at STS is from 64 to $1.2 \cdot 10^4$ Bq/kg, i.e. considerably exceeding by 8 to 3000 times, the background values. The concentration of ^{90}Sr in the same bottom sediment samples varies from 9 to $2.0 \cdot 10^3$ Bq/kg, and exceeds background values by more than 2 to 250 times. The concentration of ^{137}Cs and ^{90}Sr in seaweeds also exceeds background radionuclides content by 4 times, approximately. The presence of ^{60}Co was also registered in the samples of seaweeds and bottom sediments taken in the water area of the STS industrial site (PEK drying area). The concentration of ^{60}Co in bottom sediments in a specified point was $7.2 \cdot 10^3$ Bq/kg.
6. The concentration of ^{137}Cs and ^{90}Sr in the sea water of STS is 3.9 Bq/l and 0.41 Bq/l, respectively, which is significantly (by 100-600 times) higher than average background values in the Barents Sea water.
7. The concentration of ^{137}Cs and ^{90}Sr in the drinking water consumed in the territory of the STS and in the houses of Gremikha and Ostrovnoy villages is 0.009 Bq/l for both radionuclides. The above radio-activity values for drinking water are more than 1000 times lower for ^{137}Cs and more than 500 times lower for ^{90}Sr as compared to the existing intervention levels for these radionuclides.
8. The local foodstuffs are mainly represented by wild-growing foodstuffs: wild berries, mushrooms and sea fish, collected in the SA where concentration of ^{137}Cs and ^{90}Sr does not exceed the existing admissible levels for radionuclides.
9. In summary, the data obtained shows that, at the present time, the STS industrial site does not cause any significant impact on the adjacent territory of SA, except for sea environment in coastal areas (bottom sediments, seaweeds). The concentrations of ^{137}Cs and ^{90}Sr in the environmental items are found within background values, however in some cases we can observe that background values typical for this particular region, are exceeded. The maximum concentration of ^{137}Cs registered in the soil of the STS SA territory is 100 Bq/kg.
10. The results of personal monitoring, in combination with the calculated equivalent effective dose (EED) of radiation exposure of people living and/or working (personnel group B) in the area of STS in 2005, showed that:
    - The public external exposure EED from cosmic radiation and from global fallout and radiation of natural radionuclides is 0.67 mSv/year. The EED of the personnel group B is 0.87 mSv/year, meaning the input from man-made radiation from STS does not exceed 15%.
    - The public internal exposure EED from intake of ^{137}Cs and ^{90}Sr via the diet is 14 μSv/year. The input to the internal exposure dose from wild-growing foodstuffs of a diet does not exceed 8%.
    - The total exposure EED for the public living in SA of STS at Gremikha can be assessed to maximum 0.7 – 0.8 mSv/year.

The studies were fulfilled not periodically and, thus, do not allow to make an unambiguous conclusion concerning absence of any impact from STS industrial activity on the surveillance area and adjacent territory. In order to provide statistically significant analysis of any changes or lack of changes in radiation background at the SA as a result of the presence and operation of both STSs, a radiation-hygienic monitoring research must be carried out as the primary, by importance, regulatory function of the FMBA of Russia.

Development of criteria and norms for rehabilitation of facilities and territories of the STS of SNF and RW at SevRAO enterprise

The work carried out within the framework of the task included:

1. Analysis of information and analytical materials on rehabilitation issues and review of the existing international and national norms and standards on management of radioactively contaminated territories, showed that at the present time no norms for admissible residual radioactive contamination levels are available in Russia that one applicable to the situation typical for a STS. There were also no specific official international recommendations on this subject. Guidance documents that could be suitable for our purposes included ICRP (IAEA document on remediation of the territories previously contaminated with radioactivity as a result of past operations or accidents (IAEA, 2003), and NRPB document on methodological tools in the development of soil residual contamination criteria (NRPB, 2003)).
2. A draft regulatory document “Criteria and norms on rehabilitation of territories and facilities of State Federal Unitary Enterprise SevRAO, was developed. The above hygienic norms (HN) apply to rehabilitation of FSUE SevRAO territories and facilities contaminated with man-made radioactive materials. The HN provide the radiation criteria for remediation of the territories and structures at STS of SNF and RW which are under supervision of FSUE SevRAO of the Federal Agency on Atomic Energy.
3. The dose criteria, applicable to all types of rehabilitation operations were developed in accordance with the “Concept of environmental rehabilitation of shore technical bases of the Russian North”, i.e. renovation, conservation (storage under supervision) and liquidation. For the renovation and conservation options, regulatory criteria and norms applicable in non-standard situations are available, and satisfy, at the same time, the laws and norms existing now in Russia. For the liquidation option, it is suggested to develop new norms taking due account of international recommendations.

For each type of remediation scenario based on environmental models, the following reference levels were specified:

- surface ά and β contamination of internal and external surfaces of STS structures,
- γ dose rate,
- specific concentration of radio-nuclides in soil,
- average annual activity concentration in underground water,
- average annual activity concentration in air.
- radionuclides concentration in seafood, etc.

The above criteria and norms on remediation of the territories and facilities of STS of SNF and RW at SevRAO can be applied to each type of rehabilitation. In case of renovation and conservation, the regulatory criteria of rehabilitation satisfy the laws and norms currently applicable in Russia. For the case of liquidation, new norms have been suggested based on international recommendations.

The following three important regulatory aspects have been identified in the course of the work.

The first one relates to completeness of the results obtained in the process of environmental radiation monitoring. In SSZ and SA of STS at Andreeva Bay and Gremikha, an operator of SevRAO carries out the radiation monitoring, however, from the regulatory point of view, some disadvantages have been observed in the course of our investigation. In particular, the operator's radiochemical methods are not sensitive and determination of sample concentration is rarely carried out. It is difficult to obtain real values of radionuclide concentrations except in medium and highly active samples of environmental media. Real values for low-active (background) samples are reported, as a rule, in a form of "lower than minimum detectable activity by measuring tool". Therefore, it is impossible to assess either the quantitative dynamics of exposure to the environment off-site (in SA territory) caused by the STS, or the trend in radiation situation changing with time. In addition, the operator's monitoring does not include monitoring of local foodstuffs. So, before our investigation, there were no real numerical values for low radioactivity levels in a set of environmental media in the SSZ (seawater, drinking water, soil). The present investigation has partially rectified this absence of data.

The second regulatory aspect relates to the methodology of regulatory supervision at STS in Andreeva Bay and Gremikha. When performing this work, some points of radiation-hygienic monitoring were selected and approved by the operator, to be used on a long-term basis for forthcoming remediation of STS territories. Selection of these monitoring points was carried out taking into account the already existing monitoring points at the STS bases; considering the existing plans for remediation of the facilities, and initial threat assessments carried out in the light of FMBA of Russia's regulatory functions. Earlier a "zero background" was established prior to the activity on management of SNF and RW. Special recommendations will need to be developed for continued performance of long-term monitoring at selected checkpoints, addressing the following aspects: a) the type of environmental media, the characteristics (volume, type) of samples and frequency of sampling; b) requirements to technical equipment, methods and procedures to be used, c) interaction between stakeholders. Such a document should be approved by both the regulatory authority (FMBA of Russia) and by the operator (SevRAO).

The third regulatory aspect relates to further implementation of measures and procedures on rehabilitation of territories and facilities at STS in Andreeva Bay and Gremikha. When performing this work, the criteria and norms were developed aimed to limit the impact on the personnel and public, as well as on near-coastal water area, caused by residual radioactive contamination with man-made radionuclides of surface and sub-surface soil. When using the previously defined criteria and norms in practical work in the future, it is necessary to develop a procedure to allow the evaluation of the rehabilitation measures proposed by the operator. This would include an evaluation of whether the procedures are optimal and radiological impacts will be kept as low as reasonably achievable (ALARA), economic and social factors being taken into account. So, the regulator must select the optimal option of radiation safety guaranteeing in the course of rehabilitation operations. In relation to this, it is very important to quickly develop special regulatory recommendations (in cooperation with the operator) on optimization and assessment procedures with regards to the rehabilitation measures at STS in Andreeva Bay and Gremikha for both SNF and RW management.

2.2.2 Documents developed in the course of the work under the Project

1. As part of Task 1 of mentioned project and in conjunction with the other projects, a Threat Assessment report was prepared and published by NRPA (Ilyin et al, 2005).
2. Under Task 2, of mentioned project a internal report was prepared related to the performance of independent regulation studies of radiation-hygienic situation and exposure doses for personnel of group B and public in the area of STS of SNF and RW at SevRAO enterprise.
3. Under Task 3, of mentioned project an internal report and a draft regulatory document "Hygienic Norms" were pre-pared related to the development of criteria and norms on remediation of facilities and territories of STS at Andreeva Bay and Gremikha.

In addition, four scientific conference papers on the work of this project have been prepared and presented (Shandala et al, 2006a; Shandala et al, 2006b; Sneve et al, 2007; Shandala et al, 2007).

2.3 Project 3 Improvement of medical and radiological aspects in the emergency preparedness and response system at SevRAO

2.3.1 Review of current preparedness for medical-hygienic and emergency response at SevRAO

Preliminary assessment and analysis of threats and risks occurring in case of radiological accidents (and non-standard situations) at SevRAO facilities and in clearing up the subsequent consequences.

Within the above research study framework, the list of principal activities required for substantiation and development of a planning system for medical-sanitary support in case of emergency (Table 1), has been specified.

Inspection of SevRAO facilities and FMBA of Russia's medical institutions with the purpose to assess the state of the medical-sanitary system and its preparedness for emergency medical response in case of radiological accidents in the territory of STS at Andreeva Bay.

The purpose of this work was to assess the state of the medical-sanitary system and its preparedness for emergency medical response in case of a radiological accident occurring in the territory of STS at Andreeva Bay. It was mainly focused on the analysis of the actual situation of emergency preparedness and response at SevRAO enterprise and the medical and sanitary institutions of FMBA of Russia (MSU-120 and the Center for Hygiene and Epidemiology No. 120 of FMBA of Russia), which are responsible for emergency response measures. The above analysis was based on the findings obtained during an inspection visit to the SevRAO enterprises and institutions including the area of STS of SNF and RW at Andreeva Bay. A report and inspection protocol with recommendations were provided to the territorial and federal authorities responsible for emergency response at SevRAO facilities and adjacent territories.

The following principle findings and proposals were formulated based on the results of the inspection:

- The available set of documents regulating the emergency response planning and organization of emergency response measures at the enterprise level and at local and territorial authorities' level, is sufficient and conforms to the functions and practical goals found within the framework of Rosatom activity.
- The list of emergency situations that is used in preparation of the plans of actions for personnel and public radiation protection, requires a more detailed investigation. This relates to both the concerns about the current working practices at STS in Andreeva Bay and the special operations on SNF and RW management to be addressed in the nearest future, together with introduction of new waste treatment technologies.
- In order to implement the emergency response plan into practice, it is necessary to develop the criteria defining the situations of "emergency preparedness" and "emergency situation". The criteria should be developed jointly by the Committee for Emergency Situations at FSUE SevRAO, FSUE SevRAO Branch No.1 and FSUE SevRAO Branch No.2.
- Taking into account the existing uncertainties in evaluation of radioactivity values and content of radioactive materials stored at the sites of temporary storage of SNF and RW, we anticipate that application of mathematical methods based on in-line prediction of changes in emergency situation development will be used to represent the real problem. In connection to this, it is necessary to ensure that the Automated Radiation Monitoring System (ARMS) available at the enterprise is adequately precise and linked to weather forecasting equipment, and that interpretation of sensor readings for correspondence to interference levels, as required by the Norms of Radiation Safety (NRB-99), is fulfilled.

Table 1: Principal activities required for substantiation and development of medical-sanitary support system in the event of emergency

Measures and activities	Status of problem	Actions to be taken
Officially approved list of the design-basis and beyond the design basis accidents in the process operations on RW management and transportation	Data available from research work and studies.	Coordination and approval of the list of emergency situations' scenarios
Assessment of medical-sanitary after-effects following the design-basis and beyond the design basis accidents	Data n/a	Assessment of possible medical after-effects for personnel
Categorization of potential radiological hazards from SevRAO, in accordance with OSPORB-99	Preliminary opinion available	Categorization is most important in selecting and developing a plan of actions for public radiation protection
Available and sufficient set of documents on emergency response planning at the enterprise, at MSU and in CH and E	Preliminary data available	Conclusions and recommendations will be provided based on the results of the inspection.
Training of MSU and CH and E personnel for the work in emergency situations	Data n/a	Conclusions and recommendations will be provided based on the results of the inspection.
Plan of interaction between MSU and CH and E and between territorial and departmental medical institutions and the CH and E	Preliminary data available	Conclusions and recommendations will be provided based on the results of analysis. Analysis to be carried out on sufficiency of the available system of emergency response planning, and characteristics of the territorial medical institutions

- It is necessary to consider the possibility of developing a unified procedure for data receipt and exchange between the radiation safety service of FSUE SevRAO Branch No.1 and local civil defense and emergency situations management (CD and ES) of the Zaozersk town. This to allow prompt evaluation of the public dose burdens at an early stage in emergency situations.
- In planning and organization of radiation-hygienic measures in the surveillance area of the enterprise, it is necessary to develop an additional plan of interaction between the CH and E-120, and the CH and E of the Zaozersk town.
- In addition to the documents available at the CMSU-120, it is necessary to develop a plan of interaction with the Murmansk territorial center of catastrophes medicine.
- When establishing the Murmansk emergency response center, it is advisable to envisage the development of a regional sub-system of medical-sanitary support in case of radiological accidents. The SRC IBPh and the associated Emergency Medical and Radiation Monitoring Center (EMRMC) of FMBA of Russia have accumulated experience in crisis management and expert support covering a wide range of medical-sanitary issues. The SRC IBPh has its own regulatory base that is necessary for emergency response activities and that can be used in the following planning and implementation of the Project on foundation of the Murmansk Emergency Management. Center

2.3.2 Planning and conducting emergency response training at a site, taking the STS in Andreeva Bay as an example

This task was dose in close cooperation with SevRAO enterprise, Central Medical-Sanitary Unit No. 120 of FMBA of Russia (MSU–120), FMBA of Russia's Regional Management (RM) for the town of Murmansk and for the Murmansk region, FMBA of Russia's Center for Hygiene and Epidemiology No. 120 (CH and E–120), as well as with the representatives of the Norwegian Radiation Protection Authority. The following three stages can be identified:

- Preparatory stage (15.01-31.05.2006), which included (a) development and coordination of principle idea; (b) preparation of documents; (c) organizational measures;
- Training (5-7.06.2006) in the field under in-situ conditions at the STS of SNF and RW in Andreeva Bay and MSU–120 (Snezhnogorsk town);
- Analysis of the results of training and drawing up of the reports.

Principal findings as follows:

- personnel training was very important for improvements in the sphere of emergency preparedness and response for all groups at SevRAO enterprise and FMBA of Russia’s medical institutions. Scheduled operations were completed in full;
- the experience obtained in the course of the emergency response training will be useful for further development of the medical emergency response system and further actions necessary to improve the system;
- main problems were revealed in the course of training on key emergency response issues during personnel training at STS of SevRAO Branch No.1 in the closed territorial formation (CTF) in the Zaozersk town. This highlighted the need for further elaboration of the normative-methodical basis and improvement of quality and accessibility to the facilities that will be used in the course of emergency response actions. First of all, the above concerns specialized medical transport, radiation measuring tools and advanced medical equipment necessary for timely and adequate first aid service to those injured in radiological accidents.

The following recommendations based on the analysis of training results, are given:

1. planning and conducting the emergency response training should be carried out on a regular basis;
2. it is advisable to develop a guidance document at FMBA of Russia that would contain regulations on the frequency and contents of training activities at each particular MSU and CH and E;
3. FMBA of Russia's authorized organization (EMRMC) should take part in the development of scenarios and planning of training activities;
4. it is advisable to combine training activities with a proficiency course for medical workers. Those members of MSU -120, RM, CH and E No.120 staff and the personnel of SevRAO enterprise who attended the training course identified a need for training on observance of standards ;
5. for training purposes in the territory of the enterprise, it is desirable to combine medical staff training with emergency response training activities;
6. before each training exercise, it is useful to review the expiry date on material reserves so as to use those reserves in the exercise whose use-by date is coming up.

2.3.3 Sections of the principal (regulatory) document "Hygienic requirements for personnel and public radiation safety guaranteeing in designing the work with SNF and RW at FSUE SevRAO Branch N° 1 (R-GTP SevRAO-07), concerning requirements for emergency preparedness and response

The above work consisted in summarized analyses of the results obtained during operations by the above three directions. The following two sections of the SanPiN document were prepared:

- Prevention of radiological accidents, and
- Emergency preparedness and response

The above sections provide a detailed description of general requirements with regard to basic hygienic norms and sanitary requirements on radiation safety guaranteeing, under NRB-99 and OSPORB-99 regulation, related to prevention of radiological accidents and emergency response planning at the stage of development, operation and rehabilitation. The principles stated in the international documents (IAEA, DS298, 2006) and (GS-R-2) were also taken into account. At the same time, we can note a series of discrepancies between national and international criteria and approaches related to public protection and setting safe dose limits.

Conclusion based on the results of the work under Project 3:

1. It is known that the emergency response infrastructure at SevRAO has been established and meets the requirements of the Russian legal and normative documents.
2. The following proposals were made to improve the efficiency of the emergency preparedness and response system:
    - Detailed regulatory requirements for the criteria for announcing the "emergency preparedness" and "emergency response" situations, operating criteria for decision-making in the sphere of personnel and public protection and emergency response planning;
    - Recommendations on improvement to the alarm system and exchange of information based on agreed protocols, including promotion of advanced means of communication;
    - Decisions on organization of educational courses and training activities for specialized emergency response teams and non-regular detachments with the goal to provide medical aid on a systematic basis taking account of the specific conditions at the SevRAO enterprise;
    - Systematic training activities and educational courses focused on

training of practical skills required in rescue and urgent emergency response operations.

3. Medical and sanitary emergency response guaranteeing is the priority item in the system of emergency preparedness actions. Efficient inter-action between SevRAO enterprises and FMBA of Russia's local medical services and other territorial health organizations is critical for timely provision of medical aid to injured persons before and during hospitali-zation.

Distribution of information among the officials responsible for making decisions on improvements in the system of emergency preparedness and response on the principal findings and recommendations of Project 3 allows us to expect that the objectives stated in the Project will be realized.

2.3.4 Documents prepared in the course of the work under the Project

1. As part of Task 1 and in conjunction with the other projects, a Threat Assessment report was prepared and published by the NRPA (Ilyin et al, 2005).
2. Under Task 2 the following documents were prepared:
    - Program of FSUE SevRAO inspection visit with the purpose to evaluate the situation existing in medical emergency response planning and preparedness at the level of the enterprise and territorial organizations;
    - A Protocol dawn up by the results of monitoring operations;
    - Report "Substantiation of organi-zational emergency response duties";
    - Information report with several photos has been prepared as NRPA Bulletin "Medical response emerg-ency training at SevRAO enterprise in Andreeva Bay".

The materials provided under the projects allow us to conclude that the regulatory documentation on radiation safety guaran-teeing developed at SevRAO enterprise significantly reduced the level of uncertainty in FMBA of Russia's regulatory functions. This can be proven by the following findings.

2.4 Findings

A. The work carried out under the Project «Development of a regulatory guidance for improvement of radiation protection measures in non-standard situations, using radiological risk assessment allowed to:

1. Evaluate the potential radiological hazard from suggested SNF management options and assist in selection of the best possible decisions as stated in the OBIN document;
2. Carry out independent measurements of external gamma dose rates in the production rooms of Building No. 5 and BDS. They have shown that the gamma rates are ten and hundred times higher than those in the production rooms at currently operating enterprises of nuclear power engineering industry. The permissible working time calculated on the basis of the conservative approach (subject to full-shift working time if no measures of protection are taken) for the personnel working in above rooms is strictly limited.
3. Determine possible levels of impact to personnel from other radiological factors, namely:
    - Beta and gamma dose rates affecting the skin;
    - Surface contamination with gamma- and beta-emitting radio nuclides;
    - Physical characteristics and nuclide composition of radioactive aerosols in BDS rooms;
    - Neutron radiation dose rate.
4. Inspect the personal protective equipment and develop recommendations for its improvement and completion;
5. Develop, based on the research studies undertaken, a package of normative-

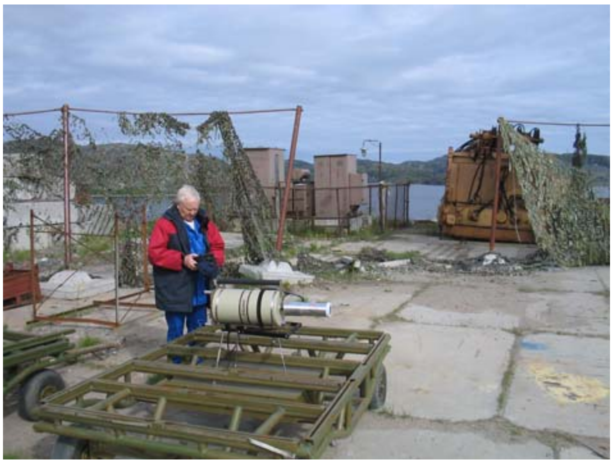
methodical regulatory documents including the final guidance (for all the three Projects) "Hygienic requirements for personnel and public radiation safety guaranteeing in designing the work with SNF and RW at FSUE SevRAO Branch No. 1" (will be published after final approval).

B. The work carried out under the Project «Development of criteria and instructions for remediation of contaminated territory and de-licensing of nuclear enterprises" allowed the:

1. Elimination of the uncertainties found in the assessment of environmental impact from the activity at SevRAO industrial sites; in the part of evaluation of quantitative dynamics of impact from man-made activity at STS in the environment off-site (namely SA). It also allowed the determination of previously lacking values on low radioactivity levels in some environmental media in SSZ (sea water, drinking water, soil).
2. Identification and coordination with the operator of points where radiation-hygienic monitoring should be carried out on a long-term continuous basis in the course of planned rehabilitation of STS territories, including the "zero background" before starting the work on SNF and RW management.
3. Development of the criteria and norms to aid the limiting of personnel and public exposure to residual radioactive contamination and also to reduce the impact on near-shore water area from surface and sub-surface contamination of soil with man-made radionuclides.

C. The work carried out under the Project «Improvement of medical and radiological aspects of emergency preparedness and response at SevRAO facilities" allowed the:

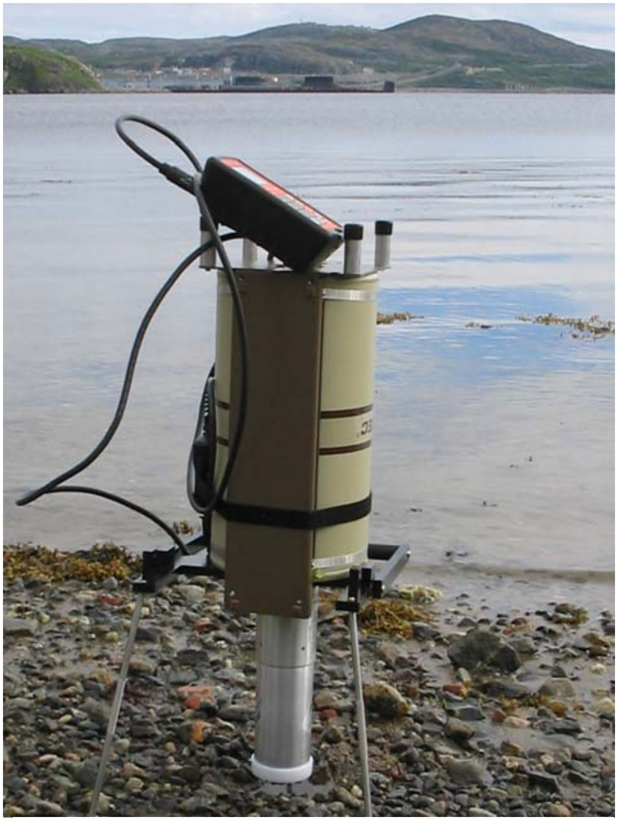
1. Identification of the principal threats and scenarios in the course of accidents. Development and fulfillment of a detailed plan of preparation for and organization of the joint emergency response training activities for personnel of FMBA of Russia's enterprises and medical institutions.
2. In the course of preparation for training and from detailed discussion of actions undertaken by the participants of training activities, corrections in the documents (emergency plans) of CMSU No.120 and RM No.120 of FMBA of Russia were performed. The documents were corrected in the part concerning prompt warning; evacuation of injured and involved persons; performance of protective measures including urgent and special sanitary-hygienic measures, as well as preventive medical measures.
3. Improvement for the preparedness of SevRAO personnel and the groups formed at the MSU No.120 and RM No. 120 of FMBA for operations in abnormal situations and in radiological emergency conditions. To lower, as much as possible, the threats associated with insufficient level of medical service rendered to injured persons; the personnel acquired necessary practical skills in urgent medical aid and radiation-hygienic actions. The administration of SevRAO and FMBA enterprises took part in training activities and acquired practical skills in crisis management in radiological emergency conditions.
4. Substantiation of the necessity to improve the normative-methodical base, the quality of and accessibility of the means used in emergency response operations. First of all, the above relates to essential re-equipment of medical transport, radiation monitoring equipment, and also to lacking medical equipment necessary for radiation monitoring and examination of involved persons and for medical aid to injured persons.



Measurement of radiation spectra near the Block of Dry Storage on-site at SevRAO facility no. 1 Andreeva Bay

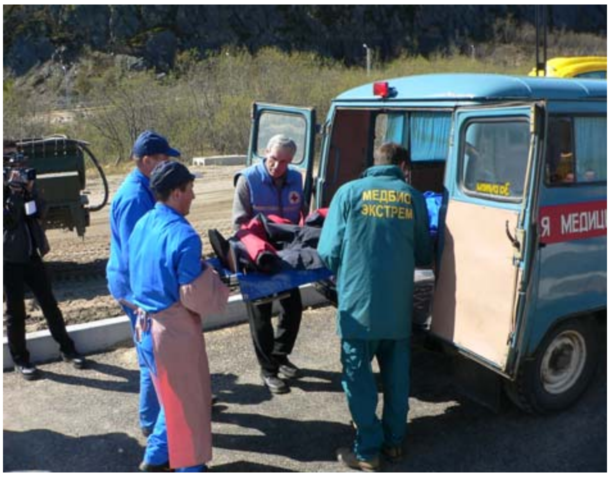
Underground water sampling from the spring at the site at SevRAO facility no. 1 at Andreeva Bay

Measurements of gamma dose rate and measurements of radiation spectrum near building 5 on-site, SevRAO facility no. 1 at Andreeva Bay

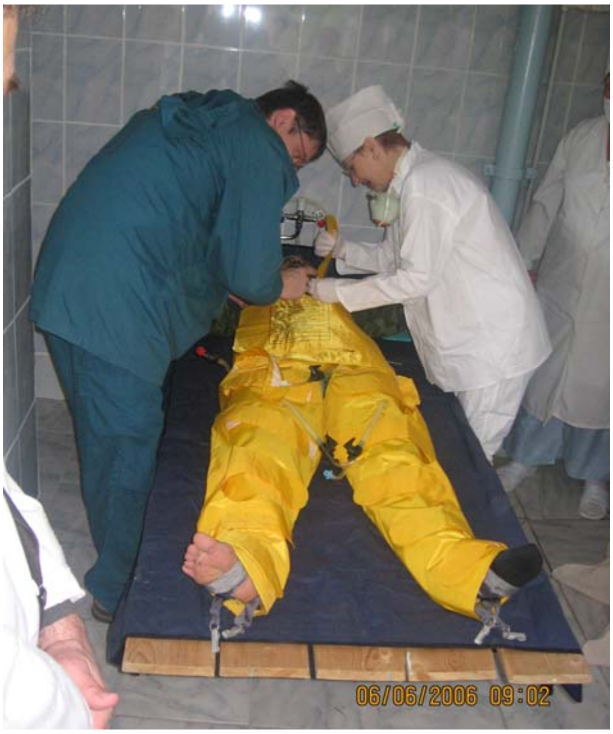


Background radiation measurements at the costal of SevRAO facility nr 1 at Andreeva Bay

Victim of the accident during the emergency exercise at SevRAO facility no. 1 at Andreeva Bay, with a fragmental wound of skin in the contaminated zone waiting for the medical first aid.



Loading of victim from contaminated into the clean zone for further transportation to the health centre.



Victim in the antishock suit. After the measuring the surface contamination, suit will be removed and before the medical treatment will be performed the victim has to be measured and decontaminated if necessary.

3 Analytical summary of the results of working visits by FMBA of Russia and SRC IBPh representatives to the UK and USA

To enhance the efficiency of the work with the above documents, by NRPA request and with approval of the Consultative Group for chemistry/biology/physics, the NATO Assistant Secretary General for public diplomacy assigned a Grant in support of the Project “Exchange of experience in the sphere of regulation to reduce the risks associated with operation of nuclear facilities”. Within the framework of the Grant, experts from the FMBA of Russia, State Research Center Institute of Biophysics (SRC IBPh) and South-Ural Institute of Biophysics visited the United Kingdom on 12-23 June, 2006 and the USA on 26 November - 10 December, 2006.

The purpose of the working visits was to exchange experience and to familiarize the experts with the structure of the radiation safety regulatory organizations in the UK and USA, their working principles and organizational methods. The nuclear industry operators in above countries are within a period of decommissioning and the system of RW management and rehabilitation of radioactively contaminated territories provided a useful basis for comparison with that in place in the Russian Federation.

3.1 Working visit of FMBA of Russia and SRC IBPh representatives to the United Kingdom

Within the period of the visit to the UK, Russian experts visited:

- **Radiation Protection Department of the Health Protection Agency (HPA)-** a state organization responsible for improvement of radiation safety and providing technical support to the enterprises on financial basis;
- **Nuclear Installations Inspectorate (NII) Health Safety Executive (HSE)** –a nuclear and radiation safety regulating authority responsible for supervision of nuclear and radiation safety at nuclear power engineering facilities in the UK, and also responsible for licensing the sites;
- **The Environment Agency (EA), -** a regulator in the sphere of radioactive materials and radioactive waste management in England and Wales;
- **Scottish Environmental Protection Agency (SEPA), -** a regulator in the sphere of radioactive materials and radioactive waste management in Scotland;
- A number of enterprises associated with the **United Kingdom Atomic Energy Authority (UKAEA) and BNFL:** (Windscale and Sellafield)**,** and also the Dounreay research site where there is decommissioning of the reactors and radiation plants with expired service life. Rehabilitation of the sites is currently being carried out.

During the visits to these organizations, the parties discussed the pressing issues important for improvement of the regulatory system for SNF and RW management at STS in Andreeva Bay and Gremikha. A detailed report based on the results of the visit to the enterprises of nuclear industry and regulatory authorities of the UK, is provided as Appendix A.

Findings: On general regulatory issues during visiting to the institutions and enterprises of nuclear industry and the UK regulatory authorities.

Comparative analysis of the regulatory systems in Russia and in the UK showed that the regulatory systems in the two countries have similar as well as differing features.

In both countries, up to now, no effective state policy has been developed as regards deep burial of long-lived solid radioactive waste. Neither Russia, nor UK has a single regulator responsible for radiation safety issues. In Russia, this function is placed on Rostechnadzor and FMBA of Russia; in the UK, the HSE and EA (and in Scotland SEPA) are responsible, making it necessary to establish special interrelations between different regulators. Neither in Russia nor in the UK, like in other European Community countries, does norms for the environmental impact by radiological factors exist. The principle "If man is protected the environment is protected, too" is applied. However, work is going on for development of such guidance.

The following aspects can be specified as differences:

- In both countries, normative-methodical basis has been formed taking account of recommendations provided by international organizations. However, while in Russia the IAEA recommendations are applied in most of the cases, in the UK those are the EU recommendations are applied.
- In the UK, an independent sub-system of sanitary-epidemiological control of personnel safety at radiation-hazardous production facilities, is absent. At the same time, environmental protection agencies in the UK and Scotland are responsible for establishing the permissible release and discharge values and for control that the above is followed.
- Medical service to the personnel working at the radiation facilities in the UK is provided though the regular public health system, with the exception of detailed annual medical examinations. In Russia, the above functions are laid on the FMBA of Russia.
- In the UK, two independent sub-systems exist for regulation of the permissible release and discharge limiting values and for control of their compliance. Sub-division is by the territorial principle, not by a functional one. As a result, some operators working in England and Scotland are subject to different regulatory bodies – the EA in the first case and SEPA in the second.
- The regulatory requirements in the UK are of a general character, while the development of specific documents and measures is the responsibility of enterprises; an operator is informed about the final goal and it is up to him to propose how the goal can be achieved, and then finally the regulator may approve. In such a case, the prime role in interaction between the regulator and operator is placed on the inspection body (including supervisory) which must state to which extent the radiation protection of personnel, public and environment is deemed to be sufficient and optimized. Whereas in Russia, supervision activities are focused on revealing non-compliances between safety measures and the normative documents.
- In Russia, contrary to the UK, the document "Regulation in situation of uncertainty during facility decom-missioning" is prepared in the initial stage of development (two approved SanPin instructions are available with the guidance for SevRAO as a result).
- In the UK, great attention is paid to cooperation with public non-governmental organizations and public opinion is influencing the decision-making process at the enterprises of nuclear industry.

Findings: On improvement of regulatory system at SevRAO enterprise following the results of working meetings with regulators in the UK.

- Focusing on the issues of radiation safety regulation the NRPA organized a series of working meetings for regulators from various countries (UK, Sweden, Norway). By NRPA request and with approval of the Consultative Group for chemistry/biology/physics, the NATO Assistant Secretary General for public diplomacy assigned a Grant for the Project "Exchange of experience in the sphere of regulation to reduce the risks associated with operation of nuclear facilities". Such an approach allowed Russian specialists to obtain fundamental understanding of the radiation safety regulatory system existing in the UK and identify the directions for improvement of the radiation safety system at SevRAO.

- In developing the criteria for rehabilitation of SevRAO industrial sites, it is beneficial to take account of the UK experience regarding possible post-accident contamination of territories reaching the levels of an effective dose up to 3 mSv/year.
- To enhance the efficiency of personnel internal exposure monitoring at SevRAO in the course of the work on SNF removal from the STS at Andreeva Bay and Gremikha, the routines developed by British experts helping to define radionuclides' metabolism at inhalation, can be successfully applied in Russia.
- In developing the regulatory documents for SevRAO, the UK Nuclear Installations Inspectorate working experience can be taken into considerations concerning the decommissioning of facilities with deviations from the design technologies. In the above process, the principle of strict stage-by-stage decommissioning has been accepted. A new stage can be started only after the previous one is over, after analysis of the actions fulfilled, and the results being used to correct the regulatory documents for the next stage.
- To enhance the effectiveness of the work on SNF management at SevRAO, it is desirable to follow the UK experience in placing the very low level radioactive waste into a separate group and preparing guidance for arrangement of disposal areas for the above waste category, monitoring of the above disposal areas and defining their radiation capacity.

3.2 Working visit of FMBA of Russia and SRC IBPh representatives to the United States of America

The purpose of the working visit of FMBA of Russia specialists to the USA was like for the UK, to familiarize with the structure of radiation safety regulatory authorities, working principles and organization, with the nuclear industry operators in above countries in the process of their decommissioning, with the system of RW management and rehabilitation of radioactively contaminated territories.

Within the period of the visit to the USA, the Russian experts visited:

- **The US Department of Energy** – DOE;
- **Nuclear Regulatory Commission** – NRC;
- **Environmental Protection Agency** – EPA;
- **Industrial sites of** Idaho National Laboratory in Idaho Falls and Hanford in Richland where decommissioning of nuclear facilities and burial of radioactive wastes takes place.

During the visits to the above organizations, the parties discussed the pressing issues important for improvement of the regulatory system of SNF and RW management at STS in Andreeva Bay and Gremikha. A detailed report based on the results of the visit to the enterprises of nuclear industry and regulatory authorities of the USA, is provided as Appendix B.

Findings:

On organizational matters:

1. In the USA, financing in the sphere of radiation safety guaranteeing, decommissioning and dismantling of nuclear facilities and rehabilitation of contaminated territories is provided within the frames of long-term federal or specialized programs.
2. There is no single regulatory body in the USA responsible for regulation of the issues related to radiation safety guaranteeing. DOE is responsible for regulation in the sphere of the armament complex, NRC for regulation in the sphere of commercial use of atomic energy, and EPA for environmental protection issues.

All the above organizations apply common laws in their activity.

3. By CERCLA law, a national Superfund program (EPA responsibility) was adopted addressing the following aspects:
   - inventory of all contaminated territories has been carried out;
   - profound analysis of the levels and character of land contamination is being carried out, migration of contaminants and their hazardous effect is studied;
   - decontamination and rehabili-tation programs have been developed;
   - work methods and procedures are defined;
   - time terms are set (for a long-term perspective – 20 years and more);
   - monitoring of the work process and results of operations for rehabilitation of territories is carried out.
4. A very positive practice accepted in the USA in the sphere of environmental issues and rehabilitation of contaminated territories is the practice to conclude tri-lateral agreements between the Department of Energy (DOE), Environmental Protection Agency (EPA) and the government of the State where the facility in question is located.
5. Great attention is given in the USA to cooperative work with local authorities and the public (booklets, books, TV programs, excursions to facilities, etc.) with the following purposes:
   - to provide information on current and planned work, and the use of both for local residents, and for the country as a whole;
   - to minimize, by explanation, the negative reaction to above work on the part of some groups of population;
   - to ally with local authorities, governments of the State and the public in the sphere of financing operations on decontamination, remediation of territories and safety improvement (the hierarchy is as follows: Governor, Congressmen and Senators of the State, USA Congress and Senate, Admini-stration of the President, President).
6. The greatest problem consists in coordination between regulators using the procedure of discord settlement (including Court proceedings). By examination of all the key questions a final decision is to be reached.

On development and application of normative documents

7. The USA can use another country's practice and international recom-mendations only if they were given consideration for their applicability and positive result in specific conditions of the USA. Blind copying of international documents is never possible.
8. The process of reviewing the existing normative documents is very long (about 10 years) and includes the following stages:
   - development of initial (original) proposals;
   - development of a new draft document (new wording of the document) submitted for con-sideration and discussion by the public at public hearings, discussions with local government, free access Internet forums, etc.;
   - response and comments feed-back;
   - very important is the procedure of discord settlement between different agencies, government of a State and public organizations;
   - adoption of the document approved by all parties (the approval is given at the expert, not politician level).
9. If complete agreement is not reached, Court procedures can be applied.
10. Any alteration to existing radiation safety documents can be made only if proved (presumably by the organization proposing such alteration) that the above alteration to the accepted practice will really improve the radiation safety

situation. In this way, any suggestions (including recommendations of international organizations) can be declined if they do not bring any perceivable practical use.

11. The Federal Law allows temporary deviations from the norms and rules now in force for specific facilities (e.g. in Hanford, a Federal law has been accepted where such deviations are defined and the time limits set to reach compliance by each particular deviation issue (the time limits are long – the year 2028 and later).

12. The above practice is advisable for PA Mayak and in some parts -for other facilities.

13. When introducing new normative documents, a transitory period is set (up to 10 years), during which specific programs are carried out.

On practical regulatory issues:

14. Liquidation of decommissioned radiological facilities (such as research reactors) includes:

- removal of fuel from the core;
- removal of fuel from the cooling pond and moving it for storage to a centralized cooling pond or to dry storage facilities;
- dismantling of auxiliary systems;
- decontamination of buildings, detection of residual contami-nation left on the construction elements;
- taking down the buildings, transportation of debris to the burial sites (after triage by contamination grade);
- enclosing the remaining highly radioactive parts of the facility (reactor, steam generator, cooling pond, etc.) into a special structure with a suitable roof, named a "cocoon";
- the "cocoon" is located in enclosed territory with no access permitted;
- once every five year, the construction elements inside the "cocoon" are subject to inspection for their condition;
- liquidation of the "cocoon" is due in approximately 70 years.

15. Personnel exposure doses during operations on dismantling of equipment, pulling down buildings, one waste management only in rare cases exceed 500 mrem (5 mSv) with the existing dose limit keeping 5 rem (50 mSv) at DOE facilities in USA.

16. Well-defined classification and associated system of waste management deserve special attention. The types of waste are listed below in increasing radiation hazard order:

- contaminated soil and construction debris resulting from ruined buildings is buried at the enterprise industrial site in shallow land burials waterproofed from the bottom and top sides; requirements to the burials are set basing on the public dose rate limit not to be exceeded within a 1000 years period;
- low level radioactive waste not containing transuranium components is buried in metal barrels at the enterprise industrial site in similarly arranged burials;
- low level radioactive wastes produced during liquid radio-active waste treatment as a result of HRW separation, will be buried in vitrified form in shallow land burials at the enterprise industrial site;
- wastes containing transuranium components are packed in metal barrels and sent in transport containers to the WIPP deep burial site in the State of New Mexico;
- the high level radioactive wastes (including those produced during treatment of liquid radioactive waste stored in underground buried tanks) in vitrified form will be sent to the Yucca Mountain repository which is to be completed by 2017; until then they will be stored in the territory of the enterprise;

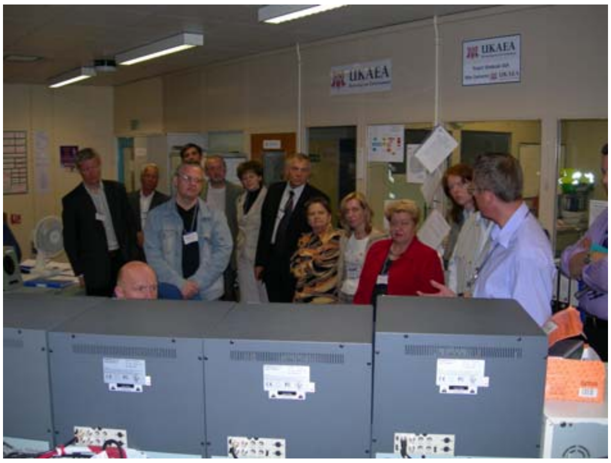
- plutonium (also in the form of unprocessed irradiated assemblies) is transported to the national plutonium storage facility where appropriate physical protection will be ensured.
- SNF is planned to be buried in the repository under development at Yucca Mountain, Nevada;
- mixed waste (radioactive matters and chemicals) are subject to the regulatory norms of the State and are stored (buried) at the site.

In Hanford, the biggest plant in the world for LRW treatment and vitrification is under construction.

17. The principles of remediation of territories:
    - critical zones where clean–up measures are of prime urgency and importance, are identified (river shores, water sources, the lenses of underground water moving towards the sources of drinking water, etc.)
    - decontamination is fulfilled in the direction from outside to inside, i.e. from less contaminated parts at the border of contaminated territory towards its center.
18. Difficulties and problems in the sphere of development and implementtation of the normative documents, decommissioning of nuclear facilities, remediation of contaminated territories in Russia and USA are similar in many ways, and thus, cooperation in this sphere is very useful.
19. In addition, regulatory cooperation in the sphere of chemical and biological safety guaranteeing would be useful.

Study trip to UK. Meeting between FMBA, IBPh, NRPA and Health and Safety Executive

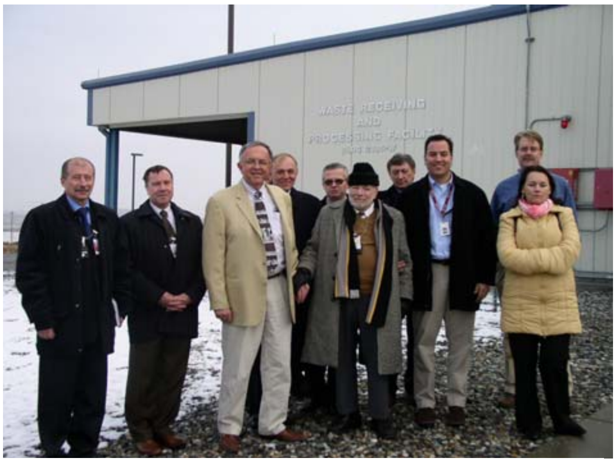
Study trip to UK. FMBA, IBPh and NRPA visit the UKAEA Windscale facility.



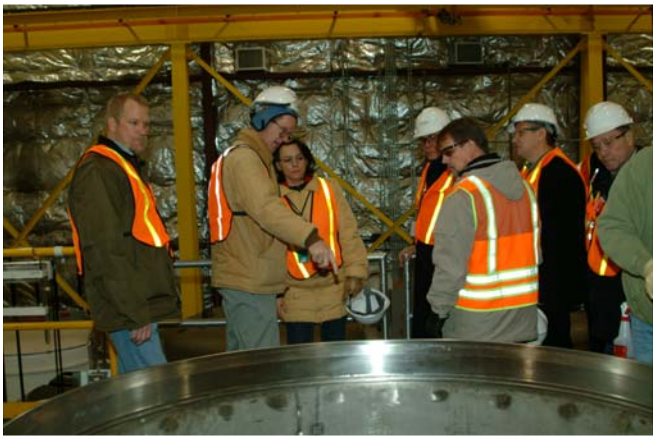
Study trip to UK. FMBA, IBPh and NRPA visit Dounray facility

Study trip to UK. FMBA, IBPh and NRPA visit the UKAEA, Windscale facility

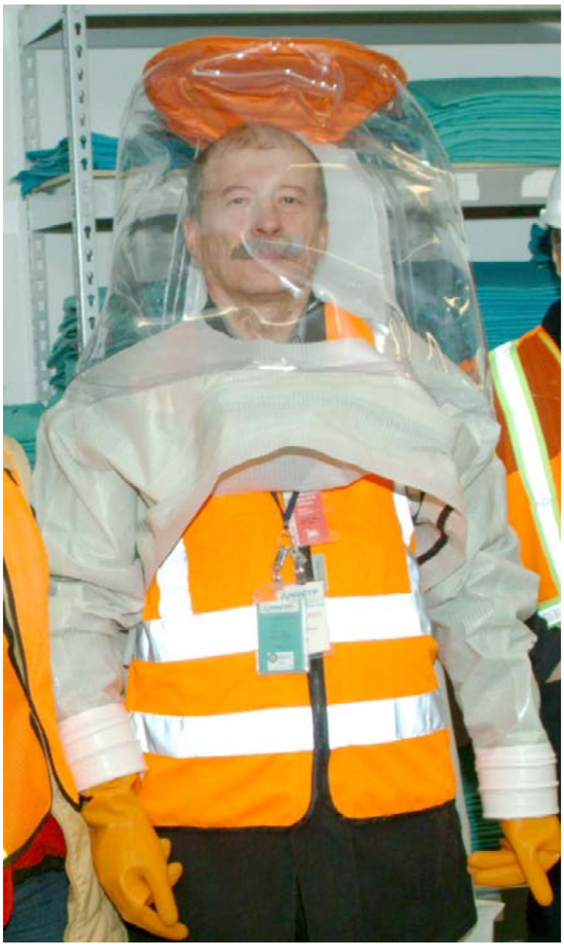
Study visit to USA. Meeting between FMBA, IBPh, NRPA and Environment Protection Agency.



Study visit to USA. FMBA, IBPh and NRPA visit radioactive waste treatment facility at Hanford National Laboratory, DOE.



Study visit to USA. FMBA, IBPh and NRPA visit radioactive waste management site (historical waste), Idahoo National Laboratory, DOE.



Study visit to USA. Demonstration of the personal protective equipment at Idahoo National Laboratory, DOE.

4 Discussion, New Developments and Conclusions

4.1 Perspectives for further NRPA-FMBA of Russia cooperation in the sphere of improvement of sanitary-hygienic supervision of radiation safety guaranteeing in Northwest Russia

The overall objective of the Projects covering NRPA regulatory support in the context of the Norwegian Plan of Actions is to ensure that the remediation work in Northwest Russia is carried out in compliance with the regulatory basis accepted in the Russian Federation, taking account of international rules and recommendations and also good practices in other countries in regulatory sphere to an extent applicable for conditions in Russian Federation. Moreover, such regulatory supervision must be efficient, so as to ensure timely and effective assistance in implementation of the industrial Projects.

The work fulfilled has helped to solve many problems calling for improvements in the sphere of radiation-hygienic supervision of the work carried out at the SevRAO enterprise, to reduce the radiological threat or settle threat related aspects. However, some urgent issues in this sphere still call for further investigation and resolution. To fulfill the above, NRPA and FMBA of Russia has agreed to continue the work on further development and improvement of the regulatory documents in the sphere of radiation safety guaranteeing. This work is carried in five directions.

Three of the work directions represent logical continuation of the Projects fulfilled within the framework of the Grants of 2005-2006, while the other two are dedicated to resolution of new issues. One of the new issues addresses the problems in management of the radioactive wastes accumulated and generated at SevRAO and containing man-made radionuclides with the levels of activity lower than LLW. The other new topic Project, Public Information is to provide the operators and public with information on the tasks that are carried out within the framework of the NRPA and FMBA of Russia cooperation. The objectives, principal research directions and the documents to be developed under all five Projects, are given below, and are due for completion in 2007.

4.2 Optimization of personnel radiation safety during the work on SNF management and RW treatment at SevRAO enterprises

Development of the guidance document "Hygienic requirements for personnel and public radiation safety guaranteeing in designing the work on SNF and RW management at FSUE SevRAO Branch No. 1" allowed the settlement of the regulatory aspects at the stage of designing the work process on SNF and RW management. However, the next work stage (development of infrastructure to support the work with SNF and RW and following operation of SNF management and RW treatment Complexes) requires new measures on optimization of personnel radiation safety to be developed. To address the above objective an appropriate Project was suggested.

The purpose of this Project is to develop and implement the regulatory documents as a normative-methodical base. These documents are to be implemented at the initial stage of optimization of personnel radiation safety during operation of the Complexes of SNF management and RW treatment.

Directions of study

- Analysis of the Project decisions with regards to principal process operations during SNF and RW management;
- Analysis of the Project decisions in relation to personnel radiation safety (organization of radiation control, use of individual and collective protective means, etc.);
- Study and analysis of the available radiation control systems and personal radiation monitoring equipment at SevRAO facilities;

- Study and analysis of the NRPA and SSI methodical approaches to optimization of personnel safety guaranteeing;
- Radiological aftereffects risk assessment for personnel;
- Development of particular measures on optimization of radiation safety of personnel.

The following documents will be prepared based on the results of the work:

1. Methodical guidance “Requirements to performance of personal radiation monitoring for personnel of FSUE SevRAO Branch No. 1;
2. Methodical document “Regulation for performance of radiation monitoring at FSUE SevRAO Branch No. 1;
3. Methodical guidance “Special features in application of the ALARA principle in the work on SNF and RW management at FSUE SevRAO Branch No. 1;
4. Scientific report of the Project.

4.3 Development of radio-ecological criteria for marine environmental monitoring and control in the course of STS rehabilitation

The given Project represents a logical continuation of the Project 2 just completed (in which rehabilitation criteria and norms have already been suggested). Implementation of this Project is associated with the development of the derived criteria for monitoring and control of the radioecological situation. The above activity will support FMBA of Russia’s regulatory decision-making in relation to the measures to be taken in the course of the work; if such work causes RW release to the marine environment in conflict with the environmental protection goals and objectives.

The purpose of this Project is to develop the derived criteria for monitoring and control of the radioecological situation in the course of renovation work, so as to help identify the most acceptable option of STS rehabilitation.

Directions of study:

- Analysis of regulatory aspects of environmental radiation safety guaranteeing and international recommendations on this point.
- Development of the data base format and sampling record, showing spatial and temporal distribution of radionuclides over the site. Expedition visit to Andreeva Bay and Gremikha.
- Development of the derived criteria for monitoring and control of the radio-ecological situation in the course of site rehabilitation activities.
- Development of draft methodical guidance documents “Radioecological monitoring on-site and in surveillance area in the course of conversion activities at STS of SevRAO.

The following documents will be developed based on the results of the work:

1. Methodical guidance “Radioecological monitoring on-site and in surveillance area in the course of conversion activities at STS of SevRAO.
2. Scientific report of the Project.

4.4 Development of operating and medical criteria for implementation of emergency plan of actions and use of emergency means of protection at SevRAO enterprises

As a result of former practices and changing conditions, some of the nuclear complex facilities or their parts, presently under SevRAO supervision, are now described as beyond normal regulatory practice conditions. Therefore a series of measures in order to bring the enterprises to typical normal practice is required. For example, in the course of work at the sites, emergency situations may develop, and it is necessary to develop preparedness measures in order to perform such range of activities as the emergency situation may require. Within the period 2005-2006, the Project “Improvement of medical and radiological aspects in emergency preparedness and response system at SevRAO facilities" was carried out by SCR IBPh experts with the assistance of NRPA specialists. One of the Project work outcomes was the increased level of emergency preparedness at SevRAO facilities in Andreeva Bay. At the same time, the need for developing for operating radiological and medical criteria for implementation of the emergency plan of actions at SevRAO enterprises and in use of most appropriate means of medical and radiological protection, was revealed.

The purpose of this Project is to develop the operating and medical criteria for initiating an emergency plan of actions and use of protective means at SevRAO facilities at an early and intermediate stage of emergency response. To accomplish these tasks we must identify the operating levels taking account of the total exposure dose levels and other logistical factors.

Directions of study:

- analysis of Russian and international approaches in evaluation of operating radiological and medical criteria at an early stage of emergency response;
- making a list of potential emergency situations and radiological parameters in case of emergency situation taking account of the available quantity of spent nuclear fuel and radioactive waste. Also taking account of their storage conditions and the actions planned to be undertaken at SevRAO facilities;
- modeling of measurement parameters obtained through the monitoring system available at SevRAO facilities, and identification of operating radiological criteria to ensure adequate emergency response in case of any potential emergency situation from the authorized list;
- development of operating radiological criteria in support of decision-making where concerns arise and early protective measures need to be taken in accordance with the authorized list of possible emergency situations at SevRAO facilities;
- development of the methodical possibilities of CMSU-120 and RM No.120 related to application of radiological and medical-sanitary criteria for urgent protective measures need to be applied to those affected by possible radiation accidents, by the following activities:
    - special instrumental medical monitoring;
    - decontamination and dressing of the contaminated wounds, making ready and sterilization of special expendable materials;
    - personal radiation monitoring of those exposed to external and internal radiation.

The following documents will be developed based on the results of the work:

1. Report "Analysis of Russian and international approaches in evaluation of operating radiological and medical criteria at an early stage of emergency response".
2. Guidance on application of radiological and medical criteria by MSU-120 and RM-120 emergency response teams as part of an emergency response system.
3. Final Report on the Project, containing reports covering each of the tasks and a report of the meetings held.

4.5 Radiation-hygienic requirements in management of the waste containing toxic substances and man-made radionuclides with a level of specific activity lower than LLW, at SevRAO enterprise

The industrial site No.1 (STS at Andreeva Bay) of FSUE SevRAO enterprise has become a site where significant amounts of RW and SNF have been accumulated. This situation arose in the course of operation and as a result of deviation from the technological process, in addition to non-standard and emergency situations. At present, a strategic plan is ready for removal of SNF for treatment and safe storage of RW. In implementation of the above plan it is supposed to place the HLW and ILW generated and accumulated at the sites as a result of former activity, in a specially arranged storage facility in slid rock. The LLW will be stored in storage facilities at the territory of the industrial site. It is planned that large amount of current waste with levels of activity lower than LLW (i.e. very low-level waste, VLLW), will be buried.

The purpose of the Project is to fulfill analysis of the present system of VLLW management at STS of Andreeva Bay and to develop the regulatory requirements for FMBA of Russia as regards supervision of radiation safety guaranteeing at SevRAO enterprise in management of the above, mentioned waste category.

Directions of study:

- Detailed identification of the waste types at the SevRAO enterprise in Andreeva Bay containing man-made radionuclides with a level of specific activity lower than LLW, in terms of the Russian legal-normative documents.
- Analysis of regulatory aspects of radiation safety guaranteeing in management of the low level radioactive waste containing radionuclides with the level of specific activity lower than LLW, however higher than the clearance levels of removal and release in countries with advanced nuclear power industry.
- Review of international approaches to the management of waste with very low level of specific activity.
- Development of sanitary-hygienic requirements for collecting, cate-gorizing, treating temporary storaging, transportation and burial of VLLW in the territory of the SevRAO enterprise at Andreeva Bay. Draft safety norms on VLLW management containing safety requirements for the period of operation of the facility and upon its closing, as well as the criteria of waste acceptability (admissibility) must be developed.
- Radiation-hygienic analysis of the situation at STS in Andreeva Bay for substantiation of the norms and criteria acceptable for VLLW management.
- Development of the Guidance “Radiation-hygienic requirements to VLLW management at STS in Andreeva Bay of FSUE SevRAO”.

The following documents will be developed based on the results of the work:

1. Reports “Analysis of Russian normative-methodical documents and international recommendations on VLLW management and assessments of their application at SevRAO facility in Andreeva Bay (taking account of review comments from western experts).
2. Report containing assessments providing characteristics of the facility in Andreeva Bay.
3. Draft guidance document on radiation-hygienic requirements to VLLW management at the SevRAO enterprise.
4. Final Report of the Project, containing reports covering each of the tasks and a report of the meetings held.

4.6 Russian-Norwegian cooperation on radiation safety in the Northwest Russia (public information brochure)

In parallel with the development of regulatory documents, we must note the importance of enhanced understanding of the significance of regulation of the remediation activities supported by western investors. The above is aimed to place a stronger emphasis on the important role of the regulatory bodies and their responsibilities. With this objective in mind, we consider advisable to develop, write and publish a popular brochure containing replies to the below simple questions:

- Where are the problems?
- Why they are addressed?
- Who is responsible?
- How the problems are solved?
- What conclusion can be made?

The material is mainly designated for the attention of regulatory and inspection bodies and for the staff involved in the process of disposal of spent nuclear fuel, radioactive waste and rehabilitation of the territories occupied by SevRAO facilities.

In order to solve the above problem it is advisable to fulfill an appropriate Project.

The purpose of this Project is to show the point and efficiency of joint FMBA of Russia - NRPA efforts in provision of control and supervision of the work on remediation of STS's in Andreeva Bay and Gremikha village, in order to raise the confidence on the part of state authorities to the level of experts' competence when dealing with the problem and to ensure, on this basis, that an unbiased assessment is made with regards to the importance of the work fulfilled.

Subjects for Brochure

1. Analysis of the conditions that preceded the occurrence of a source of potential radiation and nuclear hazard in Northwest Russia. This includes:
    - Extremely high pace of NS building in the 1960-ies and 1970-ies;
    - Treaty on the Non-proliferation of Nuclear Weapons calling for obligatory decommissioning of the nuclear submarines still containing nuclear fuel;
    - Lack of an infrastructure properly fit out to support efficient dismantling of NS, together with difficult economical situation in Russia;
    - Public concern that the environmental safety of the Kola Peninsula, European part of Russia and the countries of Northern Europe could be jeopardized.
2. SNF and RW management is one of key objectives in complex dismantling of NS and rehabilitation of radiation-hazardous facilities. This section includes:
    - General characteristics of SevRAO facilities in Andreeva Bay and Gremikha;
    - Unsatisfactory technical state of the STS's;
    - Spread of radioactive contami-nation on-site and into adjacent water areas;
    - Absence of the normative base which could be applied to the radiation situations that are not covered by existing regulatory norms and at the same time can not be classified as emergency situations.
3. Complex disposal of SNF and RW and ecological rehabilitation of radiation-hazardous SevRAO facilities is an overall objective that includes multiple work directions, objects and a range of technologies. Efficient resolution of the problem is possible only within international cooperation framework:
    - Significant interest to the problem not only in Russia but also in the countries adjacent to the Arctic region requires consolidation of material and intellectual resources;
    - The goal to reduce nuclear and radiation threat within the frames of international commitments on non-proliferation of nuclear materials and counteractions to international terrorism, as one of the priority directions in the Global Partnership;
    - Joint efforts of the countries-participants to resolve the environmental problems of the Northwest region;
    - Illustration of how Russian operators manage to improve the situation with the help of western investors, including Norwegian assistance. Importance of international industrial projects. However, any effort would be in vain unless an appropriate regulatory supervision was not carried out.
4. Norway is trying to find a common regulatory approach and cooperates with all organizations. The FMBA of Russia and SRC IBPh are NRPA's partners in the sphere of radiation safety:
    - Structure of interaction links between the MFA of Norway, NRPA, FMBA

of Russia, FSUE SevRAO and FSUE SRC IBPh;

- NRPA's role in realization of the Projects in Northwest Russia;
- FMBA OF Russia's role in the sphere of personnel and public radiation safety guaranteeing, and also in the system of emergency preparedness and response to various potential emergency situations. A brief report was provided taking "Mayak" and Chernobyl, as examples.

5. Strategy of cooperation includes the regulators' support to ensure efficient performance of the work in compliance with the Russian law and international recommendations.
6. Results of the work under the Projects:
   - Analysis of radiological situation on-site and in the water areas, including impact on personnel and contamination of the environment;
   - Evaluation of potential radiological threats and a set of measures to be taken to reduce them;
   - Ensuring radiation safety control over the work carried out at SevRAO facilities taking account of their specific conditions;
   - Medical-sanitary support to emergency response actions at SevRAO facilities;
   - Development of a set of regulatory documents on radiation safety guaranteeing as regards the range of activities carried out at SevRAO facilities;
   - Development of radiation-hygienic criteria and norms for rehabilitation of the territories occupied by SevRAO facilities;
   - A wider cooperation with western partners and Projects associated with NATO: brief review of the visits to the UK and USA.

In the course of the work under this Project, a brochure will be prepared for publication.

4.7 Basic conclusions to work completed by end 2006

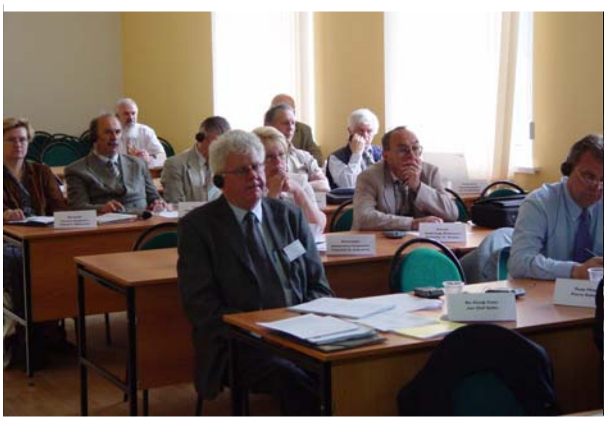
1. The analysis of the radiological threats existing at present time and possible in the course of the future work, allowed evaluation of the current situation from the point of view of FMBA of Russia's regulatory perspectives. It also allowed for selection of the prioritized directions requiring additional documents to be developed where concerns supervision and regulation aspects.
2. A series of expeditions visits carried out in 2005 and 2006 by SRC IBPh experts allowed to study the radiation-hygienic situation at the industrial sites, in SSZ and SA of STS of SNF and RW at Branch No.1 (Andreeva Bay) and Branch No.2 (Gremikha). The visits formed basis for development of the normative-methodical documents necessary for efficient and effective supervision on the part of FMBA of Russia, taking account of specific conditions of SNF and RW management at SevRAO. In the course of the work, the following was done:
   - Project 1 – criteria have been developed for improvement of radiation safety working conditions for personnel at the STS in Andreeva Bay;
   - Project 2 – norms and standards have been developed for regulatory guidance during remediation of the territory of STS in Andreeva Bay and STS in Gremikha in the course of main operations on removal of SNF and RW and upon their completion;
   - Project 3 – development of the regulatory aspects in planning of medical and sanitary activities management in the emergency situations of radiological character at SevRAO facilities.
3. As a result of the work under the Projects a regulatory guidance "Hygienic requirements for personnel and public radiation safety guaranteeing at the stage of designing the work with SNF and RW at FSUE SevRAO Branch No. 1 (R-GTP SevRAO-07) was developed and dRWn up.

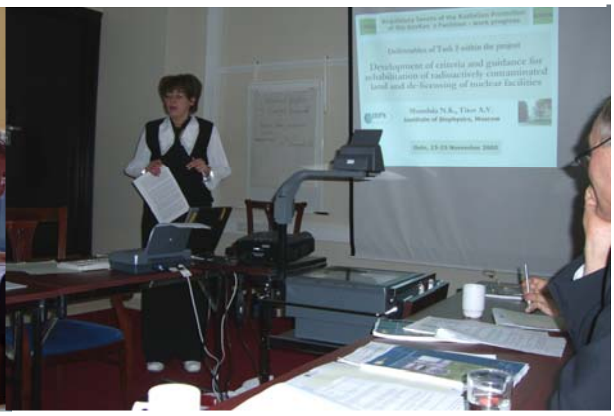
4. The working meetings arranged for FMBA of Russia specialists within the framework of the Project, through NATO Grant “Exchange of experience in the sphere of regulation to reduce the risks associated with operation of nuclear facilities”. Organization of technical support to the Project in the UK and USA, allowed to use the international practice in the development of the normative-methodical documents for improvement of sanitary-hygienic supervision at SevRAO.
5. The work fulfilled for development of the regulatory documents, training activities and working meetings with radiation protection specialists in the UK and USA. This allowed the identification of further steps in the improvement of supervisory functions of FMBA of Russia at SevRAO enterprise. The most important are the issues of optimization of the regulatory functions during construction and in further work on SNF removal and land remediation are the:
    a. management of the radioactive waste containing radionuclides with the level of activity lower than LLW,
    b. the development of optimization procedures as regards management of radioactively contaminated territories at STS in Andreeva Bay and Gremikha village.

It was decided that a public information brochure must be written and published covering the aspects of Russian-Norwegian cooperation in the sphere of radiation safety in the Northwest Russia.

Working meeting between NRPA, FMBA and IBPh in Moscow, Russia. November 2004.

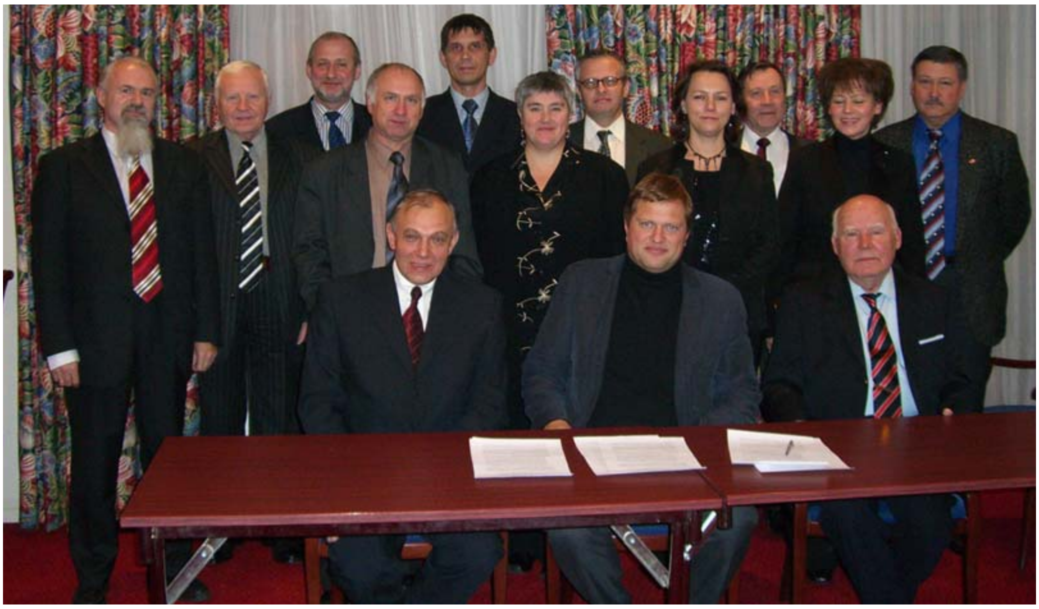
FMBA and IBPh visit KLDRA Himdalen in Norway. December 2005.





International workshop organised by NRPA, FMBA and IBPh in Moscow, June 2005.

Working meeting between NRPA, FMBA and IBPh in Oslo, Norway. December 2006 .



Annual workshop in Oslo, December 2006, between NRPA, FMBA and IBPh, From the left: Victor Rubtsov, Vladimir Yatsenko, Mikhail Savkin, Jurij Solovjev, Mikhail Kiselev, Valery Barchukov, Carol Robinson, Igor Gusev, Per Strand, Malgorzata Sneve, Oleg Kochetkov, Natalya Shandala, Leonid Iljin, Anatoly Simakov.

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6 List of abbreviations and acronyms

AMAD	Active Median Aerodynamic Diameter
ARMS	Automated Radiation Monitoring System
BDS	Block Dry Storage
Branch No.1 SevRAO	Site of temporary storage of SNF and RW at Andreeva Bay
Branch No.2 SevRAO	Site of temporary storage of SNF and RW in Gremikha village
CD and ES	Civil Defense and Emergency Situations
CERE	Complex Engineering-Radiation Examination
CH and E – 120	Center of Hygiene and Epidemiology - 120
CTF	Closed Territorial Formation
EDR	Exposure Dose Rate
EED	Equivalent Effective Dose
FMBA of Russia	Federal Medical-Biological Agency
FSUE	Federal State Unitary Enterprise
HLW	High Level radioactive Waste
HN	Hygienic Norms
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ILW	Intermediate Level radioactive Waste
LLW	Low level radioactive waste
LMC	Liquid-Metal Coolant
LRW	Liquid Radioactive Waste
MFA	Ministry of Foreign Affairs (of Norway)
MFS of Russia	Ministry for Emergency Situations
MNEPR	Multilateral Nuclear-Ecological Program in the Russian Federation
MSU-120	Medical-Sanitary Unit - 120
NII	Nuclear Installations Inspectorate
NPP	Nuclear Power Plant
NRB-99	Norms of Radiation Safety
NS	Nuclear Submarine
OBIN	Substantiation of investments
OSPORB-99	The main sanitary rules of Radiation safety guaranteeing
PAC_{pers}	Permissible Activity Concentration for personnel

PEK	Floating tank
PPE	Personal protective equipment
PRM	Personal Radiation Monitoring
RM FMBA of Russia	Regional Management FMBA of Russia
Rosatom	Atomic Energy Agency of the Russian Federation
Rostechnadzor	The Federal Service of Ecology, Technology and Nuclear Supervision
RS	Radiation Safety
RW	Radioactive waste
SA	Surveillance Area
SanPiN	Sanitary norms and rules
SevRAO	Northern Federal Enterprise for Handling Radioactive Waste
SNF	Spent nuclear fuel
SPORO-2002	The Sanitary Regulations for Handling Radioactive Waste
SRC IBPh	State Research Center Institute of Biophysics
SSZ	Sanitary Shielding Zone
STS	Site of Temporary Storage

Appendix A: Working Visit of FMBA of Russia and SRC IBPh Representatives to the United Kingdom with the Purpose to Familiarize with British Regulators' Activity in the Field of Radiation Safety

During the above visit to the United Kingdom the Russian experts visited:

- **Radiation Protection Department of the Health Protection Agency (HPA),** a governmental organization dealing with improvement of radiation safety and providing technical support to enterprises on financial basis;
- **Nuclear Installations Inspectorate (NII) - Health Safety Executive** – a nuclear and radiation safety regulation authority carrying out supervision over nuclear and radiation safety at the objects of nuclear industry and power engineering in the United Kingdom and issuing licences on sites;
- **Environment Agency (EA),** a regulator in the field of radioactive materials and radioactive waste management in England and Wales;
- **Scottish Environmental Protection Agency (SEPA),** a regulator in the field of radioactive materials and radioactive waste management in Scotland;

A number of enterprises of the **United Kingdom Atomic Energy Authority (UKAEA) and BNFL:** in Windscale and Sellafield, as well as at scientific-research site Dounreay where the decommissioning of reactors and radiation factories with their service life expired is ongoing, and the rehabilitation of the above sites is carried out.

Questions topical for the improvement of regulation system for SNF and RW management at STS in Andreeva Bay and Gremikha were raised during visits to the above organizations.

A1 Working Meeting with HPA Experts

In the HPA radiation protection department the experts of FMBA of Russia and the experts on radiation protection of HPA discussed the following issues.

- *Organization of supervision over guaranteeing radiation safety and medical servicing of personnel of the radiation-hazardous object, as well as the residents in the territory adjacent to the above object, medical-hygienic aspects of accompaniment of radiation-hazardous works at the enterprises of nuclear industry.*

In Russia these issues are in charge of the FMBA of Russia with its developed network of patient care institutions (medical-sanitary units), regional departments on sanitary-epidemiological supervision and regional centres for hygiene and epidemiology carrying out radiation-hygienic and laboratory researches.

There is not any special system for medical servicing of personnel of the radiation-hazardous objects in the United Kingdom. These functions are carried out within the public health service system. An independent subsystem of sanitary-epidemiological supervision over radiation safety of the personnel of the radiation-hazardous objects, the public and the environment is absent either. These functions as regards the personnel are carried out by the Nuclear Installations Inspectorate; and as for the environmental impact assessment and both the establishment of permissible releases and discharges and control of observance thereof, they are carried out by the EA and SEPA.

- *Advisability of integration of safety control during management of radioactive and other hazardous waste*.

In Russia the personnel (public) safety, as well as a condition of protection of the present and future generations against harmful impact of ionizing radiation and toxic agents are under subordination of the FMBA of Russia, an integral part of the general sanitary-epidemiological supervision system of Russia.

After the terrorist attack in the USA on the 11th of September 2001 the UK Government made a decision to combine all the issues concerning organization of human health protection in one department of HPA, combining subunits of HPA и NRPB. Its main functions are to submit the government information in the field of radiation and other impacts on the man, scientific researches in the sphere of safety and to issue recommendations on organization of protection against ionizing and non-ionizing radiation, chemical factor impacts, and etc. The HPA takes part in development of normative-legislative base in the sphere of safety at radioactive and other hazardous waste management.

- *Organization of Emergency response system and role of regulatory authorities in case of accident situations.*

In Russia the system for emergency response is presented by the Ministry for Emergency Situations (MChS of Russia), which has its branches in the regions. In case of an accident occurrence the MChS of Russia interacts with the Federal Atomic Energy Agency including the Situation-Crisis Centre and the Crisis Centre of Rosenergoatom Concern, which in their turn are connected with the emergency response services at the enterprises. As for the issues concerning medical help to the personnel and public, as well as radiation-hygienic monitoring in the accident area the MChS interacts with the FMBA of Russia. The FMBA of Russia, via its Centre for Emergency Response, coordinates activity of the medical institutions incorporated therein and located in the region of the accident. To liquidate the accident consequences a coordinating body is formed at the local level; the emergency response units of the local administration, health service institutions and police are involved therein.

In the United Kingdom the emergency response system links with the enterprise and local governments. Depending on an enterprise, where an accident happens, the relevant agencies are involved in its liquidation. The headquarters for liquidation of consequences include policemen, doctors, enterprise administration and authorities (the relevant infrastructures are involved depending on the accident scope). The HPA role in this case is to participate in recommendation- and decision-making by the national committee. The HPA experts give advices and work with the public. They also make sample researches with the purpose to get independent and more complete information about a state of affairs in the accident area.

- *Criteria of a territory contamination caused by accident situations*.

According to the Russian normative base (NRB-99) in case of an accident led to contamination of vast territory, an area of radiation accident is defined on the basis of monitoring and forecast of radiation situation. In the area of radiation accident the radiation monitoring is implemented and the measures on reducing of exposure levels for the public are taken on the basis of the following principles:

  - proposed interference must be of more benefit than harm for the society and, first of all, for the exposed persons, i.e. the decreasing of damage as a result of dose reducing must be sufficient to justify prejudice and cost of interference including its social price (interference validity principle);
  - form, scope and duration of interference must be optimized in such a way that the clear benefit from dose reducing, i.e. the benefit from reducing of radiation damage with the deduction of damage associated with interference, would be maximum (interference optimization principle).

The individual dose equal to and more than 30 mSv per month is an interference criterion for temporary settling out of the population. The individual dose of 10 mSv per month is the deadline for temporary settling out. If there is a forecast that the dose accumulated for one month would be beyond the above mentioned values during a year, then the decision on other permanent residence for the population should be made.

In the United Kingdom two periods are defined for radiation accident: an initial period when the dose rate is progressively reduced, and a period when the dose rate is stable at all times.

- *Approaches at rehabilitation of contaminated territories.*

Criteria for decision-making on the use of contaminated lands in Russia are as follows:

- the level of land contamination and indices of unfavourable impact on human health and the environment must not exceed the established standards;
- the total dose of public chronic exposure from all the regulated radiation practices must not exceed 1 mSv per year;
- the boundary dose for the public during operation of a separate source amounts ~ 0.01 mSv per year.

The reference appendix to NRB-99 specifies that the public protection in the territories undergone to radioactive contamination is carried out through interference on the basis of safety principles at interference. The following interference criteria are recommended at detection of local contaminations:

- research level – from 0.01 to 0.3 mSv/year, at which achievement it is required to implement research of the source to clarify a value of annual effective dose and to define a dose value to be reached in 70 years.
- interference level – more than 0.3 mSv/year. It is such a level of radiation impact, at which increasing it is required to take protective measures with the purpose to constrain exposure of the public. Scope and character of measures are determined taking due account of intensity of radiation impact on the public as per the value of anticipated collective dose for 70 years.

At rehabilitation in the United Kingdom the justification and optimization principles are guided with. The procedure of optimization must be put within the frames of dose constraints or risk as regards an individual in case of potential exposure in order to minimize possible influence of specified economic or social solutions.

Dose constraints at rehabilitation of territories are accepted at 0.3mSv/year level, with that the lethal risk is estimated at 10^{-5} $year^{-1}$ level. Dose constraints define the level, beyond which the measures on dose reducing almost always must be taken. The effective dose of 0.03mSv/year is accepted as an unconditionally reasonable one, at which the lethal risk amounts 10^{-6} $year^{-1}$.

The requirement to optimize protection is applied at all the levels of dose or risk and presents a continuous process. It means that the relevant authorities must periodically ask whether all reasonable measures are taken for dose reducing or not.

- *Possibilities of bio-dosimetry methods in reconstruction of an accident dose.*

At present both countries use single-type methods of bio-dosimetry (method of cyclic chromosomes, micro-nucleate method, fish method) with 0.1Gy sensitivity. It has been pointed to a potential for the mastering of gene activation method allowing to enhance sensitivity up to 0.01Gy.

However the ways of solution of the above issue in Russia and the United Kingdom differ. In Russia the implementation of these methods are in charge of laboratories of the regional Medical-sanitary units, and in the United Kingdom and European countries at present a system for rapid involvement of geneticists from the neighboring countries is formed for the effective use of bio-dosimetry. With that purpose each radiation geneticist has permanent contacts with the HPA co-ordination body and in case of an accident the above expert can be urgently called for at any time of the day.

* *Peculiarities of metabolism of radionuclides at intake thereof inside body.*

The Russian and British experts discussed the models of experiments with the animals and volunteers at study of radionuclide bio-kinetic mechanisms. The British scientists' significant success in development of estimation programs for metabolism of radionuclides at intake thereof inside the body, especially for trans-uranium radionuclides, has been noted.

A2 Visit to the Nuclear Installations Inspectorate HSE

In the HSE Nuclear Installations Inspectorate the experts of the FMBA of Russia and the experts of the Inspectorate discussed the following issues:

* *Organizational building of a system for the state supervision over nuclear and radiation safety.*

It has been mentioned that from the point of view of organization, purposes and objectives these systems in both countries have much in common. However, in Russia the inspection activity is more formalized by regulations, whereas in the United Kingdom the regulatory requirements have the general character (the ultimate goal, what should be achieved, is put for the operator, and the operator decides how to achieve it).

The routine of implementation of inspection functions is practically identical both in Russia and the United Kingdom. The inspector has great powers as regards access to the site, familiarization with working documentation, arrangement or implementation of measurements independent on the operator, imposing of administrative sanctions, including suspension of practical activity and initiation of judicial inquiries.

* *Activity of regulatory and inspecting bodies after termination of reactor operation.*

The Russian and British experts have underlined the significance of this issue at the modern stage of nuclear power engineering development in both countries. The reason is that the first reactors were commissioned in the 50s and now their service lives are expired. Today the topic problem is to decommission these reactors and to perform rehabilitation of the territories, where they were built. In Russia till now neither of the NPP units is finally dismantled, however already several units are in a condition of laying-up after the fuel has been removed from the core.

There are many aged reactors in the United Kingdom too; mainly, these are the gas-cooled reactors. From 1976 till 1989 14 such reactors were decommissioned. There are in total 28 reactors of the same type in the United Kingdom. A part of them is under operation, but the terms for decommissioning thereof are approaching.

The Nuclear Installations Inspectorate considers that the period of reactor decommissioning and its dismantling with the next rehabilitation of the territory is a specific period in the work with reactor and it requires special approaches.

Thus the experts of the Inspectorate consider that the regulatory strategy must comprise:

* strategic planning (decision-making, tryout of options and development of project);
* after reactor shutdown the operator must remove fuel during 25 years and choose decommissioning methods;
* documenting of measures in kind of decommissioning plans reflecting as well the issues concerning radiation safety, which may be corrected depending on conditions.

It seems very important and timely to take this progressive practice in the United Kingdom into account at development of regulatory normative methods for FSUE SevRAO.

* *Regulation of decommissioning of radiation-hazardous objects with uncertain conditions.*

In the course of discussion of the above problem it has been noted that at a number of enterprises, both in Russia and the United Kingdom, including as well the FSUE SevRAO, the non-standard or accident situations have happened, and during operation the technological processes have been changed in comparison with the design ones. If to take into account the insufficient volume of information on systems and equipment state, then one can conclude that the conditions forming uncertainty are available at the enterprise.

The experts of the Inspectorate consider that these conditions define the following character of activity:

- detailed analysis of possible options is made; the whole process is divided into technological stages, with that every stage must be safe;
- at development of every next stage the experience received at the previous stage must be taken into account;
- style of management must be of a command type;
- methods of work – selection of optimal algorithms in the course of preliminary exercises, for that all the technological operations are divided into groups with detailed description thereof and definition of critical points in every group;
- standards on territory rehabilitation must be practicable and acceptable; the choice of a “brown lawn” shall be made more often, but with that an unnecessary exposure must be excluded.

The main goal of regulation is the step-by-step reducing of the risk as an approach to the problem as a whole, even if the risks are increasing in certain situations. Thus it is necessary to rely more on the operator.

Russia has started to gain practice in “Regulation under conditions of uncertainty during decommissioning of the object” (there are two Sanitary rules approved; a guidance for SevRAO is at the stage of issuing), whereas the United Kingdom’s practice therein has a long history.

A3 Visit to the Environment Agency (EA)

In the Environment Agency the experts of the FMBA of Russia and the experts of the Agency discussed the following issues:

Basic principles of RW management.

At present the RW management policy both in Russia and the United Kingdom is practically similar. The researches being implemented in both countries have resulted in general conclusion that the safest method of RW burial is the placing thereof in deep geological formations.

The following is also common for both countries:

- an absence of assessment algorithms accepted by the developer of environmental impact assessment solutions;
- an absence of methods for analysis of scenarios and exposure ways (dose formation);
- an absence of methods for assessment of reliability of proposed models and obtained calculations;
- an absence of political solution concerning LLW storage at the place of its generation, because of its large volume and since its transport at greater distances will lead to propagation of contamination;
- an absence of political solution concerning advisability of conversion of the enterprises after decommissioning thereof in LLW storage facilities.

The general strategy of RW management in the United Kingdom is the thesis “to concentrate and to store”, and the following refers to the main principles:

- the operator must get permit on generation of waste till its start;
- principle of balancing; it means that the best decision is laid between the operator’s expenses and perfect condition of the nature;

at analysis of accident consequences one should consider that the impact on the environment is as important as on the man.

Organization of normative-legislative regulation.

In both countries the normative-methodical base is formed with due account of international organizations’ recommendations. However, Russia takes into account mainly the

IAEA recommendations, and the United Kingdom – the European Union ones. Inside the state, both in Russia and in the United Kingdom, three levels of regulations exist.

In Russia and the United Kingdom the first level includes the laws presenting a multilateral legal document and regulating a certain sphere of human activity or relations. However, some aspects of this activity can be omitted in the legal regulation or can require clarification. To fill these gaps in the laws the President's or RF Government's decrees are worked out. These normative-legal rules are mandatory for execution by all the juridical and natural persons in Russia.

In Russia the basic laws forming normative-legal base for SNF and RW management are: On the Use of Nuclear Energy No. 170-FZ dated from 21.11.1995, On the Public Radiation Safety No. 3-FZ dated from 30.03.1999, On the Sanitary-Epidemiological Well-being of the Public No. 52-FZ dated from 30.03.1999, "On the Production and Consumption Waste" No. 89- FZ dated from 24.06.1998 and On the Protection of the Environment dated from 10.01.2002.

In the United Kingdom two groups of laws stipulate SNF and RW management: protection of the man and control over radioactive substances. The first direction, protection of the man, comprises the following laws: On the Protection of Labour and Health, Act on the Nuclear Facilities specifying basic requirements for personnel safety and requirements for nuclear facilities licensing, Act on the Emergency Preparedness and Informing the Public, Medical Exposure specifying recommended levels of medical exposure and Exposure Practice stipulating routine of handling with orphan sources, sources having latent activity, sealed, non-identified sources, including latent accidents. The second direction, control over radioactive substances, comprises: Act on the Radioactive Substances defining routine of storage and use of radioactive substances, including radioactive waste; Act on the Transportation of Radioactive Substances, which is close to the corresponding IAEA document, law On the Environmental Protection with the incorporated principle about importance to regulate impact both on the environment and on man.

The next (second) level of normative-legal regulation in Russia is norms and rules being developed by Rostekhnadzor, Rospotrebnadzor and FMBA of Russia, MChS of Russia, with focus on the sanitary norms and rules from the point of view of protecting human. They are as follows: SP 2.6.1.758-99 Norms of Radiation Safety (NRB-99), SP 2.6.1.799-99 Basic Sanitary Rules of Radiation Safety Guaranteeing (OSPORB-99), SP 2.6.1.61168-02 Sanitary Rules of Radioactive Waste Management (SPORO-2002), SanPiN 2.6.1.07.03 Hygienic Requirements for Designing of Enterprises and Facilities of Nuclear Industry (SPP PUAP-03).

Mainly the documents of the above level are aimed at normative regulation. They are developed on the basis of the RF laws and mandatory for execution by all the juridical and natural persons in Russia.

In the United Kingdom, as well as in Russia, the licensing is a basis for the second regulation level. However, unlike Russia, the normative base is presented by the main requirements stated in the document "Conditions for Realization of Licence". Here the main requirements to radiation safety are stated, necessary for implementation at obtaining a licence. These conditions are similar for each enterprise dealing with radioactive substances.

To enhance supervision efficiency at the radiation-hazardous object during performance of concrete technological cycles and operations the FMBA of Russia and Rostekhnadzor develop methodological recommendations and handbooks for their subordinated divisions, which are not obligatory for operator. However, the above documents (the documents of the third level) being guidelines for supervision at the radiation-hazardous object, stimulate the operator to take thereof into account at organization of radiation safety at the enterprise.

In the United Kingdom, as well as in Russia, the regulatory authorities develop necessary regulations and methodological documents (the documents of the third level), which allow the enterprise effectively to realize the requirements of the first and second levels. Handbook "Principles of Safety Assessment" is an example of such a document in the United Kingdom.

RW classification.

As for the issues concerning RW classification, the United Kingdom and Russia have common approaches. So, both countries use classification of waste as per its level of specific activity: low-level radioactive waste (LLW), intermediate-level radioactive waste (ILW) and high-level radioactive waste (HLW). In the United Kingdom the forth group of waste – very low-level radioactive waste (VLLW) – is defined. However, the forming principles of classification differ.

In particular, in Russia the strict regulated approach to division into groups is applied, every group has concrete levels of activity. Except for division by activity, waste in this classification is also divided by character of radionuclides contained therein: beta-emitting radionuclides, alpha-emitting radionuclides and trans-uranium radionuclides, which differ from each other within the frames of one group of activity. For instance, RW with less than 10^3 kBq/kg specific activity refers to LLW group with beta-emitting radionuclides, RW with less than 10^2 kBq/kg specific activity refers to LLW group with alpha-emitting radionuclides, and RW with less than 10^1 kBq/kg specific activity refers to LLW group with trans-uranium radionuclides.

In the United Kingdom alongside with activity level and radionuclide composition in RW classification an attempt is made to take due account of decay time too. Thus, LLW group includes RW, which contains alpha-emitting radionuclides with the specific activity less than $4*10^3$ kBq/kg or beta-emitting radionuclides with the specific activity less than $12 *10^3$ kBq/kg. The intermediate-level radioactive waste is the next group. Group of high-level radioactive waste includes RW able to extract heat, for which removal it is necessary to create special devices. As a rule, at NPP it is SNF.

Criteria forming group of waste with very low-level activity (VLLW):

There are some differences in management of this category of waste between the United Kingdom and Russia. In the United Kingdom the group of RW with very low levels of activity is defined (VLLW). As a rule, this group includes such waste as ground and construction waste. Availability of trans-uranium elements and α-irradiators in this waste must be not more than 0.4 kBq/kg by the specific activity level, and the specific activity of β- irradiators can be from 0.4 kBq/kg to 40 kBq/kg for the enterprises of civil industry and from 0.4 kBq/kg to 10 kBq/kg for the units and institutions of the Defence Ministry.

In Russia a category of RW with very low level of activity is not defined, however the normative document (OSPORB-99) specifies a category of waste corresponding to VLLW. It consists of two subgroups. It is an industrial waste containing radionuclides of restricted use and a waste, which use in the economy is not expedient by economic, ecological or social reasons. It has boundary values of the specific activity by beta-emitting radionuclides from 0.3 to 100 kBq/kg, by alpha-emitting radionuclides - from 0.3 to 10 kBq/kg, by trans-uranium radionuclides – from 0.3 to 1 kBq/kg. Waste of the first subgroup, which can be used in the economy, must meet the following requirements:

- availability of a state sanitary-epidemiological supervisory body's conclusion on certain kind of its use;
- mandatory radiation monitoring;
- absence of non-fixed radioactive contamination.

However, in practice the issues concerning management of such waste, in particular, arrangement of testing grounds for its burial, requirements for radiation monitoring system, as well as methods for calculation of ground radiation capacity depending on hydro-geological features of a district, presence of population therein, and etc., have not yet tried out.

In Russia the waste, irrespective of radionuclide type, with the specific activity till 0.3 kBq/kg is exempted from control. This waste can be used in the economy without any additional requirements to radiation safety. Routine of management thereof is regulated by degree of its toxicity after sanitary-epidemiological conclusion.

A4 Visit to the Scottish Environmental Protection Agency (SEPA)

In the Scottish Environmental Protection Agency (SEPA) the experts of the FMBA of Russia and the experts of the Agency discussed the following issues:

Peculiarities of organization of radiation safety regulation in Scotland.

The SEPA, as well as the EA, was founded in 1995 in accordance with the Law On the Environmental Protection dated from 1995. Its mission is to protect the environment not only against release of radioactive substances, but, as a whole, against all the factors in air, water and ground, as well as vehicles polluting the environment, including radioactive substances. At present the SEPA pays great attention to the decommissioning of nuclear industry enterprises. The SEPA is an integral part of the EA, and its activity covers Scotland.

At management of radioactive substances and RW the EA acts within the frameworks of the European agreements, and the SEPA being an integral part of the EA executes these decisions.

The SEPA and EA have the following in common:

- unified scientific base;
- unified regulations;
- joint work with the HPA and Agency for nutrition;
- unified documents on ILW management at sites;
- unified memorandum on distribution of functions with the Nuclear Installations Inspectorate;
- joint participation in the group on development of political decisions on RW management;
- joint participation in audit and development of political decision on LLW management;
- joint participation in development of political decision on HLW management.

Despite of these similarities the SEPA and EA have a number of distinctions:

- try-out of radioactive substances management strategy takes into account the specific character of Scotland (less population; sources of drinks are mainly the lakes, and etc.);
- peculiarities of the Scottish legislation, a fiscal one by its organization, i.e. the case assessment and its investigation are obligatory;
- the environment is a subject of the Scotland Parliament's control, and the Parliament gives instructions on activity in this direction;

SEPA basic functions:

- control of implementation of the basic standards on radiation safety and regulation of radioactive substances transportation in vehicles;
- mandatory execution of the Scotland Government's directives;
- development of handbooks and methodological instructions; in particular, the handbook on biota protection has been elaborated, the handbook on releases and activity in the contaminated territories is under development.

Trends of the use of territories of the British nuclear industry enterprises' sites after decommissioning thereof.

Principles of solution of the above aspects are similar in both countries. After determination of contamination level one of three decisions can be made:

- laying-up of the territory (the protective area is created, and radiation monitoring is carried out);
- restricted use of the territory (radiation examination and rehabilitation measures with subsequent radiation monitoring);
- unrestricted use of the territory (as a rule, after rehabilitation and subsequent radiation examination a decision on exemption from control and next use of the territory for the economy or settlement is made).

At present this problem is topical for SevRAO enterprise. At both sites of this enterprise (Andreeva Bay and Gremikha settlement) the activities on reconstruction of infrastructure allowing for safe performance of work with SNF, are ongoing. In other words, at this stage the rehabilitation of the sites should be fulfilled till the levels allowing to guarantee safe performance of work by personnel. In future the Andreeva Bay and Gremikha sites can be brought to the restricted use level, with removal of low- and intermediate-level radioactive waste outside, or can be laid-up after building of RW storage facilities in these territories until the moment when a political decision on RW management and creation of conditions for burial of this RW in compliance with the above decision, will be made.

In this respect, the experience of similar work being performed in the United Kingdom is very important. Activities on decommissioning of a number of the British nuclear industry enterprises in Dounreay, Chapelcross and Handrace are the examples. These sites are in different stages of decommissioning by scope of the performed work.

In particular, the Handrace site is at stage 1 of decommissioning. The long-term plan of reactors decommissioning till 2090 was developed; it is corrected every 5 years. A plan of concrete actions for every year is developed on the basis of the above plan. For the plan a schedule is dRWn up, and control over actions is carried out according thereto. Since the strategy determines transfer from a greater hazard to a smaller one, therefore at first the fuel is unloaded, the storage facility for waste is built and then the reactor and, after it, buildings are dismantled. Activities on decommissioning have been started since 1995. After implementation of thorough CERE /complex engineering-radiation examination/ all the auxiliary buildings, except for the reactor building, will be demolished. Storage facility will be built for low- and intermediate-level radioactive waste, where the waste will be stored till making a decision on construction of a repository for burial. After RSb removal the territory will be designed as a landscape, and a decision on its further use will be made.

There are 3 reactors at the Dounreay site: one of them is with liquid metal coolant; fuel production and reprocessing factory. The last batch of fuel was delivered here for reprocessing in 1995. Since that time the decision on site decommissioning has been made and no fuel has been delivered.

To control the site decommissioning the NDA was founded, which developed a number of strategies and the decommissioning plan. The operator, taking into account the RS studies implemented by SEPA, and on the basis of ALARA principle must choose the most optimal strategy.

A5 Visit to the industrial sites in Windscale and Sellafield

During the visits to the industrial sites in Windscale and Sellafield **(UKAEA and BNFL),** where a number of enterprises of the British nuclear industry is under decommissioning, the concrete aspects of radiation safety regulation in this period of enterprise activity were discussed:

An example of making a decision on reactor decommissioning with complete rehabilitation of the territory up to the level of agricultural activity.

At present the Government of the United Kingdom establishes an organization dealing with decommissioning of the enterprises with expired service life. 6 sites of the nuclear industry are under its subordination. Activity on decommissioning of almost a half of research reactors is ongoing. Program on decommissioning of gas-cooled reactors is realized. With that, the level of rehabilitation of every site is defined by social importance thereof. For instance, the oldest site near Oxford was decontaminated till the background values, since school was located nearby and the residents demanded its complete rehabilitation.

Personnel dose burden during performance of work on gas-*cooled reactor decommissioning.*

Practical activities on reactor decommissioning were started in 1998. Fuel has been unloaded since that time, and it is planned to remove the reactor by 2007. Its disassembling is performed by means of oxygen-propane cutting. The dose rate reaches 60-90 μSv/h. The generated waste, mainly low- and intermediate-level radioactive wastes, is collected in concrete boxes and placed in the storage facility. At present there are 122 concrete boxes with LLW and 113 boxes with ILW. As for HLW, it was only SNF. Completion of decommissioning is planned by 2012. 60 workers and 40 experts perform this work. Control over radiation state and asbestos concentration is carried out. Other chemical factors are not followed.

A6 Visit to the industrial site in Dounreay

During the visit to the industrial site in Dounreay **(UKAEA),** where at present a number of enterprises of the British nuclear industry is under decommissioning and in future the whole site will be rehabilitated, the following aspects were discussed:

Organization of management of LLW being generated during reactor decommissioning.

Dounreay is a scientific-research site erected in 1955. Today there are 3 reactors (2 research reactors and 1 commercial reactor) at the site. At present at one of the reactors the disassembling of the boiler is performed, at the second one - the reprocessing of liquid sodium, which was used as a coolant (it is the only reactor with LMC in the UK). The third reactor is shutdown.

HLW at the Dounreay site is generated only from SNF, which is transported from the site just after its unloading from the reactor. ILW is generated, as a rule, at dismantling of equipment and reactor installation walls. The other waste is LLW.

The produced LRW is concentrated in the special shop and then cemented and placed in concrete containers in the erected storage facility, where other ILW is also placed in concrete containers. Historically, LLW was stored in concrete trenches, but at present it is placed in containers and stored in the storage facility. Waste containing trans-uranium elements with the specific activity more than 0.4 Bq/g is stored in the separate storage facility.

Control over waste is carried out as follows:

- taking due account of its origin;
- take samples on radionuclide composition, with that radiochemical studies are made on waste source;
- measure dose rate of γ-radiation;
- use method of neutron irradiation of packed waste for definition of availability of trans-uranium elements in waste;
- do an X-ray of barrels with waste packed therein to control their filling-in.

Control over impact on the environment is carried out according to the plan specially developed. For the above purposes the intake of samples from air, sea water and 10 wells, ground, as well as samples of algae and fauna representatives is carried out with the periodicity specified in the plan.

Problem regarding “hot particles” detected in the coastal zone and at the site in Dounreay.

“Hot particles” are the micro-particles of fuel or metal uranium or plutonium formed in the process of scientific researches in the 60s, when the technologies of management of ionizing radiation sources were imperfect. Particles were formed at machining of metal plutonium, when the irradiated material was treated. Then the above particles got in the drainage systems and were dump in the sea through the drainage pipe. “Hot particles” were also formed at incident with the breeder at the stage of refueling.

The first particle was found on the seacoast in 1983. The most high-level activity particle with 10^8 Bq/particle was detected in the sea, the last one with $4*10^5$ Bq – on the seacoast in May 2006. Usually activity of particles range within 10^3-10^5 Bq. The total number of detected “hot particles” amounts 1200 pieces. At present monitoring for these particles both in the sea and on the coast is carried out.

Appendix B: Working Visit of FMBA of Russia and SRC/IBPh Representatives to the USA with the Purpose to Familiarize with US Regulators' Activity in the Field of Radiation Safety

During the above visit to the USA the Russian experts visited:

- US Department of Energy – DOE;
- Nuclear Regulatory Commission – NRC;
- Environmental Protection Agency – EPA;

Industrial sites in the Idaho National Laboratory, Idaho Falls town, and in Hanford, Richland town, where the decommissioning of nuclear objects and the burial of radioactive waste are carried out.

The aspects topical for improvement of SNF and RW management regulation system at STS in Andreeva Bay and Gremikha were discussed during visits to the above organizations.

B1 Visit to the U.S. Department of Energy – DOE

DOE was founded to overcome the energy crisis of the 70s. Alongside with various functions concerning energy the DOE is engaged in development and production of nuclear weapon, fulfills control functions at the subordinated sites. After termination of the "cold war" the DOE deals with rehabilitation of contaminated objects.

The following issues were discussed in DOE:

Structure and mission of DOE.

The American experts (Christine Gelles – Director, Office of Disposal Operations, Office of Environmental Management, Karen Guevara – Director, Office of Compliance, Douglas Tonkay – Office of Disposal Operations) presented how radiation safety regulation is organized in the USA. Three Federal Agencies are in charge of this direction. With that, the duties are divided in the following way:

DOE	as a monopolist, is responsible for military aspects of nuclear energy application;
NRC	an independent agency, is responsible for regulation in the field of commercial use of nuclear energy and management of certain radioactive materials;
EPA	establishes standards unified for the USA on radiation and chemical impacts, as well as requirements for RW storage facilities; solves issues concerning storage of high-level activity waste in deep formations; establishes standards on pollution of water resources; directly interacts with the state governments and develops recommendations.

DOE is a self-regulating organization having no branch regulators at the level of states.

DOE, in its activity, leans on the following laws:

1) Atomic Energy Act – DOE was founded in accordance therewith. The purpose was to divide the civil and military objects.

2) Laws regulating different aspects of management of radioactive and toxic chemical waste:

- NEPA (National Environmental Policy Act) – adopted in 1969;
- RCRA (Resource Conservation and Recovery Act) - adopted in 1976;
- TSCA (Toxic Substances Control Act) - adopted in 1976;
- CERCLA (Comprehensive Environmental Response, Compensation, and

Liability Act) - adopted in 1980, it is known as well as the Superfund;

- FFC Act (Federal Facility Compliance Act) - adopted in 1992.

Classes of waste and routine of management thereof are stated in DOE Order 435.1 from 1999. The DOE and NRC regulatory requirements for RW slightly differ. For high-level activity waste the requirements are close to the IAEA ones.

The strictest requirements are stated for waste containing over 3,700 Bq of alpha-emitting trans-uranium elements per gram. The above waste must be buried in deep formations without any opportunity to be removed.

Low-level radioactive waste is buried at the site of its generation in shallow-land storage facilities, if there is such an opportunity. If not, it is transported to Hanford or Nevada, where three commercial storage facilities are available.

It is planned to store high-level radioactive waste in the Yucca Mountain repository in Nevada (to be commissioned in 2017).

Since 1990 the USA has not been engaged in SNF reprocessing.

DOE budget is 28 billion dollars a year.

DOE program in the field of radiation protection.

DOE, in its activity in radiation protection organization, applies the international recommendations, President's Decree dated from 1987, DOE Order 5480.11, 1988 and Federal Regulation 10 CFR 835, 1993, amended in 1998. At present the transition to more modern ICRP recommendations is ongoing.

The main elements of radiation protection programs are: use of ALARA principle, dose limitation, monitoring, access control, installation of radiation warning labels and signs.

Organization of monitoring system.

DOE has gained historical data concerning personnel doses at 14 DOE basic sites (4 million records). Information about doses from different DOE sites is submitted in unified format to the DOE Headquarters, as well to the NRC – for comprehensive accounting of individual doses, since an employee can work in the organizations of various subordination in different years of his/her professional activity. Information about radiation situation at DOE enterprises (dose burden, amount of generated radioactive waste of different classes) is annually published in form of reports.

Rehabilitation of territories.

Peculiarities of work on decontamination and rehabilitation are as follows: a lack of information on the objects being decontaminated and rehabilitated; since these objects are old, there is a need in involvement of experienced employees, who can remember something about the above objects. That's why the step-by-step analysis of work safety and the planning are applied.

At dismantling and decontamination it is necessary to remove the existing physical barriers at the given object, thus the analysis how it affects safety of works being performed is required. There is often a need in creation of new safety systems and in construction of new protective structures.

Definition of work priorities – what is to be done in different terms – is one of the aspects of planning:

- in the nearest term;
- in the longer term;
- in the distant future.

At the beginning of work it is necessary to be reassured of an absence of degradation of constructions earlier erected.

Monitoring of the environment is carried out by the services of DOE and states.

At planning of work on rehabilitation of contaminated territories the rehabilitation criteria (the stage of a "green or brown lawn", and etc.) are set up by the EPA, the state governments (the standards of certain states on pollution of the environment are stricter than the federal ones), DOE, NRC. Then the process of development of coordinated decision follows. Sometimes the final decision is made in court.

At present the comprehensive results of epidemiological surveys in the field of radiation safety are available, while the data in the field of chemical safety, especially under simultaneous impact of several factors, is not enough.

The criterion of efficiency of radiation protection of the environment used in the USA is as follows: if the man is protected, then the nature is protected too.

B2 Visit to the Nuclear Regulatory Commission (NRC)

The U.S. Nuclear Regulatory Commission (NRC) is an independent agency formed on the basis of the Act on reorganization in power engineering dated from 1974 to regulate civil (but not military) use of nuclear material. The NRC is managed by the Commission of five members.

Emergency response aspects

The level of emergency measures is established in advance, and the accident liquidation plans are dRWn up. In case of an excess of the above level the administration of enterprise informs the state government and NRC, who define their actions. NRC gives only recommendations to the state governments and follows implementation of required measures. Calculation of dose burdens is made by means of computer program RASCAL (Radiological Assessment System for Consequence Analysis).

Criterion for population settling out of the accident area is the forecast to get 1 rad per 4 days by critical group (including dose from external gamma-radiation of radioactive cloud, from gamma-radiation of precipitates and inhalations of radioactive gases and aerosols).

Emergency exercises are permanently conducted at the enterprises. The state governments are informed about a loss of a radioactive source, and special units of state carry out the search thereof with possible involvement of the public. The public is instructed on their behaviour in case of detection of suspicious articles. The DOE has means (even airplanes) for searching the lost sources too.

NRC standards on radiation protection and interrelation of NRC with other U.S. agencies and international organizations.

All the NRC documents in the sphere of dose standards (even substantiation thereof) are widely available for the public. NRC contacts with DOE in the field of standards development. The IAEA recommendations are used as the reference materials. The basic document for the development of NRC standards is the Federal document, Part 20 – Standards for protection against radiation. The NRC itself approves its standards after wide discussion, including with DOE. The DOE has its own documents, practically the same ones.

The established dose limits are:

- Annual dose for personnel:
  - 0.5 Sv – dose for separate organs or tissues;
  - 0.5 Sv – for skin;
  - 0.15 Sv - for lens;

for persons till 18 years old – 10% from the limit for adults.

- For pregnant women: 5 mSv during pregnancy. The woman must tell about her pregnancy so that the measures on dose restriction can be taken.
- Public exposure:
  - 1 mSv – for effective dose equivalent;
  - the effective dose equivalent is limited by the value of 0.1 mSv from release in the air during regular operation.

For unlimited use of the territory after licence termination (decommissioning or use in the mode of a “green lawn”) the limit of 0.25 mSv is established; in addition the ALARA principle must be applied to reduce dose burdens.

Zoning of the sites:

- radioactive area – 0.05 mSv per hour from external exposure;
- area of high radiation – 1 mSv per hour from external exposure;

- area of very high radiation – 5 Gy per hour;
- area of polluted air – concentration over 1 DC or 12 DC -hours per week.

Requirements to personal monitoring for staff (external exposure):

- individual dosimeter is used, if a probability of 10%-excess of dose limit for staff from external exposure exists;
- if the predicted dose is over 1 mSv – for pregnant women;
- if the predicted dose for minors is over 1 mSv for absorbed equivalent dose or 1 % from other limits.

Requirements to personal monitoring for staff (internal exposure):

- in case of exceed of 10 % from annual limit;
- over 1 mSv of anticipated effective dose for minors;
- over 1 mSv for pregnant women during pregnancy.

Requirements to monitoring for the public are not established. Control over radioactive releases and discharges is required.

Issues concerning regulation at decommissioning of nuclear objects.

No requirement concerning aspects of decommissioning has been stipulated in the enterprise projects. In the projects of new power reactors such issues must be envisaged.

B3 Visit to the Environmental Protection Agency (EPA)

EPA is the only U.S. agency charged with protecting human health and safeguarding the environment.

EPA realizes the national policy in the field of scientific and research activity, education, protection and assessment of the environmental condition. EPA develops and enforces the following rules: it works over creation and implementation of provisions reflected in the laws as regards the environmental protection and put into effect by the Congress. EPA is in charge of review and adoption of national standards for different programs concerning the environment, and it sends its representatives responsible for access, monitoring and elimination of contradictions to the states and reservations (tribes). EPA is entitled to impose sanctions, when national standards are not met, and to take other measures to help states and tribes in achievement of desirable conditions of the environment.

In the laboratories located across the country the Agency makes assessment of the environmental situation and defines, comprehends and solves current and forthcoming tasks concerning the environment; consolidates works of scientific partners, such as the state organizations and the organizations belonged to the private sector, the academy of sciences and other agencies; presides in issues associated with emergency events in the environment, as well as carries out planning in development of science and know-how in the field of risk evaluation and control.

EPA programs of radiation protection.

EPA develops norms on exposure restriction, evaluates radiation impact on human, informs the public about the results of its studies. The most part of all the projects on radiological risk evaluation is carried out in EPA. EPA issues its works in kind of reports.

EPA conducts monitoring of ambient dose rate in the environment, analyzes samples of air and water collected all over the country.

EPA carries out control over the RW repository being under construction in Yucca Mountain, Nevada (to be commissioned in 2017), the active deep burial of waste containing trans-uranium elements in New Mexico, as well as the low-level radioactive waste storage facilities.

The EPA Superfund's policy and recommend-dations as regards radiation.

CERCLA (THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPEN-SATION, AND LIABILITY ACT, or Superfund) is devoted to the full-scale response to ecological problems, indemnities and liabilities. There are about 1.5 thousand contaminated sites in the USA, at which the work within the Superfund frames is performed; about 70 of them are contaminated with radioactive substances and others are polluted with chemical ones. In the process of remediation work the EPA takes part in development of feasibility study and formalization of decision.

Opinions of the local governments and residents are obligatory taken into account at decision-making on cleaning.

The general standards of EPA on admissible content of radionuclides in the environment are as follows:

- for radium and thorium – 0.185 Bq/g;
- for content of radon in buildings – 0.02 working levels of radon-220 and -222 decay daughter products;
- emission of radon in open air - 20 pCi/m^2-s;
- low-level radioactive wastes are those creating 0.25 mSv/year dose for body, 0.75 mSv/year for thyroid gland and 0.25 mSv/year for any critical organ, except for thyroid (these standards differ from the NRC standards for decommissioning – 0.25 mSv/year and 1 mSv/year correspondingly);
- stricter standards may act in certain states.

Standards concerning drinking water:

- 0.185 Bq/l – for combination of radium-226 and -228;
- 0.04 mSv/year from beta-particles and photon sources - on body or any of internals;
- 0.555 Bq/l as per total activity of alpha-particles (without radon and uranium);
- 30 mkg of uranium per liter;
- 1.11 Bq/l for content of uranium -234 and -238 in subsoil waters;

Stricter standards may act in certain states.

B4 Visit to the Idaho National Laboratory – INL

INL was founded in 1949 as a laboratory for testing of nuclear reactors. It is situated in south-east of the Idaho desert at the site of 890 square miles. For many years the INL has been considered as the enterprise with the greatest number of nuclear reactors in the world. 52 nuclear reactors were built there.

Radiological problems at decommissioning and demolishing of radiation objects.

Radiological problems connected with decommissioning require flexibility from all the executors of the given program. The Laboratory has gained large experience in work with RW.

Main radiological problems:

- control over contamination of surfaces;
- control over and reducing of contamination of air environment;
- observance of ALARA principle (dose control);
- waste control;
- convincing of workers of safety of planned works;
- planning of future works.

The ways to solve radiological problems:

- Personnel must comprehend problems being solved outside the work performance area.
- Comprehension is the main part of solution.
- It is necessary to spend more time on work planning than on its performance.
- Work program must be adapted for the real conditions.
- It is necessary to analyze radiological data on permanent basis and enter changes in the work program.
- Documenting of zero radioactivity is as important as of high levels of radioactivity.

- Development of standard methods of control over different working machinery in accordance with the risks it creates.

Planning and performance of radiological works:

- Proper organization of work is the most important thing.
- Employees are the experienced experts, who have been worked within the project frames for many years.
- All the works must be performed in a safe manner.
- Keeping of doses at as low as reasonably achievable level (ALARA).
- Control over doses and keeping of individual and collective doses at low level are the priority goals.

It is necessary to use modern monitoring systems; control over air pollution is the most difficult aspect. It is necessary to make analysis of benefit-harm: not to allow doses, if an operation gives no benefit.

Radiological control at dismantling of equipment, systems and constructions.

There is a need in combined systems for control over air and surfaces. Dust suppression must be carried out by means of wetting of polluted surfaces. One has to put up with the negative side - slippery floors because of damp dirt and presence of oil.

Control system must be adapted to the concrete conditions.

It is important to pay attention to the pipes before destruction of the system, whether they contain residual activity or not. Leaktight boxes (including gloveboxes) and ventilation systems must be used.

After removal of pipes, equipment and construction waste the surfaces should be prepared for demolishing.

The above preparation includes:

- application of fixing coats for preparation of contaminated surfaces for demolishing;
- removal of equipment and systems;
- cleaning and washing with vacuum cleaner
- use of coloured indication for surfaces with different level of contamination.

Control over the use of heavy equipment to demolish buildings.

Building structures should be demolished in their less contaminated sections to reduce formation of radioactive dust. Constant wetting should be done.

Discussion of the project concerning accelerated reprocessing of radioactive waste. Radiological problems.

The main sites on management of accumulated RW were shown. The following operations are performed there: removal of RW from aged underground storage facilities, examination, non-destructive analysis of the contents, opening of containers, repacking, shipping thereof for burial.

Site for accelerated removal of waste.

The shallow-land storage facility, where a large number of barrels with radioactive waste placed there more than 40 years ago is planned to be removed and sorted, is topped with a big structure in kind of a tent with two-layer walls. The first layer (an internal tent) is designated for protection against contamination; in case of significant contamination thereof it can be blown off. The second layer (an external tent) prevents release of radioactive substances in the environment.

Active SNF storage pond.

It is the only SNF storage pond remained in INL and functioning since 1984. Till nowadays it is loaded with SNF from the active Upgraded Research Reactor and the fuel from the decommissioned aged storage ponds (except for fault assemblies). Group on criticality prevention controls fuel criticality.

At present the work on removal of fuel from the above pond and transfer thereof in the dry storage facility is ongoing. The packages with SNF are removed, inspected on contamination (admissible 1,000 decays/(cm^2·min)) and transported in a big vehicle to the dry storage facility. The exposure dose for staff in the storage facility at 100 % employment thereof does not exceed 300 mrem/year (3 mSv/year).

The storage facility has a very good system for water purification with application of ion-exchange resins, and the water in the pond is of drinking quality. Water pH is 5.5-6, temperature is 75 F (at a lower water temperature the air temperature will be too low and uncomfortable for personnel).

The buffer area that must be always pure is defined around the work performance area.

Chambers for decontamination with application of decontaminating agents and steam are available for the case of package seal failure. No such cases have taken place during operation of the storage.

To perform work dealing with possible radioactive contamination the staff puts on additional second overalls (disposable or decontaminated ones), shoe covers, gloves. To protect breathing organs they use respirators with panoramic mask, filter, supercharger (directly in filter), accumulator separately connected with cable.

High-level radioactive waste storage facilities.

Since 1952 (till the 90s) the INL had reprocessed fuel of commercial reactors (250 types of assemblies), led to high-level radioactive waste generation. In the 1990s the SNF reprocessing was stopped, since it was impossible to provide air contamination standards at the existing factories. High-level radioactive waste in bulk and granulated solid form is stored in the towers of a silage type. Delivery of waste to the new Yucca Mountain repository will start in 2020.

SNF storage pond being decommissioned.

The SNF storage pond now being under decommissioning was built in 1953, and in 1993 the whole fuel was transferred to the new storage facility. The work on dismantling of equipment and building is ongoing. The dose rate is several hundreds mR/hour. Air contamination is within permissible limits; it is measured with portable devices and air samplers in the breath zone. Internal exposure for personnel is controlled by means of PRS /personal radiation spectrometry/ (Cs-137, Sr-90) and bio-tests.

The ventilation system in the building is very imperfect: ventilation is available only at the places of fuel storage.

Low-level radioactive waste storage facility.

The storage facility was built in 2003 according to the CERCLA. Close interrelations are carried out with the state governments and EPA. Various low-level radioactive wastes (including mixed ones) are accepted for storage; it is required to get special permit for burial of waste of higher level every time.

The solid waste storage facility occupies 65 acres; staff is 45 employees.

Its depth is 35 foots, the wet seal is 14 layers of PVC-film on glue basis of 30 cm total thickness. Waste enters in containers of different types; if container is incomplete, concrete is added therein. Dose rate from the container till 750 mR/hour is mainly defined by Cs-137.

Pond-evaporator was built for liquid waste. Bottom is 3 foots of gravel, then – similar glue layer of PVS-film.

As a rule, PPE is unnecessary at work performance.

The storage has the safe fence to protect the territory against animals, the pond-evaporator is not protected against birds.

Wells in the territory are designated for control over contamination of surface and subsoil waters.

It is planned that filling-in of the above storage facility will be carried out till 2012. Storage term is 1,000 years.

At each site the DOE has scientific groups engaged, for instance, in studying of radionuclides transfer in the air, aerosols dispersity, migration in surface and subsoil waters. These studies have been already conducted for 40-60 years.

Computer modeling programs are developed and widely used in the USA. Mainly, they are developed in Oak Ridge.

Temporary storage of aged waste removed from ground.

The storage facility is a large hangar from the goffered metal. It was built above the place of shallow-land burial of the 1950s waste in steel barrels. All the barrels were removed and at present they are stored in this hangar.

Personnel in the storage facility carry out control over leaktightness of barrels and decontamination of outside surface, puts bar-codes and performs loading in trucks for sending the waste for resorting thereof.

If a barrel is leaked, it is additionally packed in a barrel of a larger size.

Policy of management of trans-uranium waste has been change eventually:

1950-70 – waste in barrels was dug into the ground;

1970-84 – waste was stored in barrels in stacks;

1984-90 – waste was stored on the roofed asphalted platforms.

At present the burial for trans-uranium waste has been built in the state of New Mexico.

B5 Visit to the factory in Hanford

DOE performs work at the Hanford site with involvement of the following prime contractors:

AdvanceMed Hanford (AMH) carries out a series of work on professional health care;

Bechtel National, Inc (BNI) carries out designing, construction and commissioning of a Factory on waste management designated for vitrification of the waste stored in tanks at the Hanford site;

CH2M HILL Hanford Group, Inc. (CH2M HILL) carries out storage, characterization and recovery of waste in underground tanks;

Fluor Hanford, Inc. (FH) is the principal contractor on nuclear legacy treatment;

Pacific Northwest National Laboratory (PNNL) carries out researches in the environmental and know-how sphere;

Washington Closure Hanford LLC (WCH) is in charge of prevention from toxic substances discharge in the river, clearing of contaminated ground, subsoil waters and non-active nuclear enterprises.

The Federal government purchased the Hanford site in 1943. Its area amounts 1,517 square kilometers in south-east part of the state of Washington. The Hanford site was chose for the realization of atomic project in 1943, because it presented a sparsely populated and droughty area (annual amount of precipitation is within 6 inches – 150 mm), with enough water resources (the deep river Colombia), sufficient power supply, railways.

At present 150-160 thousand people live in the 30-mile area. Monitoring stations are located in the area within 60 miles from the industrial site.

The enterprises are grouped at the following nine main sites:

Site 100	Sites of nine decommissioned reactors for plutonium production located along the Colombia river.
Sites 200 (the eastern and western ones)	Total area of the sites is near 50 sq. miles (145 sq. kilometers). Laboratory objects, characterization of waste, tanks for LRW storage, recovery of the environment.
Site 300	Former fuel production factory - it was decommissioned; sealed research reactor.
Site 400	Nuclear research breeder and auxiliary installations.
Site 600	Other objects.
Site 700	Administration building in Richland (Federal building).
Industrial centre Richland	Enterprises providing site's activity (i.e. warehouses and transport agencies).
Site 3000	Buildings of the Battelle Institute (Pacific Northwest National Laboratory).

General information on the site; regulation of activity at the site. Management of radioactive *waste and spent fuel. Decontamination of the site.*

As a result of long activity the territory of the site of 100 sq. miles (259 sq. kilometers) area has been contaminated with radioactive substances. Since in the first years the low-level radioactive waste was directly dumped in the Colombia river, the subsoil waters has been contaminated. Liquid radioactive waste was dumped in the settler. As nothing had been done to prevent release of volatile radioactive and chemically toxic substances, they released outside the site (carbon tetrachloride, mercury, tritium).

High-level radioactive waste (53 mln. gallons) is stored in the subsurface tanks of 1 ml. gallons.

At present no industrial activity is carried out at the site: all the objects were decommissioned; only operations on decontamination or laying-up of the objects and territory are performed.

Activity on decontamination of the territory and various objects at the Hanford site is regulated by the trilateral agreement between the DOE, EPA and Washington state government.

Decontamination at the Hanford site is performed by two units: one unit carries out decontamination of the ground, other one – decontamination of tanks.

There are 25 mln. cubic foots of low-level radioactive waste buried in 175 trenches, 1,700 places with radioactive contamination, 500 contaminated buildings at the site.

There is mixed (radioactive + chemical) waste too. In accordance with the CERCLA the storage facility for mixed waste was built. Ponds hold about 2,000 capsules containing Cs-137 and Sr-90, 130 MCi in total. Cesium capsules are planned to be delivered for commercial use, for that it will be necessary to repack them.

The project River corridor on the cleaning of the territory along the Colombia river is ongoing. Dismantling of auxiliary systems and demolishing of auxiliary buildings near the shutdown reactors are carried out within the frameworks of the above project. The reactors are wrapped in "cocoons" - special buildings with new roofs. By present time 5 of 9 reactors have been wrapped in "cocoons", 3 reactors are to be wrapped in "cocoons", and one reactor (the first one, reactor B, at the site) is planned to become a museum. Every five years an inspection of building structures will be conducted inside the "cocoon".

The works on prevention of contaminated subsoil waters discharge in the Colombia river are performed. It is realizable as here the grounds are characterized with low migration of radionuclides. The applied methods for limitation of migration of underground contaminated lens are chemical barriers. Purification of subsoil waters in those points, where contamination spots are available, is applied too. Water purified till the drinking water standard is again dumped in the ground. Thus, 2 billion gallons of subsoil waters were purified.

A large quantity of spent fuel is stored at the site. As a result of long-term storage of fuel in the cooling ponds the rods have been corroded and it has led to contamination of water in the aged ponds and accumulation of radioactive scrap on the bottom of the ponds. The most part of fuel was removed from the ponds and placed for dry storage. Shipment of this fuel for burial to the Yucca Mountain repository (the state of Nevada) being under construction is planned. Reprocessing of irradiated fuel is prohibited in the USA (except for the fuel from navy reactors).

By present time 350 of 1,700 contaminated places have been decontaminated, with that 6.5 mln. tons of contaminated grounds have been buried. One of the complicated problems is a lack (loss) of information on where and what low-level radioactive waste was buried.

Work on identification, separation and repacking of radioactive waste is ongoing: the "real" waste containing trans-uranium elements is packed and shipped for burial to the state of New Mexico, the remaining low-level radioactive waste is packed and buried at the Hanford site.

A new factory on reprocessing and vitrification of liquid radioactive waste in under construction at the site. Completion of construction thereof is planned by 2018, cost is 12 billion dollars. Vitrified high-level radioactive waste will be sent to the Yucca Mountain repository (the state of Nevada) being now under construction. Vitrified low-level radioactive waste will be buried at the Hanford site. Trans-uranium waste will be sent to the repository in the state of New Mexico. Operations on radioactive waste vitrification have not been earlier performed at the Hanford site.

According to the current legislation the RW character is defined not by its activity, but by its origin. There is the agreement with the NRC stating that, if high-level radioactive waste is removed from the waste, then the remaining waste can be considered as low-level radioactive one.

Extraction of LRW from the tanks is a very complicated problem: since liquid was pumped out of the aged tanks with monolayer walls in order to prevent leakage, the remaining sediment became hardened. It is necessary to use robots to remove it. As agreed with the state it is necessary to remove no less than 99 % of waste from every tank, i.e. less than an inch of sediment layer would be remained on the bottom. To close empty tanks it necessary to meet a series of requirements. At present a draft of the document stipulating that the empty tanks and pipes can be left in situ, covered with ground and topped with waterproof layer to decrease water inflow, is under development.

Radiological problems during dismantling of auxiliary systems and buildings and wrapping of nuclear reactors in "cocoon".

Earlier it was enough just to burn a building in order to demolish it. Now it is necessary to disassemble it. One of the problems arising at disassembling of building is a need in protection against beryllium and asbestos used in structures. DOE uses strict standards on beryllium content that is close to its natural one. That is why it is necessary to apply special protective measures. Building can be preliminary washed, but this method is inefficient. Or surface contamination can be fixed with epoxy films. Finally the method of covering the surfaces with polymeric films by means of fire hydrants was chose, then – mechanical demolishing of structures; thus no spreading of dust in the environment takes place. Wetting is constantly used for dust suppression. But the cheapest way is to leave everything as it is, namely what is done in most questionable cases.

As for the decontamination of the territories, the state government plays leading role therein.

Visit to the decommissioned site designated for uranium production.

Industrial rooms were decommissioned and laid-up. Preparation for dismantling of equipment and demolishing of buildings is ongoing.

Visit to the site for operations with low-level radioactive waste containers.

Temporary storage of containers containing RW of low-level activity, such as ground, construction waste and etc., is carried out at the site.

Visit to the enterprise for packing of trans-uranium waste (Waste Receiving and Processing Facility).

The goal is: to resort the aged waste, define the waste containing trans-uranium elements and send it for burial to New Mexico.

The aged waste removed from the ground is delivered in barrels. The most part of waste is garbage and unfit PPE. X-ray and neutron-activation analysis of contents in the barrels, suction of gases, repacking in new barrels and loading thereof in containers for transportation are carried out.

Repacking of waste is made in gloveboxes. At this site personnel perform work in special overalls as a prevention measure, at other sites – in usual clothes. Every glovebox is equipped with dry and water fire-fighting systems. Measures against pricks through gloves during waste sorting are: thorough X-ray analysis of barrel contents, use of special types of gloves (including those made of kevlar). In the given shop no plutonium pricks took place, but in the PFP – they were.

Control of internal exposure of personnel (urine sampling, PRS /personal radiation spectrometry/) is carried out by the Pacific Northwest National Laboratory (PNNL). Constant monitoring of alpha-activity of the air is implemented. Monitoring of neutron radiation is implemented only for delivered barrels.

Control of radiation safety is carried out by an expert from DOE. Except for the above, according to the current agreements the inspection of the state is entitled to conduct unexpected checks without any advance notification.

Actually personnel obtain the annual exposure doses of no more than 500 mrad (5 mSv/year) at the dose limit of 5 rem/year (50 mSv/year). To decrease exposure the ALARA methods are applied: gamma-radiation dosimeter with electronic chip on breast, ring dosimeters on fingers, monthly analysis of actually obtained doses, additional protection measures, if necessary.

Job-permit is issued by the radiological group independent on the enterprise administration and looked through by the work performance group. Each employee makes a record "read and understood" in the job-permit. Expenses on safety guaranteeing refer to obligatory payments. 2 billion dollars from the annual budget of 6.9 bln. dollars are assigned for utility service payments, 1 billion dollars – for safety ones.

Visit to the site for extraction of chromium compounds from subsoil horizons.

Contamination of subsoil waters with chromium compounds has been caused by discharge of solutions containing chromium (for example, in kind of bichromate) used for decontamination of equipment. The goal is not to admit inflow of subsoil waters contaminated with chromium in the Colombia river, since it would lead to poisoning of places for salmon spawning. Pumping out of subsoil waters and purification thereof by means of ion-exchange resins are ongoing.

Visit to the site for burial of low-level radioactive waste (ground, construction waste from the demolished objects, and etc.)

All the works are performed in accordance with the trilateral agreement between the DOE, EPA and state governments.

At present there are 6.5 million tons of waste at the site; the planned capacity is 25 million tons. Regulation of activity is carried out according to the CERCLA, the DOE orders and standards; representatives of the EPA are the members of project management team.

Waste is delivered in big containers in trucks through the transshipping site. In the process of unloading the wetting of waste surface layer and covering it with special mixture (water, ashes, cement, polyester fibre) are carried out. Location of every waste batch is registered by the satellite navigation system.

Wet seal systems: the bottom is 3 foots of clay, a layer of plastic (polythene of high density), 1 foot of gravel, a layer of plastic. On top – 2 foots of clay, a layer of plastic, 3 foots of fertile ground, grass.

There are the testing ground for mixed waste and the repository for burial of vitrified waste.

Visit to the shop for pressing of RW barrels.

Remote opening of barrels with waste and sorting thereof with application of manipulators are performed. Observance of the process is carried out both directly through protective window and by means of TV cameras.

RW reprocessing factory being under construction.

The factory after its construction completion in 2018 will be the largest one on reprocessing of liquid radioactive waste. Cost of factory construction is 12 billion dollars. Operations on extraction of high-level active component from the LRW being stored in the enterprise territory will be performed at the factory. Low-level radioactive waste generated at LRW reprocessing as a result of extraction of high-level radioactive waste, in vitrified form will be buried in the shallow-land storage facilities at the enterprise site. High-level radioactive waste in vitrified form will be sent to the Yucca Mountain repository for burial after 2020. Temporarily the high-level radioactive waste will be stored at the enterprise territory.

Site for storage of single-compartment units of nuclear submarines (115 units).

The site is a foundation pit of near 300 m width, till 1 km length and about 30 m depth. 115 units are located therein at present.

Disposal of nuclear submarines is carried out at the shipyard in Seattle. Single-compartment units (with mass from 850 to 1,200 tons) are loaded on board the barge and transported to Hanford by sea and the Colombia river. Then the units are reloaded in trailer (350 wheels) and delivered to the site. Stacking of units in the foundation pit is performed on concrete rails with the help of wire ropes.

All the single-compartment units will be permanently stored at the given site.

B6 Meeting with the representatives of DOE, the state and EPA

The themes discussed at the meeting are: practice of conclusion of trilateral agreements between the DOE, EPA and state governments, work experience of the U.S. regulators. According to the CERCLA all the agencies (including the Defence Ministry) are obliged to conclude a trilateral agreement (parties: agency, EPA, state governments). The trilateral agreement, first of all, establishes a procedure for making a decision met the requirements of all three parties. Issues concerning know-how and outcomes of concrete work performance are stated in other documents within the frameworks of Superfund program carried out by EPA. The Law of the state on natural resources care is aimed at the same goals. The trilateral agreement gives an opportunity to reach the public's trust. The public takes part in the development of trilateral agreement and control over its realization; there is a steering committee elected by the residents in the state of Washington (in the state of Idaho – by analogue).

The DOE, EPA and state governments jointly define priorities in rehabilitation of the territories, after that the DOE submits the Congress the offers on amount of funding of the above work. The most difficult thing in definition of a strategy of work is to solve till what level it is necessary to decontaminate the territory at the enterprise site, since the decreasing of risk can be made by different means. The practice of work at the Hanford site has shown the priority of operations on cleaning of the Colombia river shore: collection of waste, removal of contaminated ground and storage (burial) thereof inside the site far from the river. Decontamination work is performed from the outside to the inside.

The Hanford site significantly differs from other contaminated territories in the Superfund list. The Federal Law was adopted for Hanford. The program of work was defined by the trilateral agreement. Three parties defined critical tasks. The DOE plays the main role: namely, DOE develops a concrete program of works. If the EPA does not agree with this program or its certain provisions, the procedure for settlement of disputes at various levels, up to the upper one, comes into force. According to the Federal Law the EPA makes a final decision.

The federal agencies must perform decontamination works maximum fast; but in practice the limiting factor is an amount of funding. The state cannot finance the works on decontamination at the enterprise site, since it is a federal property. The state governments can influence on an amount of funding allocated in the federal budget for the next year through negotiations and consultations with the congressmen, as well as through requirements to the terms of performance of planned works. It is important that the demand to increase the funding of works would be set up by all three parties. The public has enough possibilities to influence on the program of works on territory decontamination. There is also the federal program of the cleaning of the territories.

Statens strålevern
Norwegian Radiation Protection Authority

StrålevernRapport 2007:1
Virksomhetsplan 2007

StrålevernRapport 2007:2
Representative doser i Helse Øst. Representative doser for røntgendiagnostikk rapportert fra virksomheter i Helse Øst høsten 2006

StrålevernRapport 2007:3
Radioecological consequences of a potential accident during transport of radioactive materials along the Norwegian coastline

StrålevernRapport 2007:4
Measuring radon levels at high exposures with alpha-track detectors. Calibration and analysis

StrålevernRapport 2007:5
Upgrading the Regulatory Framework of the Russian Federation for the Safe Decommissioning and Disposal of Radioisotope Thermoelectric Generators

StrålevernRapport 2007:6
Stråledose til screena kvinner iMammografiprogrammet i 2005 og 2006

StrålevernRapport 2007:7
Implementation of the Obligations of the Convention on Nuclear Safety in Norway

StrålevernRapport 2007:8
Årsrapport fra persondosimetritjenesten ved Statens strålevern 2006

StrålevernRapport 2007:9
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StrålevernRapport 2007:10
Radioactivity in the Marine Environment 2005. Results from the Norwegian Marine Monitoring Programme (RAME)

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